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THE NEOGENE FLORA AT SOŚNICA NEAR WROCŁAW IN THE LIGHT OF GEOLOGICAL, AND PALYNOLOGICAL INVESTIGATIONS

Neogeńska flora z Sośnicy koło Wrocławia w świetle badań geologicznych i palinologicznych

ABSTRACT

The results of geological and palynological investigations of the sediments at Sośnica near Wrocław are presented. As appears from geological research, the Sośnica clayey sediments, containing pollen of plants, belong to the upper part of Poznań series, to the variegated-clays horizon. The investigated area is situated in the southern, border region of the sedimentation basin of the Poznań clay series: as a result, the clay has evolved in a somewhat different manner here.

The analysis of the pollen composition revealed the presence of mesophytic forest of a temperately warm climate.

The results of geological investigations, and the correlation of the pollen diagram from Sośnica with the Upper-Miocene and Pliocene diagrams from SW Poland lead the authors to conclude that the fossil flora of Sośnica is of the Pliocene age.

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INTRODUCTION

Sośnica is situated about 18 km west of Wrocław (Fig. 1). Towards the middle of the nineteenth century H. Goeppert found a fossil flora here and described (1855) 139 species of plants, vascular for the most part, preserved in the form of leaves, seeds, and fruits. For a long time Sośnica was considered the classical locality of Neogene foliaceous flora. However, both Goeppert's contemporaries and later researches differed in their

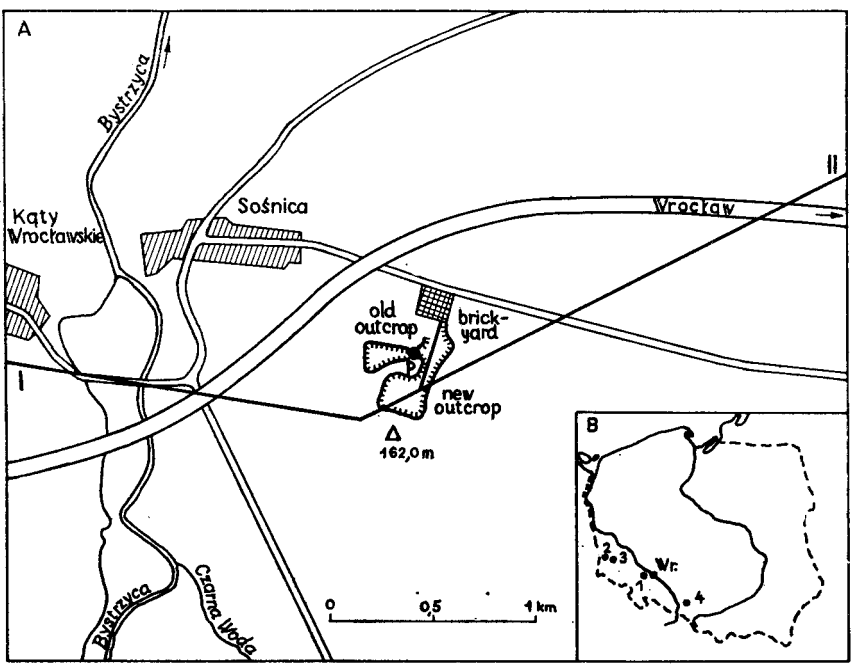

Fig. 1. A. Distribution of exposures of young Tertiary sediments near Sośnica. I—II — situation of geological cross-section in the region of the Sośnica brick-kiln (cf. Fig. 2), P — site where samples were taken for pollen analysis; B. Localities of Upper Miocene and Pliocene localities in South-Western Poland selected for comparison and studied by means of pollen analysis: 1 — Sośnica, 2 — Gozdnica, 3 — Ruszów, 4 — Stare Gliwice

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views as to a more exact estimate of the age of this particular flora. In order to establish as accurately as possible the stratigraphic position of the Sośnica sediments, as well as to reconstruct the picture of vegetation and climate during their sedimentation period, new palaeobotanical and geological investigations were undertaken (1967—1972). The present report is limited to the presentation of the results of palynological and geological investigations. Palaeobotanical investigations on macroscopic remains are still in progress.

Palynological material collected in 1967 was derived from an outcrop situated approximately 100 m east of the site from which Goeppert presumably took his material.

The geological investigations were carried out by S. Dyjor, the palynological research by A. Stachurska and A. Sadowska.

AN OUTLINE OF THE GEOLOGICAL STRUCTURE OF THE INVESTIGATED AREA

Geologists concerned with the neighbourhood of Wrocław have tended to differ as to the exact stratigraphic position of the deposits in the Sośnica brick-kiln. The relation of these sediments to the Tertiary coal-bearing formation of Lower Silesia was also unknown. It was therefore thought advisable to give an outline of the geological structure of the areas adjoining Sośnica on the basis of recent research carried out in South-Western Poland (Stachurska et al. 1967, Dyjor, 1968, 1970, Oberc, Dyjor 1969, Stachurska et al. 1971).

The young Tertiary formation of the neighbourhood of Sośnica and Wrocław differs somewhat in its petrographic composition and the evolution of its sediments from the young Tertiary coal-bearing formation of the Central-European Lowland. In the vicinity of Wrocław the disappearance of brown-coal beds and the typically shaped clayey deposits known as Poznań clay is observed. On the other hand, sediments richer in thick-detritic material, intercalated with beds of green and blue clay appear. These petrographic traits and the absence of uninterrupted brown-coal beds, led Michael (1905) to draw the boundary line here between the Poznań clay of the lowland and the Sub-Sudetic coal-bearing formation. According to Jentsch (1910, 1913) Poznań clay represents Pliocene sediments. He reached this conclusion as a result of his own investigations, and of the palaeobotanical research carried out by Menzel (1910). A similar view of this formation was also adopted by a number of later researches, e. g., Berger (1938), Quitzow (1953), Areń (1957), Ksiązkiewicz, Samsonowicz, Rühle (1965), Różycki (1968). The line of the central course of the Odra was assumed as the southern boundary of the range of Poznań clay (known also as

variegated clays). The assumption was founded on the fact that the sediments lying south of this boundary are markedly varied as to petrography, in which respect they differ from the typically formed Poznań clay. They were usually classified as Miocene sediments of the Fore-Sudetic area. The idea of such a differentiation of this formation in the region of Wrocław was refuted by Wunschük (1925) and Berger (1938), who attributed the difference of its evolved forms to the occurrence of Poznań clay within the border zone of the basin. The problem was thoroughly studied and presented in several publications (Dyjor 1968, 1970; Oberc and Dyjor 1969; Buczkowska and Dyjor 1971). They found that the different formation of the evolved sediments of the Poznań series in this part of the basin may be accounted for on palaeographic grounds. In the border zone of the basin the sand-and-gravel material transported from the Sudetic Mts. was deposited as well as that from the insular zone in the Fore-Sudetic area. Near by was the long range of hills of the Ślęża massif, and a number of smaller, lower hills, such as these built of metamorphic rock in the vicinity of Piotrowice Wielkie. As a result, the local sediment assize is composed of many petrographic varieties, such as gravel, sand, kaolin clays, green and blue clays. This formation was defined as the Poznań series (Oberc, Dyjor 1969).

Poznań series

Three horizons are distinguished in the full profile of the Poznań series: the lower horizon of grey clays, occurring above the „Henryk" brown-coal bed, the central horizon of green clays with glauconite, and the upper horizon of variegated clays.

In the neighbourhood of Wrocław only two of the horizons, the middle and the upper one, have survived in their entirety. The absence of the uninterrupted „Henryk" brown-coal bed is observed and of the horizon of grey clays which usually accompany it in the hanging layer. Their counterparts are the thin lays or lenticles of coal-bearing clays and of brown coals occurring in the bottom of the Poznań series or in its lower links (Fig. 2). This phenomenon is typical of the watershed zone within which these areas are situated. It has been found, moreover, that the sediments of the Poznań series in the neighbourhood of Wrocław vary greatly as to thickness, which is connected with the great morphological variety of the Tertiary base. Thus, near Piotrowice Wielkie, the deposits of Tertiary crystalline base are exposed on the surface, while a few kilometres to the east, at Kąty Wrocławskie, the Poznań series is more than a hundred meters thick, reaching over 140 m near Mokre and Muchobór (Fig. 2).

Horizon of green clays with glauconite. As in the whole Fore-Sudetic area, the horizon is composed of alternating banks of green and blue clays, with sand grains of various sizes, and muds.

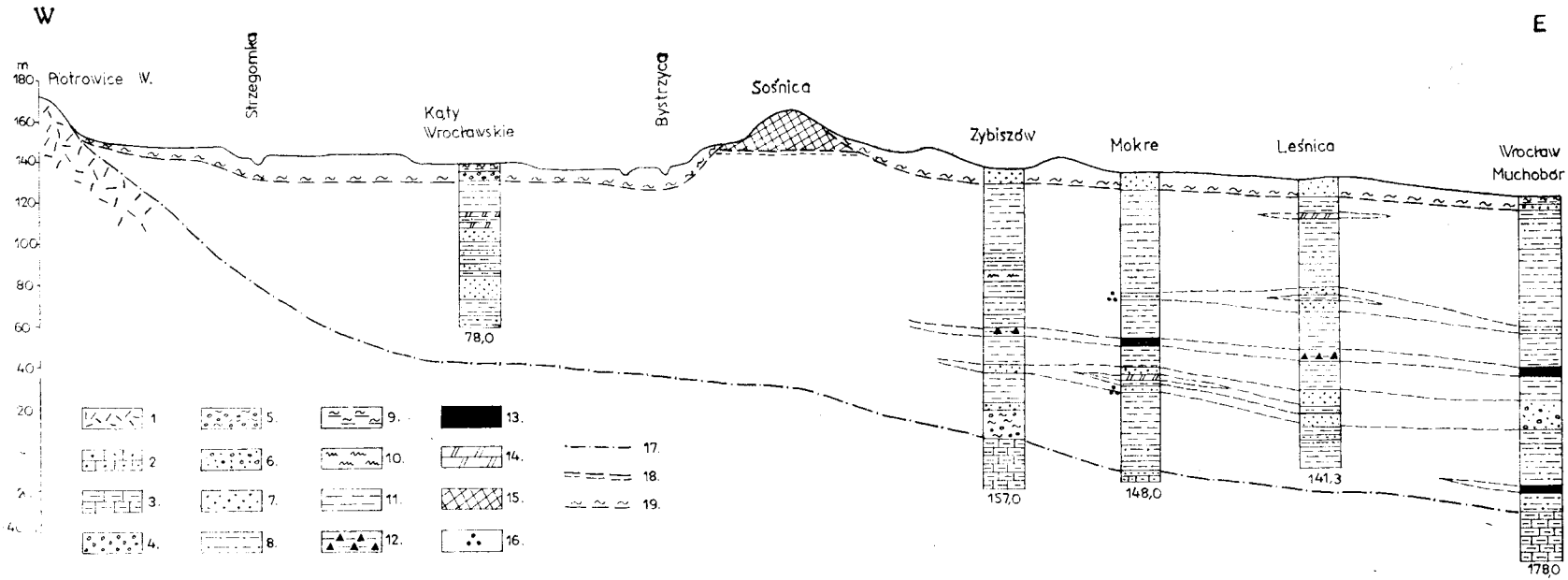

Fig. 2. Geological cross-section in the neighbourhood of Sośnica near Wrocław, showing also the Gozdnica series overlying the erosional inselberg. Tertiary substratum: 1 — metamorphic rock; 2 — sandstones; 3 — shales. Tertiary and Quaternary deposits: 4 — gravel; 5 — loamy gravel; 6 — sand with gravel admixture; 7 — sand; 8 — sanded-up clay; 9 — loam; 10 — mud; 11 — clay; 12 — coal-clay; 13 — brown coal; 14 — clayey marl; 15 — lithologically unisolated deposits of the Gozdnica series in the neighbourhood of Sośnica; 16 — glauconite; 17 — boundary between the deposits of Tertiary substratum and the Poznań series; 18 — boundary between sediments of the Poznań series and the Gozdnica series; 19 — boundary between Tertiary and Quaternary deposits

Ryc. 2. Przekrój geologiczny w okolicy Sośnicy koło Wrocławia uwzględniający zaleganie serii Gozdnicy na ostańcu erozyjnym. Podłoże trzeciorzędu: 1 — skały metamorficzne, 2 — piaskowce, 3 — iłołupki. Utwory trzeciorzędowe i czwartorzędowe: 4 — żwir; 5 — żwir zagliniony; 6 — piasek z domieszką żwiru; 7 — piasek; 8 — ił zapiaszczony; 9 — glina; 10 — mułek; 11 — ił; 12 — ił zawęglony; 13 — węgiel brunatny; 14 — margiel ilasty; 15 — nierozdzielone litologiczne utwory serii Gozdnicy w okolicy Sośnicy; 16 — glaukonit; 17 — granica między utworami podłoża trzeciorzędu a serią poznańską; 18 — granica między osadami serii poznańskiej i serii Gozdnicy; 19 — granica między utworami trzeciorzędowymi i czwartorzędowymi

The varying content of the sandy and clayey fractions is clearly manifest in the profile of the sediments, from the spring area in the south, up to the basin's central area.

The vicinity of outcrops of Tertiary bed, in the neighbourhood of Piotrowice Wielkie, had a bearing upon the conditions under which the Poznań series sedimentated at Sośnica. This island supplied crumbled material to the basin. A boring performed at Kąty Wrocławskie has shown the prevalence of sand-and-mud material over green or blue clays in the sediment. At Leśnica and Muchobór, situated further east, it is the clay sedimentation that prevails. In the green and blue clays as well as in clayish muds there is a marked accumulation of marlaceous concretions, sometimes of porous marl layers. They were found at different depths at Kąty Wrocławskie, Mokre, and Leśnica. In the upper part of the boring at Mokre, glauconite has been found to occur in the sandy clays. At Leśnica boring mollusc shells have been found, in a poor state of preservation. This seems to indicate that at the time when the Poznań series was sedimentating, the sea basin extended to Sośnica. This is further corroborated by the occurrence in the Poznań series deposits of gypsum which has been found to occur also in the grey-green clays with flora (Fig. 3). At Sośnica grey-yellow or red-brown spots and streaks appear in the upper part of the horizon of green clays with glauconite. They have also been found to occur at Mokre and Leśnica. Similar sediments occur in the upper part of the Poznań series in a great many borings within the town of Wrocław and in its neighbourhood (Różycki 1961, 1968). This is a transition zone to the higher situated horizon of variegated clays.

Horizon of variegated clays. This horizon of which the upper part of the Poznań series is composed occurs throughout the investigated area. The presence of oxydized iron compounds is an indication of the oxydizing environment and of the changes taking place in the conditions of sedimentation.

Typical variegated clays were found to occur in the clayey-facies sediments in the town of Wrocław, similar to those in the surroundings of Poznań. On the other hand, towards west, near Sośnica and Kąty Wrocławskie, they have only survived in a fragmentary form. At Kąty Wrocławskie the horizon of variegated clays was cut by Quaternary erosion. Variegated clays only occur here on the near-by hills, among others at the outcrops of the Sośnica brick-kiln. On the western wall of the new working excavation, the upper part of the Poznań series profile has been exposed (Fig. 3). It consists mainly of clayed muds and sands with intercalated beds of grey and grey-green clays. The layers vary in thickness, ranging from 50 to 80 cm. The layers are disposed almost horizontally, with a slight inclination towards the NE. In the sand-and-mud and clay layers irregular yellow-brown spots and streaks may be observed. The

lower part of the exposure contains grey and grey-green clays, with intercalated beds of sanded-up clays, sandy muds and clays. In the bank of grey green-tinged clay damaged fragments of the impressions of leaves occur. These clays are somewhat sanded up, with thin layers of pulverulent sands. Small gypsum crystals have been found to occur there. Within the lower part of the clays some lenticles of thick-grained quartz-feldspar sands occur.

The old exposure in the brick-kiln of Sośnica is situated (approximately) 150 m to the north from the one now being working (Fig. 1). It is overgrown, and only in some places a few wall fragments are accessible where Tertiary clays and sands may be observed. Comparison of the evolved forms of sediments in the former exposure where samples were collected for pollen analysis, with the well exposed upper part of the profile of the variegated-clays horizon in the new exposure, shows that they belong to the same horizon. However, in the old exposure the flora in the clayey layer originated under somewhat different conditions, and this led to a more abundant accumulation of better preserved plant remains. On the other hand, in the new exposure, only occasional badly preserved fragments of impressions of leaves are found. This should be attributed to the local sedimentation conditions within the basin, and perhaps to diagenetic processes as well.

Gozdnica series

The Poznań clays are overlaid with gravel-sandy deposits in which no Scandinavian material has been found. Berger (1938) called them the "grey facies", related to the fluvial sediments of the old bed of the river Bystrzyca. It overlies inconsistently the Poznań clays and dates from the Pliocene age. Similar sand-and-gravel sediments from the neighbourhood of Uraz and Kąty Wrocławskie, were attributed by Tietze and Behr (1942) to the Pliocene. Vein quartz and feldspar as well as weathered porphyry, gneiss, granite-gneiss, and mica-slate have been found in them.

In the Sośnica brick-kiln exposure, on the walls of the excavation works, the sediments of Gozdnica series stand out distinctly from the Poznań series. The thickness of the Gozdnica series in the brick-kiln does not exceed 6 meters. The series is distinguished by the great variety of its sediments (Fig. 3). The banks of kaolin clays, slightly sanded-up, merge into markedly sandy varieties with intercalated quartz-feldspar loamy gravel. In some places in the kaolin clays there is an accumulation of pieces of lignite and coal-bearing substance. This sediment resembles the horizon of fossil soil. However, sporomorphs were not found to occur in this layer.

The loamy gravel layers within the banks of kaolin clays vary in

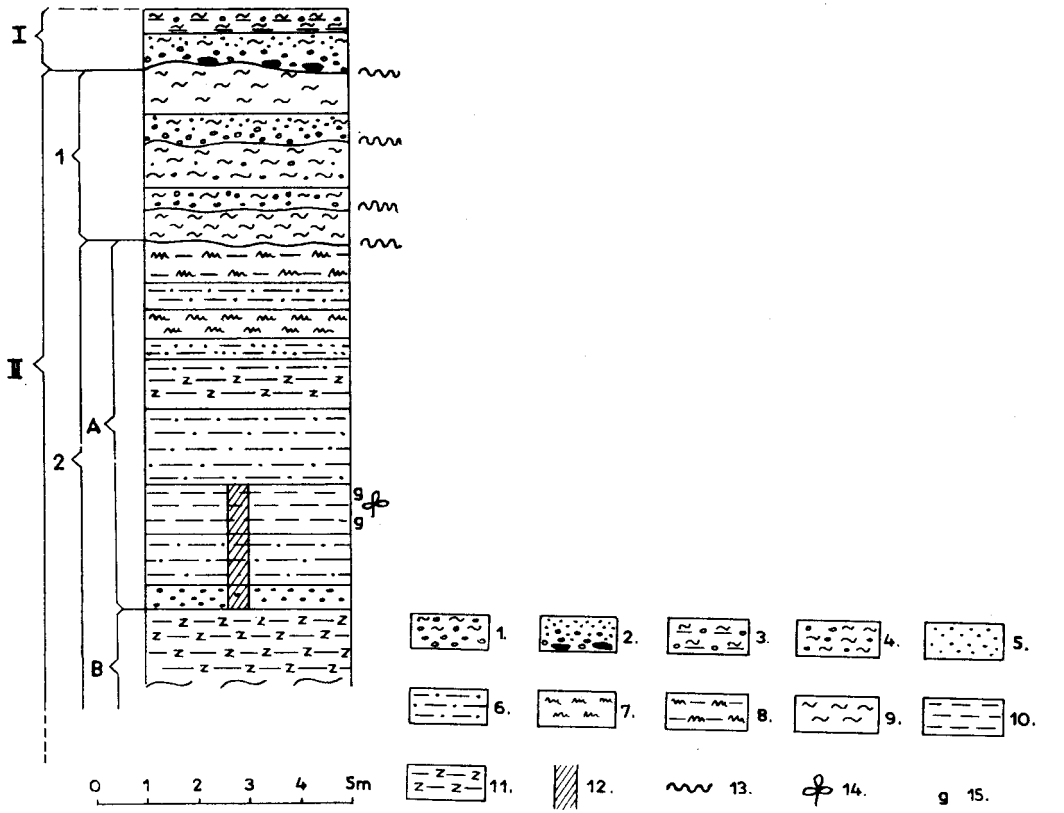

Fig. 3. Synthetic profile of Tertiary and Quaternary deposits at the outcrop of the Sośnica brick-kiln (drawn on the basis of the profiles of excavation walls at the old and new outcrops, 1969—1971). 1 — quartz-and-feldspar gravel, with loam at the top; 2 — gravel, in the upper part changing into vari-grained sand; 3 — boulder clay intensely sanded-up; 4 — kaolin clay, intensely sanded-up; 5 — sand; 6 — sanded-up clay; 7 — mud; 8 — laminated clayey mud; 9 — kaolin clay; 10 — grey clay; 11 — green clay; 12 — site where profile was taken for pollen analysis; 13 — erosional discordance; 14 — foliaceous flora; 15 — gypsum crystals. Stratigraphic divisions: I — Quaternary deposits undivided; II — younger Tertiary deposits: 1 — Gozdnica series; 2 — Poznań series; A — horizon of variegated clays; B — horizon of green clays with glauconite (top sector)

Ryc. 3. Syntetyczny profil utworów trzeciorzędowych i czwartorzędowych w odkrywce cegielni w Sośnicy, zestawiony w oparciu o profile ścian wyrobiska w starej i nowej odkrywce, stan z lat 1969—1971. 1 — żwir kwarcowo-skaleniowy w stropie zagliniony; 2 — żwir przechodzący w stropie w piasek różnoziarnisty; 3 — glina zwałowa silnie piaszczysta; 4 — glina kaolinowa silnie piaszczysta; 5 — piasek; 6 — ił zapiaszczony; 7 — mułek; 8 — mułek ilasty laminowany; 9 — glina kaolinowa; 10 — ił szary; 11 — ił zielony; 12 — miejsce pobrania profilu do badań palinologicznych; 13 — niezgodność erozyjna; 14 — flora liściowa; 15 — kryształy gipsu. Podział stratygraficzny: I — utwory czwartorzędowe nierozdzielone; II — utwory trzeciorzędu młodszego: 1 — seria Gozdnicy, 2 — seria poznańska, A — poziom iłów płomienistych, B — poziom iłów zielonych z glaukonitem (odcinek stropowy)

thickness, from under 20 cm up to ca. 1·20 m. Thin lenticles of quartz-feldspar gravels also occur in the old exposure grey-green clays with foliaceous flora.

The sand-and-gravel sediments are thickest in the upper part of the new outcrop. They are usually banks about 1 m thick, composed of thick-grained gravel, with fractional strata. On the uneven surface of the kaolin-clay bank thick-grained gravel lies discordantly. It is composed of quartz grains, white kaolinized feldspar, of gneiss and granite gneiss boulders and weathered porphyry. The diameter of gravel grains decreases as one moves upwards, and an addition of kaolin binder makes its appearance. Similarly evolved sediments were found to occur in the south-east part of the former exposure, above the clayey sediments with foliaceous flora. This is the loamy gravel characteristic of the Gozdnica series: it has been found in its typical evolved forms in the neighbourhood of Gozdnica, Ruszów and Lubin (D y j o r 1966, S t a c h u r s k a et al. 1967, S t a c h u r s k a et al. 1971). The evolved forms of the sediments in the upper part of the Poznań series and the overlying sediments of the Gozdnica series in the vicinity of Gozdnica and Ruszów closely resemble the corresponding deposits in the neighbourhood of Sośnica.

The Poznań series sediments originated in an aquaeous basin and have the characteristics of quiet sedimentation. Layers of clay with admixed gypsum and coal substances, mostly of lignite fragments were found in the horizon of variegated clays. The sediments of the Gozdnica series originated under different conditions. The occurrence of kaolin clays, sands, gravels and loamy gravels, as well as of horizons of fossil soils, shows that they originated as fluvial deposits. The slightly rounded gravel fraction material and its small sorting off indicate that it was transportation by rapid rivers with large amounts of rock. Such radical changes in the conditions of sedimentation could only have occurred under the impact of tectonic factors which appear over the whole Sudetic area. This dependence indicates that the processes which brought about the disappearance of sedimentation in the Poznań series took place at approximately the same geological time as the origination of syntectonic sedimentation of the Gozdnica series in the western part of the Sudetes (Gozdnica, Ruszów) and in the neighbourhood of Sośnica.

DESCRIPTION OF GEOLOGICAL PROFILE COLLECTED FOR POLLEN ANALYSIS

No	Depth in m	Sediment
1—3.	0·0—0·5	Light-grey, blue tinged clay, with yellow-brown spots, with vertically situated root fragments. Lamination of sediment poorly visible.

4—5.	0·15—0·25	Light-grey, blue tinged clay, with yellow-brown spots, laminated. On the surface of the laminae badly preserved impressions of plant and leaf detritus.
6.	0·25—0·30	Light-grey, blue tinged clay, with yellow-brown spots, laminated. Small fragments of lignites are visible in the sediment.
7.	0·30—0·35	Light-grey clay, blue tinged, laminated. In the clayey lays gypsum crystalls, disposed in rosette-like fashion are visible.
8.	0·35—0·40	Light-grey clay, blue tinged, with yellow-brown spots. Gypsum crystals are dispersed through-out the rocky mass.
9.	0·40—0·45	Light-grey clay, blue tinged, with yellow-brown spots, poorly visible lamination. Impressions of leaves are discernible upon the surface of the laminae.
10—16.	0·45—0·80	Light-grey clay, laminated. Towards the bottom lamination becomes more marked, being composed of layers, ca. 2 mm thick, of dusty and clayey material. Well preserved impressions of leaves in the sediment.
17.	0·80—0·85	Grey clay, laminated, with lays of dusty sand up to 2 mm thick, with pulverized light mica. Impressions of leaves well preserved on the surface of laminae.
18—19.	0·85—0·95	Grey clay with laminae, up to 2 mm thick, of dusty sand with pulverized light mica occurring in it. Scattered gypsum crystals are discernible in the sediment. Well preserved impressions of leaves occur on the surface of the lays.
20—22.	0·95—1·10	Dusty mud, stratified, with clayey binder. The lays, up to 1 cm thick, are composed of dusty-sandy yellow-brown mud and of dark-grey clayey sediment.
23—34.	1·10—1·70	Grey clay, sanded-up, non-stratified, with streaks of precipitated yellow-brown iron compounds, 2—3 mm thick. In some places there occur thin lays of dusty sand with pulverized light mica.
35—37.	1·70—1·85	Grey clay, with admixture of dusty material, with poorly outlined lamination. Yellow-brown spots occur in the bottom.
38—41.	1·85—2·05	Grey clay, non-stratified, with irregular, yellow-brown spots. In the lower part somewhat more dusty material, with laminae of light mica. In this sector lamination of the sediment is discernible.
42—45.	2·05—2·25	Dusty mud, slightly sanded-up, laminated, with pulverized light mica.

46—48. 2·25—2·40 Dusty grey sand, laminated, with clayey binder. An accumulation of light-mica dust upon the surface of the laminae.

METHOD

The profile for palynological investigations derives from the western wall of the old exposure (Fig. 1) and comprises 48 samples. It was impossible to take samples from sediments lying deeper, for the exposure was filling with water. The samples were taken at 5 cm intervals.

The sediment was macerated in hydrofluoric acid, which was combined with Erdtman's acetolysis (1943), some of the samples were macerated for a long period of time, in order to extract the largest possible amount of organic material. In these cases the sediment was steeped in hydrofluoric acid for 24 hours, and then Knox's flotation method was applied (K n o x 1942).

In each of the horizons 500 to 700 pollen grains of trees and shrubs were counted only in exceptional cases was the number limited to two hundred. The list of sporomorphs determined and the absolute numbers of occurrence in the different horizons are presented in Table 1*. 114 taxons were designated. The „Varia" column in the Table comprises both the undetermined sporomorphs, and those in a very poor state of preservation, i. e. of uncertain determination.

The values of the percentual proportion of the particular plants were calculated according to the sum-total, i. e. the sum of tree and shrub pollen.

CHARACTERISTICS OF THE VEGETATION AND AN ESTIMATE OF ITS AGE BY POLLEN ANALYSIS

Historical outlines of Sośnica flora investigations

Interest in the fossil flora of Sośnica is of long standing, dating back to 1855, when it was first presented by G o e p p e r t. He described 139 plant species found in the clay sediments of the Sośnica brick-kiln in the form of leaves, seeds, fruits, fructifications, stems, inflorescence catkins, and other remains. The flora described by him showed a predominance of *Angiospermae* over the conifer plants, while the most frequent plant remains were the leaves of the *Angiospermae* genera. On the basis of the floristic composition G o e p p e r t attributed the Sośnica flora to the Pliocene age.

* Table 1 and Fig. 4 are under the cover.

Heer (1855) was of a different opinion, and attributed the Sośnica flora to the Upper Miocene age. On comparing the flora of Sośnica with that of the Upper-Miocene of Oeningen (Switzerland) and with the Pliocene flora of Montajone (Tuscany), he concluded that the flora of Sośnica should be considered as Upper Miocene, the differences in comparison to the genetically richer flora of Oeningen being attributed to the geographical position of Sośnica.

Since then many works relating to this interesting flora have been published.

In 1917 and later in 1920 Kräusel attributed the Sośnica flora to the Upper Miocene age; with his team (Meyer, Reimann, Reichenbach) he submitted the fossil flora of the Upper and Lower Silesia to revision. It was also regarded as Upper Miocene by Kirchheimer (1937), Szafer (1946, 1961), and Kostyniuk (1950).

Berger (1950) compared the flora of Sośnica to the Lower Pliocene flora of Vösendorf from the Vienna Basin area. He made a critical review of previous opinions as to the age of the Sośnica flora, and asserted that, while having no characteristics of Miocene flora, both its generic composition and the climatic conditions under which the vegetation of that time had lived, seemed to indicate that it was early Pliocene flora.

Of later authors concerned with Neogene florae Czeczottowa (1951) attributed the flora of Sośnica to the Upper Miocene, Quitzow (1953) considered it as a Sarmatian flora, while Raniecka-Bobrowska and Czeczott (1958) again attributed it to the Upper Miocene.

The age of the Sośnica flora was also estimated by Mai (1967) and Ahrens, Bülow and Cepek (1968). In the stratigraphic division of the Neogene in the German Democratic Republic which Mai (l. c.) himself established, he located the Sośnica flora in the XIII floristic horizon, comprising the vegetation of the youngest Miocene and Pliocene. Ahrens et al. (1968) includes it in Tortonian-Sarmatian flora. Illinskaya (1968) considered that the Sośnica vegetation resembled the Pliocene plant communities of the Ukraine. Knobloch (1969) held that the Pannonian flora of Moravská Nová Ves (Czechoslovakia) was very similar to that of Sośnica.

This brief review shows clearly that the age of the Sośnica flora is still an open question and continues to be a subject on which different opinions are held.

Characteristics of vegetation according to pollen analysis

In the pollen flora preserved in the sediment from Sośnica, the pollen of *Angiospermae* is predominant. Of the 114 established taxons, only 12 are of the conifer-tree genera, while 7 belong to cryptogamous plants.

The pollen grains of some genera, such as *Carya, Pterocarya, Ulmus, Alnus,* and *Acer,* vary greatly, which seems to indicate that these genera might have comprised various species.

The profile examined includes 2·4 meters of sediment. In the bottom sandy-mud sediments occur, higher up — the sanded-up clays, while in the top there are clays in which numerous macrofossils have been preserved. In the pollen diagram, however, two sectors may be distinguished: the lower, with a prevalence of coniferous trees, and the upper, where deciduous trees predominate. In the bottom part of the profile (lower sector) among the coniferous trees *Pinus* of the *diploxylon* type and *Pinus* of the *haploxylon* type prevail, while the following genera occur less frequently: *Abies, Podocarpus, Picea, Sciadopitys, Tsuga,* and trees of the *Taxodiaceae-Cupressaceae* group. Of the deciduous trees, *Alnus, Betula, Carya, Engelhardtia, Liquidambar, Pterocarya, Quercus,* and *Ulmus* are noted to occur. In the upper sector of the profile the rôle of coniferous trees is not significant, while the proportion of deciduous trees markedly increases, especially the genera *Carpinus, Fagus, Parrotia, Pterocarya, Quercus, Ulmus,* and *Zelkova.* It seems that the palynological results here presented, particularly in such a brief profile, do not illustrate plant succession over any long period, they are, however, a reflection of the plant communities which developed in the nearest and somewhat more removed environment of the sedimentation basin. The water basin, the existence

Table 2
Tabela 2

List of vascular plant genera determined at Sośnica according to macroscopic remains (Goeppert 1855, Kräusel 1917, 1920, Raniecka-Bobrowska, Czeczott 1958, Micek 1959)

Lista rodzajów roślin naczyniowych oznaczonych z Sośnicy na podstawie szczątków makroskopowych (Goeppert 1855, Kräusel 1917, 1920, Raniecka-Bobrowska, Czeczot 1958, Micek 1959)

Acer	*Getonia*	*Prunus*
Alnus	*Glyptostrobus*	*Pterocarya*
Araliaceae	*Juglans*	*Pyrus*
Betula	*Leguminosae*	*Quercus*
Büttneria	*Libocedrus*	*Rhododendron*
Callitrites	*Lindera*	*Rhus*
Carpinus	*Liquidambar*	*Salix*
Carya	*Myrica*	*Sequoia*
Cassia	*Paliurus*	*Steinhauera*
Castanea	*Parrotia*	*Taxodium*
Ceanothus	*Persea*	*Trapa*
Celtis	*Philadelphus*	*Ulmus*
Crataegus	*Pinus*	*Vitis*
Eucommia	*Platanus*	*Zelkova*
Fagus	*Populus*	*Zizyphus*

of which is proved, among others facts, by the occurrence of pollen of *Butomus, Potamogeton, Sparganium,* and *Typha,* was constantly supplied with material carried by water, as can be seen both from the type of the sediment (sands), and from the presence of sporomorphs coming from the grooving of the older deposits, — as well as by the presence of *Hystrichosphaeridae.*

As results from geological investigations, the surroundings of Wrocław and Sośnica in the Tertiary were varied as to their topography, and in the nearest neighbourhood of the Sośnica basin there were a number of hills beginning only 4 km to the west of Sośnica, near Piotrowice Wielkie. To the south in the neighbourhood of Sobótka and Strzeblów, these hills were fairly high. Water flowed down them towards the banks of the basin, carrying sandy-clayey sediments with it. Within the full sedimentation cycle, periods of violent sedimentation alternated with milder ones, this resulted more sandy deposits in the bottom of our profile and more clays in the top. The varying topography produced different habitats, a fact expressed in the pollen diagram by the occurrence of at least two different forest communities.

Next to the basin, and in all probability along the river banks as well in wet, sometimes swampy habitats, grew communities composed of the genera *Glyptostrobus, Taxodium, Alnus, Liquidambar, Myrica, Nyssa, Platanus, Pterocarya,* and *Salix.* As to herbaceous plants, there was a more abundant growth of ferns and mosses of the *Sphagnum* genus.

The forest communities on dry habitats situated higher were of a different character. The surrounding hills were covered by a forest, deciduous for the most part, rich in different species, with a well-developed shrub horizon and many creepers. The genera *Carpinus, Carya, Engelhardtia, Fagus, Parrotia, Quercus,* and *Ulmus-Zelkova* are prominent here. In the shrub zone there were genera of the families *Araliaceae, Caprifoliaceae, Ericaceae, Leguminosae, Oleaceae, Rhamnaceae,* the genera *Ilex* and *Tamarix,* and the creepers *Rhus, Vitis, Partenocissus,* and *Hedera.*

In the pollen flora, moreover, considerable amounts of coniferous-tree pollen is preserved, in particular that of two forms of pine (*Pinus* of the *diploxylon* type, and *Pinus* of the *haploxylon* type). It does not seem, however, that these trees represent any separate forest communities. Coniferous trees were constant components of various forest communities, in particular of those covering the highest neighbouring hills. This probably accounts for the marked proportion of the pollen of the two pine types in the bottom of the profile. These pollen grains most easily transported over long distances, fell on the surface of an extensive water basin which was more „open" in its initial phase. This supposition is corroborated by the fact that many genera of trees which predominate in the upper part of the profile, are also present in its bottom sector, along with a large number of pine.

Though it is difficult to compare directly the list of plants determined according to the macrofossils with the list of flora obtained by pollen analysis (as it is impossible to define the majority of sporomorphs as to species), nevertheless, for general orientation, such comparison has been made in Tables 1 and 2. As could be expected, there are both similarities and differences. Apart from a number of genera common to both lists, such as *Acer, Alnus, Betula, Carpinus, Fagus, Liquidambar, Parrotia, Pinus, Platanus, Quercus, Salix, Ulmus, Taxodium,* there occur some taxons not found in the pollen, e. g., *Büttneria, Castanea, Lindera, Persea, Philadelphus, Populus, Trapa* — as well as some others, represented only by the pollen, e. g., *Abies, Caprifoliaceae, Cercidiphyllum, Cornaceae, Corylus, Engelhardtia, Ericaceae, Hedera, Ilex, Nyssa, Reevesia, Podocarpus, Sciadopitys, Staphylea, Tsuga.*

The lack of determination of the pollen as to species renders it equally impossible to analyse the flora as to the proportion of the different plant-and-geographic elements. On the other hand, however, taking into consideration the genera found both in macroscopic remains and in the pollen, it may be concluded that the vegetation of which the Tertiary plant communities of the examined area were composed, included genera now growing in Central Europe (*Alnus, Betula, Carpinus, Fagus, Ulmus*), in Atlantic North America (*Carya, Nyssa, Rhus, Taxodium*), and, to a lesser extent, genera characteristic of the East Asia (*Cercidiphyllum, Engelhardtia*), of the Mediterranean area (*Olea, Ostrya*), and of Caucasian province (*Parrotia, Zelkova*).

The flora of Sośnica is rich as to variety of species. In the denoted taxons many families and genera are represented by plants found only in Tertiary plant communities, growing in a temperate climate. In the pollen spectra, analysis has failed to reveal the pollen of the tropical plants. The forest communities which developed on the examined area, were differentiated depending on the type of habitats, and on more elevated heights, also on the exposition. These were multi-generic forests, with a well developed shrub horizon and many creepers, covering — it may be assumed — large areas with compact forest complexes. This is indicated by the small proportion of the herbaceous plants. The presence of trees such as the *Tsuga*, of the genera of the *Taxodiaceae-Cupressaceae* group, and, of deciduous trees such as *Carya, Celtis, Cercidiphyllum, Corylopsis, Decodon, Engelhardtia, Eucommia, Liquidambar, Nyssa, Ostrya, Pterocarya, Reevesia,* and *Rhus* prove beyond doubt that the plant community was Tertiary. On the other hand, the quantitative prevalence of the genera of trees of the moderate zone, growing now in Central Europe, such as *Betula, Carpinus, Fagus, Quercus, Ulmus,* seems to indicate that the sediment which had preserved such a pollen assemblage, is representative of the younger Tertiary. This supposition is confirmed by the considerable proportion of pine. Thiergart (1940) asserts that the large

proportion of *Pinus* in the pollen flora of Tertiary deposits is characteristic of Pliocene forests and that, moreover, a large amount of pollen of the *Pinus* of the *haploxylon* type is characteristic of the Lower Pliocene age. In the Sośnica profile the proportion of the two types of pine is almost the same but the large proportion of this genus as compared to the less frequent Tertiary coniferous trees, such as *Tsuga, Sciadopitys, Taxodiacae*, and in the case of deciduous trees, the prevalence of genera typical of Pleistocene and contemporary forest communities in Central European areas, indicate that the Sośnica sediments did not accumulate in the Miocene, but were younger and represent the Pliocene.

The Sośnica diagram compared to some Neogene diagrams from South-Western Poland

In investigating the age of the Sośnica flora the authors have taken into consideration several recent publications on palynological studies concerning Upper Miocene and Pliocene floras (Fig. 1).

Between 1964 and 1971 the results of pollen analysis of the following deposits were published: the Upper Miocene brown coal in the brown coal series I (Ziembińska 1964, Ziembińska, Niklewski 1966, Raniecka-Bobrowska 1970), Tortonian deposits of brown coal of the „Henryk" bed, and the top and bottom layers of the Poznań clay series (Sadowska 1970, Stachurska et al. 1971). Upper Miocene sediments of Gozdnica series (Stachurska et al. 1971), and finally Pliocene sediments of Gozdnica series, at the locality Ruszów (Stachurska et al. 1967) (Table 3).

The pollen spectra of Upper Miocene deposits were distinguished by the prevalence of trees of the *Taxodiaceae-Cupressaceae* group, by a prominent amount of the pollen of *Castanea, Myrica, Nyssa, Rhus, Pollenites edmundi, Pollenites liblarensis*, and in the case of the deposits of the Gozdnica outcrops, by the occurrence of the *Sapotaceae* pollen and a large proportion of *Symplocos* pollen. The fact that the pollen spectra of Upper Miocene sediments from different localities are, in general, similar, seems to prove that at that time there was a similar plant composition, and therefore, also similar climatic conditions, over a large area of the region under discussion. On the other hand, the fact that these spectra are at variance with the pollen diagram obtained at Sośnica, should be regarded as one more argument for an age earlier than the Upper Miocene.

Work on Upper Miocene (Sarmatian) flora was also conducted on areas more distant, at Gliwice Stare in Upper Silesia (Oszast 1960, Szafer 1961). In the pollen spectra of Gliwice clays there is also a large proportion of trees of the *Taxodiaceae-Cupressaceae* group, but they differ from the Lower-Silesian sediments of the Upper Miocene in the richer proportion of deciduous trees and in the presence of evergreen shrubs characte-

Table 3
Tabela 3

Correlation of the Upper-Miocene and Pliocene profiles of SW Poland containing fossil floras (hatched fields)

Age	Localities	Gozdnica (Stachurska et al. 1967)	Ruszów (Stachurska et al. 1967, 1971)	Sośnica (Stachurska, Sadowska, Dyjor, 1973)	Stare Gliwice (Oszast 1960, Szafer 1961, Kleczkowski 1966, Kleczkowski et al. 1972)	Lubin Legnicki - - Ścinawa (Ziembińska 1964)	Floristic - -stratigraphic zones after Mai (1967)
Pliocene	Upper		Gozdnica series	Gozdnica series	Gozdnica series		
	Lower		Stratigraphic break	Stratigraphic break	Stratigraphic break		
Miocene	Sarmatian	Gozdnica series Stratigraphic break Horizon of variegated clays Horizon of green clays with glauconite Horizon of grey clays Poznań series	Horizon of green clays with glauconite Horizon of grey clays Poznań series	Horizon of variegated clays Horizon of green clays with glauconite Poznań series	Clayey land and brackish sediments Brown coal-bed		XIII
	Tortonian	Brown coal-bed "Henryk"	Brown coal-bed "Henryk"	Brown coal-bed "Henryk"	Marine sediments of the Subcarpathien foredeep	I Lusatian series	XII

ristic of the Mediterranean region. These differences may probably be referred to the locality of Gliwice Stare situated near the banks of Paratetidis. On the other hand, as regards pollen flora at Sośnica, these differences are so much more prominent and vital that they should be regarded as an indication of plant communities of a different age, growing under slightly different climatic conditions. For, in fact, the character of the vegetation of Gliwice Stare resembles the Upper Miocene vegetation in Lower Silesia more than that of Sośnica.

This brief review of several Upper Miocene floras shows that they possess, regardless of whether they lie nearer Sośnica, or further away from it — certain features in common, while the difference may be attributed to the local habitat- and topographical conditions. On the other hand, the Sośnica flora differs from each of those areas. The character of the forest communities which once grew at Sośnica recalls the forests recorded for the Pliocene age.

On the Lower Silesia area a pollen diagram was drawn for the Ruszów Pliocene sediments (S t a c h u r s k a et al. 1967). The obtained pollen spectra reflect plant communities of wet habitats, on the banks of a water basin, with prevalent *Alnus* with an admixture of *Nyssa* and of trees of the *Taxodiaceae-Cupressaceae* group. On the other hand, these was a forest in drier habitats, situated higher up and further away, its specific composition almost identical with that of the dry-habitat forests at Sośnica. The Ruszów sediments were also submitted to detailed geological investigations (D y j o r 1966): as a result, their age was attributed to the Pliocene.

One of the recent publications on the Pliocene sediments worked out by the pollen-analysis method is the diagram of Domański Wierch near Czarny Dunajec in the Podhale region (O s z a s t 1970). In spite of the fact that these two localities lie rather far from each other, similarities in the pollen composition can be observed, above all as regards deciduous forests on drier habitats, composed, as at Sośnica, of the genera *Carya, Carpinus, Fagus, Quercus, Tilia,* and *Ulmus.* A common feature of the forest communities in both localities is the predominant proportion of tree genera of which the Pleistocene and the present-day stands of Central Europe are composed: this, as results from the most recent diagram analyses for various regions, seems to be the distinctive feature of Pliocene forests. The specific position of Domański Wierch, in a mountain region, found expression in the diagram in the predominant amount of *Picea* pollen, representative of a pine forest of the higher mountain altitudes, a fact not observed at Sośnica, as the hills surrounding this latter locality were much lower. Another difference — as compared to Sośnica — is the more marked proportion of *Alnus,* and a significantly more abundant occurrence of herbaceous plants. The age of the Domański Wierch sediments was recognized as the youngest Pliocene or even as

a period of transition betwen the Plio- and Pleistocene (Oszast l. c.). The analysis of the similarities and differences of the two diagrams imposes the conclusion that the sediment of Sośnica was accumulated during the Pliocene, but not in the youngest: in fact, that it is from the Lower Pliocene.

DESCRIPTION OF SELECTED SPOROMORPHS

This chapter is concerned only with the plants whose sporomorphs were reported at Sośnica as so far unrecorded or seldom recorded in palynological publications. All the remaining sporomorphs, those determined as well as those not determined in detail, are presented on the photograph plates (Plates I—XIX).

Ulmaceae

Celtis sp.

Pollenites cribellatus Dokt.-Hrebn. 1956

Pl. VIII, Figs. 6, 7

Pollen grain circular in shape, suboblate, polyporate. Number of pores mostly amounting to 5—6, less frequently to 4 or 7. Pores distributed irregularly on the grain surface, or assembled on the equatorial line. The pore is surrounded with an annulus of thickened exine. Exine thin, with finely punctate sculpture. The grain size varies from 25 to 42 μ.

The *Celtis*-genus pollen has not often been so far recorded in palynological publications. In Poland it was first described by Doktorowicz-Hrebnicka who found it in the Lower Pliocene brown coals in the neighbourhood of Olsztyn and Warsaw (1956). Later it was recorded in the Pliocene sediments at Ruszów (Stachurska et al. 1967), in Mio-Pliocene sediments at Gozdnica (Stachurska et al. 1971), and in Miocene sediments (Oszast 1960, 1967, Stuchlik 1964, Sadowska 1970).

Eucommiaceae

Eucommia sp.

Tricolporopollenites parmularius R. Potonié 1934, Th., Pfl. 1953, Kremp 1960, Kedves 1970

Pl. XII, Figs. 1—3

Pollen grains 3-colporate. Not all colpi are of the same length, hence the grains are not symmetrical in polar view. Membrane of the colpi finely granulate. In equatorial view dimensions from 35 × 24 to 40 × 32 μ.

The pollen of the genus *Eucommia* was found recurrently in the older and younger Tertiary sediments, but it was determined only morphographically as *Tricolporopollenites parmularius*. In 1960 Oszast determined this form of pollen as representing the genus *Eucommia*, in the Neogene of Stare Gliwice, where the pollen of this tree was found comparatively often (up to 3 per cent).

At Sośnica the *Eucommia* pollen was found only occasionally. In 1959 Micek described the fruits of *Eucommia europaea* Mädler found at Sośnica.

Hamamelidaceae

Parrotia sp.

Pl. XI, Figs. 7—12

Pollen grains 3-colpate, subprolate. Colpi wide, acute. Dimensions of pollen grains vary from 33—45 μ (polar view) and 40 × 31 up to 49 × 36 μ (equatorial view). Exine reticulate with typically "beaded-like" thickened muri.

Grains thus constructed are closest to the *Parrotia*-genus pollen. In the Sośnica sediment this pollen occurs in abundance, particularly in the upper part of the profile. *Parrotia* macroscopic remains were determined at Sośnica by Meyer (1917).

Cercidiphyllaceae

Cercidiphyllum sp.

Pl. XII, Figs. 4—8

Pollen grains spheroidal or subprolate, 3-colpate. Colpi very wide, in the form of deep „lacunae", sometimes of uneven length. Dimensions of the found grains in polar view 32 and 36 μ, in equatorial view 32 × 32 μ and 47 × 28 μ.

This genus was recurrently described in the sediments of the older and younger Tertiary (from the Oligocene to the Pliocene), but always from macroscopic remains. In pollen form it was recorded by Oszast (1967) in the Tortonian deposits at Piaseczno near Tarnobrzeg.

At Sośnica only a few grains of *Cercidiphyllum* pollen were found.

Lythraceae

cf. ***Decodon*** sp.

Pl. XII, Fig. 20

Pollen grains 3-colporate, pores round. In polar view triangular in outline, in equatorial view outline longitudinally ovate. Dimensions of marked grains in equatorial view about 34 μ.

Macroscopic remains of this genus have been fairly frequently found in the European Tertiary floras. In Poland they were found by Szafer (1950), Raniecka-Bobrowska (1957), Łańcucka-Środoniowa (1957). Raniecka-Bobrowska determined them also at Sośnica (Micek 1959). On the other hand, *Decodon* pollen was noted only by Stuchlik (1964) in Neogene sediments at Rypin (up to 61%) and by Oszast (1967) in the Tortonian clays at Piaseczno.

At Sośnica *Decodon* pollen occurs only sporadically.

Vitaceae

Vitis sp.

Pl. XIII, Figs. 7—9

Pollen grains 3-colporate. Colpi narrow crassimarginate; pores small, regularly circular. In polar view the dimension of the marked pollen grains about 15 μ, in equatorial view — from 19 × 17 μ to 24 × 22 μ. Exine thin on the surface finely reticulate, lumina small.

In the European Tertiary the macroscopic remains of the genus *Vitis* occur with great frequency, while the pollen of this plant has been found but seldom. It was recorded by Nagy (1958) in Hungarian Pliocene, whereas in Poland's Miocene sediments it was described by Stuchlik (1964) and Oszast (1967).

At Sośnica the pollen of *Vitis* occurs frequently almost throughout the whole profile, in an amount not exceeding 1 per cent.

Partenocissus sp.

Tricolporopollenites macrodurensis (Pf. & Th.) Th. Pf. 1953

Pl. XII, Fig. 10

Pollen grains 3-colporate, perprolate. Pores large, round, distributed in the equatorial zone of the grain. In equatorial view the dimension of the found pollen grains amounted to 51 × 28 μ. Exine rather thick, of two layers. Exine reticulate, with characteristically thickened muri of the reticula.

Pollen of this type so far recorded infrequently in Tertiary sediments, was determined by Thomson and Pflug (1953) as *Tricolporopollenites macrodurensis*. Stuchlik (1964) found pollen grains with such morphological features in sediments at Rypin and determined them as *Partenocissus*.

At Sośnica only one *Partenocissus* pollen grain was found.

Sterculiaceae

Reevesia sp.

Pollenites confinis (R. Pot.) Th. 1938
Pollenites anulus (R. Pot.) Kremp 1949
Pollenites rotundus (R. Pot.) Kremp 1949
Pentorites sp., *Tetroites* sp., *Trioites* sp. Klaus 1953
Polyporopollenites silesiae Mazancova 1962
Porocolpopollenites rotundus (R. Pot.), forma *reticulata* Stuchlik 1964
Porocolpopollenites arslanensis Nakoman 1968
Reevesiapollis Krutzsch 1970

Pl. XII, Figs. 11—15

Pollen grains 3-5-, for the most part 4-colporate, suboblate. Colpi very short, pores rounded, depressed, distributed in the equatorial zone of the grain. Exine fairly thick, with two layers distinctly marked, reticulate, with large lumina, of varying dimensions. Pollen grains ranging in dimensions from 23 to 29 μ.

The fossil forms of pollen with such morphological features were recorded by many authors (comp. the synonymics), but without any exact systematic designation. Suggestions made by various authors tend to refer this pollen to the families of *Salicaceae, Oleaceae, Caprifoliaceae, Hamamelidaceae, Tiliaceae.* In Poland such a form was determined by Stuchlik (1964) as *Porocolpopollenites rotundus* (R. Pot.) forma *reticulata,* who referred it to the *Oleaceae* family. Krutzsch (1970) determined pollen of this type as the genus *Reevesia.* In 1971 Averdieck described a form of identical appearance as belonging to the *Balsaminaceae* family. Sadowska (1972) on finding this pollen in Miocene brown coal at Olszyna in Lower Silesia determined it as a pollen of the genus *Reevesia,* a tree growing now in East Asia (Hao 1956).

At Sośnica the pollen of this type of tree occurs sporadically.

Araliaceae

Hedera sp.

Hederoidites megagertrudae (R. Pot.) Pot., Thom. & Th. 1951
Tricolporopollenites wallensensis Th. & Pf. 1953

Pl. XIII, Figs. 20, 21

Pollen grains 3-colporate, subprolate-prolate. Colpi rather long and wide, tapering, pores depressed. Exine thick, distinctly with two layers, lumina diminishing towards the colpi. Dimensions of grains in polar view 32 μ, in equatorial view from 29×23 μ to 40×35 μ.

Hedera pollen was not often recorded in Tertiary sediments. At Sośnica it occurs fairly often, throughout the profile, though its per cent is always low.

Oleaceae

Fraxinus sp.

Pl. XIV, Figs. 8, 9

Pollen grains 3- or 4-colpate, spheroidal-suboblate. Exine rather thick, surface reticulate. Lumina large, of uneven size, muri rather thick. Size of the found pollen grains from 17—25 μ.

The pollen of *Fraxinus* genus has very seldom been recorded in Tertiary sediments. In Poland it was noted by S t u c h l i k (1964). It is very likely that this type of pollen in fact occurred more often among forms reported by various authors, and generally recorded as cf. *Oleaceae* (cf. M a m c z a r 1960, Pl. XIII, Fig. 184).

At Sośnica *Fraxinus* pollen occurs fairly often, particularly in the upper part of the profile.

CONCLUSIONS

The analysis of Sośnica clays by the palynological method, which had not been previously applied to them, and the simultaneous geological investigations of the area under examination, were undertaken in order to solve the hitherto controversial problem of the age of the sediments and the fossil vegetation preserved in it.

The inquiry is a continuation of the previous geological and palaeobotanical investigations carried out on the Neogene sediments in southwestern Poland.

The analysis of the pollen composition proved that the vegetation of the Tertiary sedimentation basin, both in the near neighbourhood of Sośnica, and in the hills surrounding it, was a forest vegetation, of the mesophytic community type, living under temperately warm climatic conditions. Its most characteristic features — including in questionable Tertiary vegetation — are as follows: the predominance of trees of the genera now growing in Central Europe, an absence of the pollen of tropical plants, and low proportions of the pollen of plants prevailing in the Upper Miocene sediments.

A correlation of the pollen diagram from Sośnica with several Upper Miocene and Pliocene diagrams leads to the conclusion that the Sośnica

vegetation has more features characteristic of Pliocene forest communities.

This estimate is consistent with the findings of the most recent geological investigations carried out in Lower Silesia and in the province of Zielona Góra (Łużyce Region) during the last few years (Dyjor 1968, 1970, Oberc, Dyjor 1969). As results from these investigations, the Poznań clay series basin also extended over the whole Fore-Sudetic area. Thence, Sośnica is situated in the southern part of that basin. An analysis of the evolved sediments in Sośnica outcrops seems to indicate that the horizon with flora should be referred to the upper sector of the Poznań series (Fig. 3).

Taking into account both the generic composition and the general character of forest vegetation preserved in the Sośnica clays, as well as the geological position of these clays set against the background of the whole young Tertiary formation on the examined area, the authors conclude that, in all probability, the Sośnica sediments should be classed as belonging to the Lower Pliocene.

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STRESZCZENIE

WIEK FLORY Z SOŚNICY KOŁO WROCŁAWIA W ŚWIETLE BADAŃ GEOLOGICZNYCH I PALINOLOGICZNYCH

Praca zawiera wyniki badań geologicznych i palinologicznych osadów ilastych w Sośnicy, skąd szczątki makroskopowe roślin zostały po raz pierwszy opisane przez Goepperta (1855). Rewizję tej flory przeprowadził Kräusel (1917, 1920). Sośnica uważana jest za klasyczne stanowisko neogeńskiej flory liściowej, której wiek był wielokrotnie dyskutowany.

Goeppert (1855) ocenił florę z Sośnicy jako plioceńską. Za górnomioceńską uważali ją: Heer (1855), Kräusel (1917, 1920), Kirchheimer (1937), Szafer (1946, 1961), Kostyniuk (1950), Czeczottowa (1951), Quitzow (1953), Raniecka-Bobrowska, Czeczott (1958) oraz Ahrens et al. (1968). Wiek plioceński przypisują roślinności z Sośnicy Berger (1950), Iliinskaja (1968) i Knobloch (1969). Mai (1967) w podziale stratygraficznym neogenu NRD umieszcza florę z Sośnicy w XIII poziomie florystycznym, obejmującym roślinność najmłodszego miocenu i pliocenu.

Sprzeczne były również opinie geologów, określających stratygraficzną pozycję osadów cegielni w Sośnicy.

Formacja młodotrzeciorzędowa okolic Sośnicy i Wrocławia wykazuje pewne zróżnicowanie w składzie petrograficznym i wykształceniu osadów w porównaniu z węglonośną formacją Niżu środkowoeuropejskiego. Brak ciągłych pokładów węgla brunatnego i typowo wykształconych iłów poznańskich w okolicach Wrocławia skłonił M i c h a e l a (1905) do przeprowadzenia wzdłuż środkowej Odry granicy między iłami poznańskimi a subsudecką formacją węglonośną. W u n s c h ü k (1925), B e r g e r (1938), a następnie D y j o r (1968, 1970) oraz O b e r c i D y j o r (1969) wiążą odmienne wykształcenie formacji trzeciorzędowej w tej części basenu z jej występowaniem w strefie brzeżnej basenu iłów poznańskich. Według tych autorów, basen serii poznańskiej obejmował swym zasięgiem również teren bloku przedsudeckiego. Na znoszone z Sudetów i ich przedpola osady składają się żwiry, piaski, gliny kaolinowe oraz iły zielone i niebieskie. Formację tę określono nazwą serii poznańskiej (O b e r c, D y j o r 1969). W pełnym profilu serii poznańskiej wydziela się trzy poziomy: dolny — iłów szarych, zalegający ponad pokładem węgla brunatnego „Henryk", środkowy — iłów zielonych z glaukonitem, i górny — iłów płomienistych. W okolicy Wrocławia w pełni zachowały się tylko dwa poziomy — środkowy i górny. Brak tu ciągłego pokładu węgla brunatnego „Henryk" i poziomu iłów szarych. Ich odpowiednikami są cienkie warstwy lub soczewy iłów i węgli brunatnych w spągu serii poznańskiej (ryc. 2).

W cegielni w Sośnicy znajdują się dwie odkrywki — stara, z florą makroskopową, z której pobrano profil do badań palinologicznych, i nowa, obecnie eksploatowana (ryc. 1). Syntetyczny profil geologiczny obu tych odkrywek przedstawia ryc. 3. Odsłaniający się w tych odkrywkach profil osadów ilastych odpowiada stropowej części serii poznańskiej — poziomowi iłów płomienistych. Iły te przewarstwione są mułkami i piaskami, występują w nich kryształki gipsu i charakterystyczne żółto-brunatne plamy.

Nad iłami poznańskimi zalegają niezgodnie utwory żwirowo-piaszczyste, określone nazwą serii Gozdnicy. Seria ta, której miąższość w cegielni w Sośnicy dochodzi do 6 m, składa się z ławic glin kaolinowych z przewarstwieniami żwirowców kwarcowo-skaleniowych i wykazuje duże podobieństwo do typowo wykształconych osadów tej serii w okolicy Ruszowa i Gozdnicy. W przeciwieństwie do osadów serii poznańskiej, które powstały w wyniku spokojnej sedymentacji w zbiorniku wodnym, osady serii Gozdnicy świadczą o transporcie przez szybko płynące rzeki. Ta zmiana warunków sedymentacji, która musiała nastąpić pod wpływem działających na terenie Sudetów czynników tektonicznych, wskazuje na to, że przerwa w sedymentacji serii poznańskiej w obu wymienionych rejonach była prawdopodobnie równoczesna.

Materiał do badań palinologicznych pobrano z zachodniej ściany starej odkrywki (ryc. 1) w ilości 48 prób, w odstępach co 5 cm. Osad macerowano w kwasie fluorowodorowym w połączeniu z acetolizą Erdtmana. Oznaczono 114 taksonów. Wartości procentowe udziału poszczególnych roślin obliczono na podstawie sumy totalnej, utworzonej z sumy pyłku drzew i krzewów.

W spągu profilu występują osady piaszczysto-mułkowe, wyżej — iły zapiaszczone, a w stropie iły z zachowanymi w nich szczątkami makroskopowymi. W diagramie pyłkowym wyróżnić można dwa odcinki: dolny, charakteryzujący się panowaniem drzew szpilkowych, i górny — z przewagą drzew liściastych. Diagram nie ilustruje sukcesji roślinnej, widać w nim jednak odzwierciedlenie zbiorowisk roślinnych, jakie występowały w najbliższym i nieco dalszym otoczeniu zbiornika sedymentacyjnego.

Urozmaicona topografia okolic Sośnicy w młodszym trzeciorzędzie stwarzała różne siedliska, co w diagramie pyłkowym wyraziło się obecnością dwu odrębnych zbiorowisk leśnych. W najbliższym sąsiedztwie zbiornika (o jego istnieniu świadczy obecność pyłku *Butomus, Potamogeton, Sparganium, Typha*), na bagnistych i wilgotnych siedliskach rozwijały się zbiorowiska z rodzajami: *Glyptostrobus, Taxodium, Alnus, Liquidambar, Myrica, Nyssa, Platanus, Pterocarya* i *Salix*, a z roślin zielnych paprocie i torfowce. Rozciągające się dokoła wzniesienia, które rozpoczynały się już w pobliżu Piotrowic Wielkich, w odległości 4 km od Sośnicy, pokrywał las, głównie liściasty, bogaty gatunkowo, z piętrem krzewów i z licznymi pnączami. Dużą rolę odgrywały w nim rodzaje: *Carpinus, Carya, Engelhardtia, Fagus, Parrotia, Quercus, Ulmus-Zelkova*, z krzewów rodzaje *Ilex* i *Tamarix* oraz przedstawiciele rodzin *Araliaceae, Caprifoliaceae, Ericaceae, Leguminosae, Oleaceae* i *Rhamnaceae*, a z pnączy *Rhus, Partenocissus* i *Hedera*.

Bogaty ilościowo pyłek drzew szpilkowych, szczególnie sosny, prawdopodobnie nie reprezentuje odrębnego zbiorowiska leśnego. Drzewa te mogły wchodzić w skład zbiorowisk leśnych pokrywających okoliczne wzniesienia.

Brak oznaczeń gatunkowych pyłku uniemożliwia przeprowadzenie dokładniejszej analizy flory z Sośnicy pod względem udziału elementów geograficznych. Biorąc jednakże pod uwagę rodzaje znalezione zarówno w szczątkach makroskopowych, jak i w pyłku (por. tab. 1 i 2), wyrazić można przypuszczenie, że w skład roślinności młodotrzeciorzędowej badanego obszaru wchodziły rodzaje żyjące współcześnie w Europie Środkowej, w atlantyckiej części Ameryki Północnej oraz, w mniejszym stopniu, rodzaje charakterystyczne dla Azji Wschodniej, Obszaru Śródziemnomorskiego i Prowincji Kaukaskiej.

W bogatej florze sośnickiej oznaczono wiele taksonów charakterystycznych dla klimatu umiarkowanie ciepłego. Nie stwierdzono natomiast występowania pyłku roślin klimatu tropikalnego. W leśnych zbio-

rowiskach zaznacza się zróżnicowanie w zależności od siedlisk i ekspozycji. W tych wielogatunkowych zwartych lasach z dobrze wykształconym piętrem krzewów, z pnączami, z małym udziałem roślin zielnych, występują rodzaje drzew, określające to zbiorowisko jako niewątpliwie trzeciorzędowe. Z drugiej strony przewaga ilościowa rodzajów drzew strefy umiarkowanej, żyjących dziś w Europie Środkowej, a także duża ilość pyłku *Pinus haploxylon,* uważanej przez Thiergarta (1940) za formę charakterystyczną dla lasów plioceńskich, przemawia za najmłodszym piętrem trzeciorzędu.

Dla dokładniejszego oznaczenia wieku flory z Sośnicy, porównano jej diagram pyłkowy z kilkoma diagramami stanowisk flor górnomioceńskich i plioceńskich z południowo-zachodniej Polski (tab. 3).

Spektra pyłkowe osadów górnomioceńskich z różnych stanowisk (Oszast 1960; Ziembińska 1964; Ziembińska, Niklewski 1966; Raniecka-Bobrowska 1970; Sadowska 1970; Stachurska et al. 1971) są podobne do siebie, co świadczy o panujących w tym czasie na dużym obszarze badanego rejonu podobnych warunkach klimatycznych. Odmienność tych spektrów od obrazu palinologicznego flory z Sośnicy przemawia za wiekiem tego stanowiska młodszym niż górny miocen.

Większe podobieństwa wykazują spektra palinologiczne Sośnicy z diagramami plioceńskimi z Ruszowa (Stachurska et al. 1967) i Domańskiego Wierchu (Oszast 1970). Diagram z Ruszowa odzwierciedla zbiorowiska leśne siedlisk wilgotnych oraz położonych wyżej siedlisk suchych. Na siedliskach suchych rósł las o składzie rodzajowym zbliżonym do poznanego w Sośnicy. Diagram z Domańskiego Wierchu, położonego w znacznej odległości od Sośnicy i w głębi Karpat, wykazuje wyraźne podobieństwa w składzie gatunkowym lasów liściastych. Wspólną cechą zbiorowisk roślinnych tych obu stanowisk jest dominowanie tych rodzajów drzew, które budują plejstoceńskie i dzisiejsze lasy Europy Środkowej. Porównanie spektrów pyłkowych z Sośnicy i Domańskiego Wierchu, który reprezentuje najmłodszy pliocen lub plio-plejstocen, pozwala na wysunięcie przypuszczenia, że osady z Sośnicy są wieku dolnoplioceńskiego. Dowodzi tego również pozycja geologiczna iłów sośnickich rozpatrzona na tle młodotrzeciorzędowej formacji badanego terenu.

Instytut Botaniki i Biochemii Uniwersytetu Wrocławskiego
Zakład Paleobotaniki

Centralny Ośrodek Badawczo-Projektowy
Górnictwa Odkrywkowego „Poltegor", Wrocław

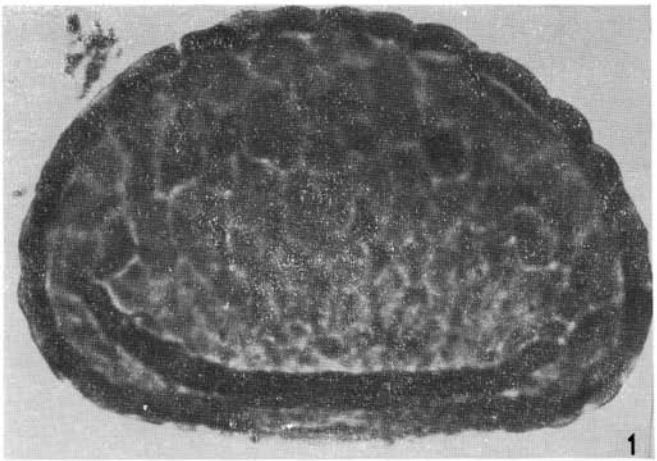
TABLICE

Plate I

Tablica I

× 1000

1—11. *Filicinae*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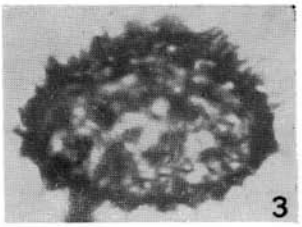
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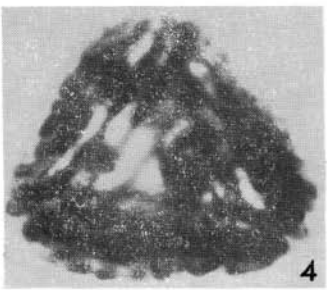
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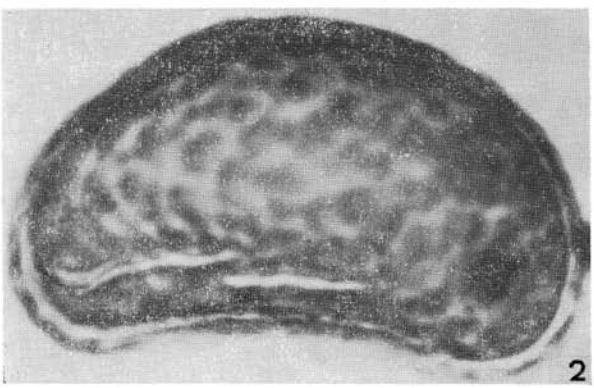
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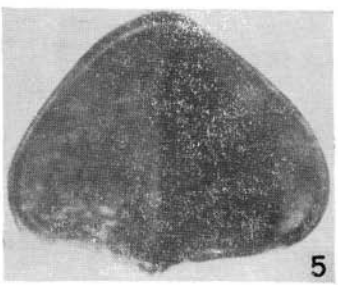
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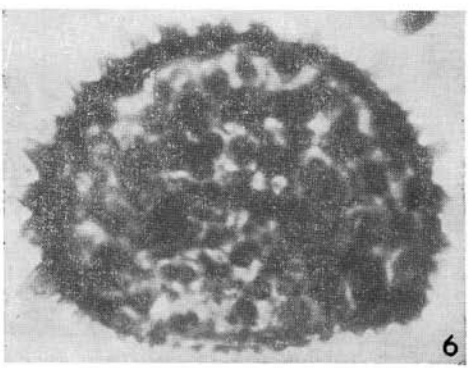
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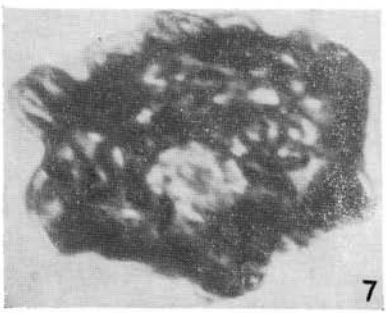
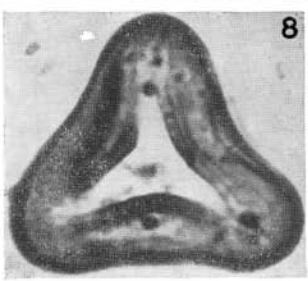
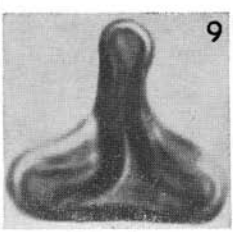

7


8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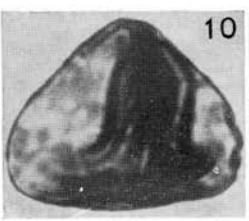
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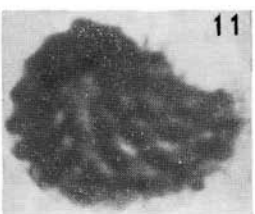
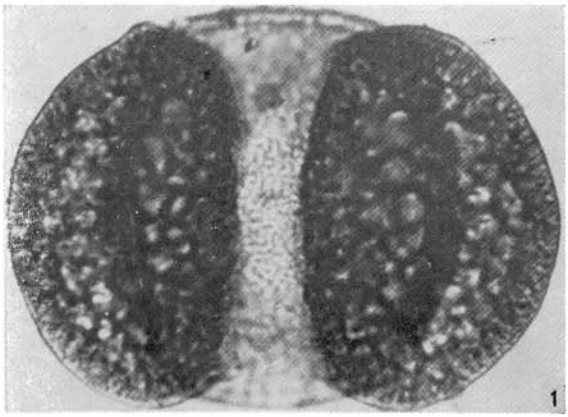

11

Plate II

Tablica II

× 800

1—9. *Pinus* t. *diploxylon* Rudolph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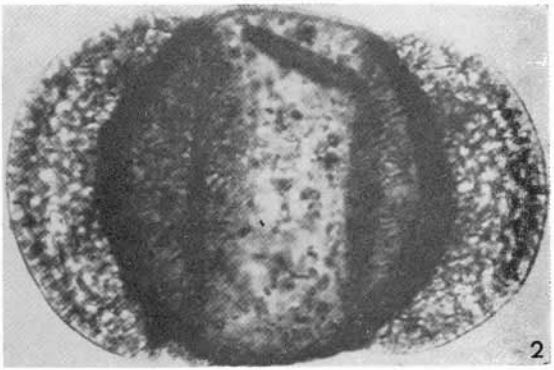
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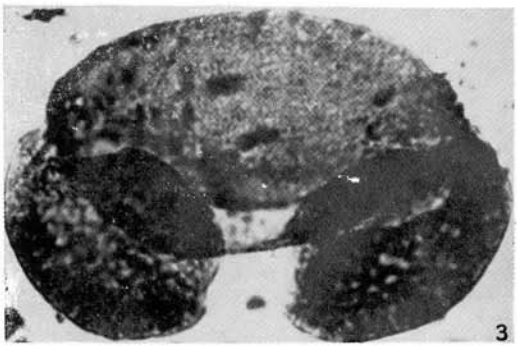
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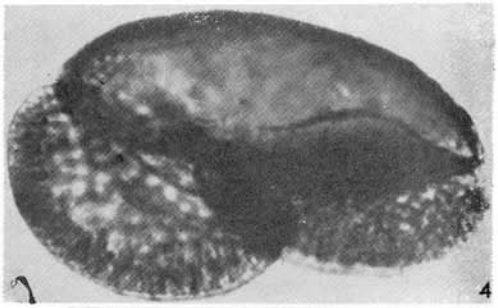
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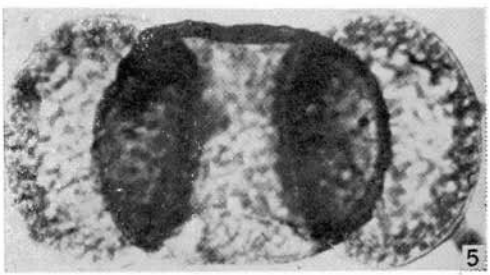
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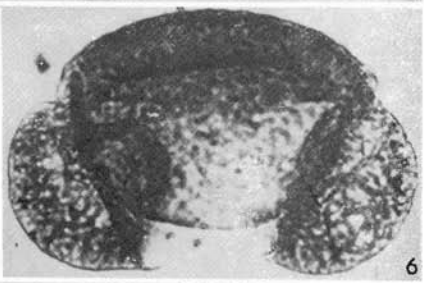
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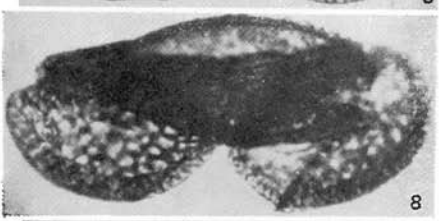
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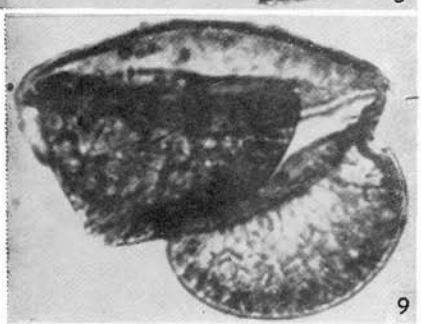
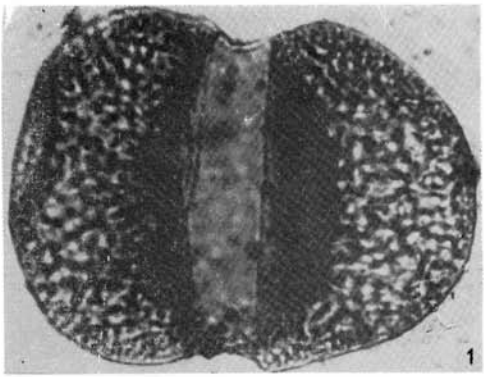

9

Plate III

Tablica III

× 800

1—9. *Pinus* t. *haploxylon* Rudolph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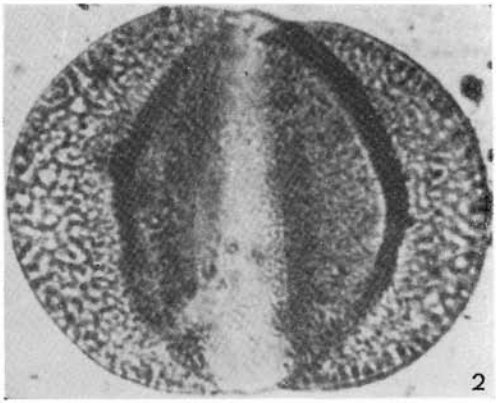
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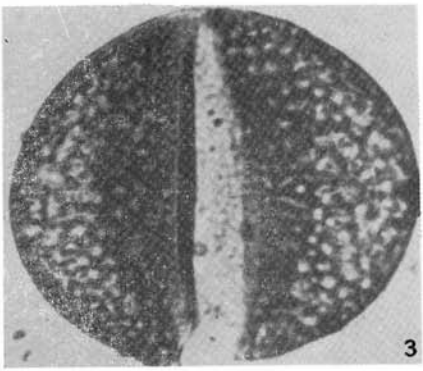
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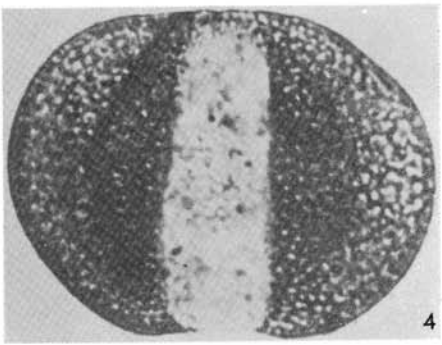
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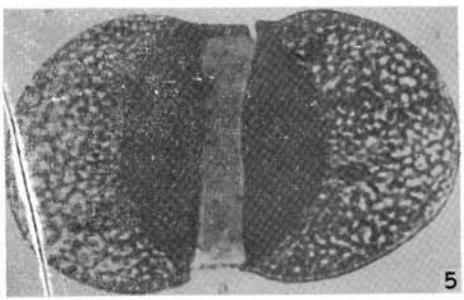
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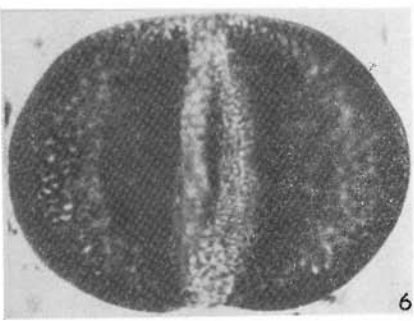
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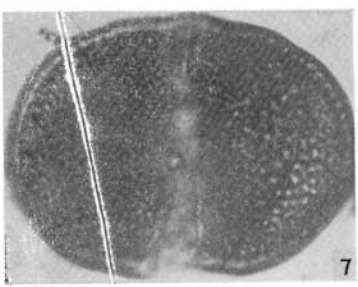
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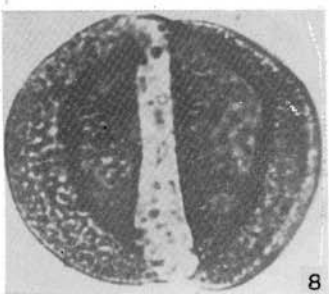
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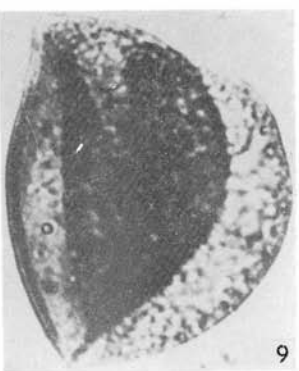
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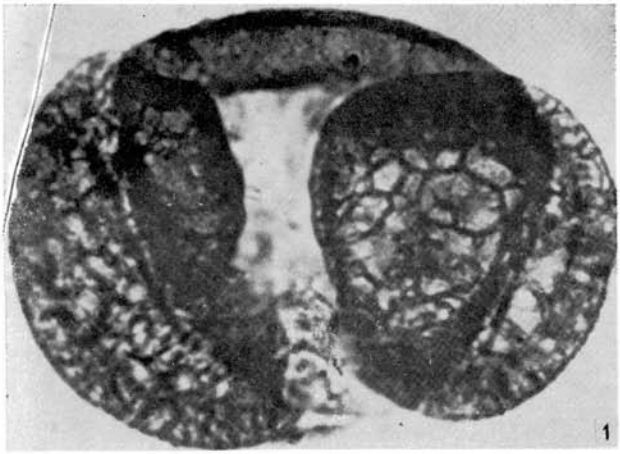
Plate IV

Tablica IV

× 800

1. cf. *Pseudolarix* sp.
2, 3. *Abies* sp.
4— 7. cf. *Podocarpus* sp.
8—10. *Taxodiaceae*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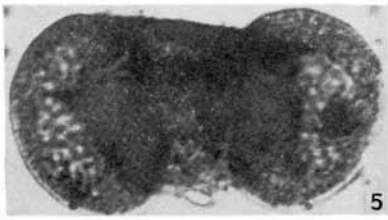
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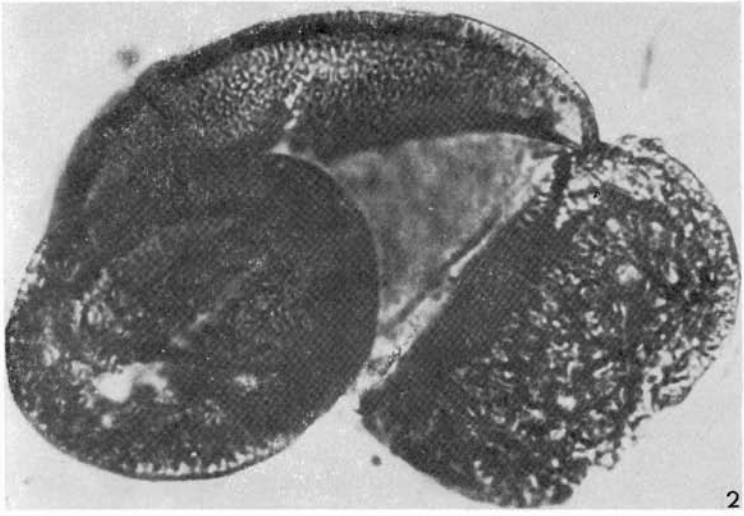
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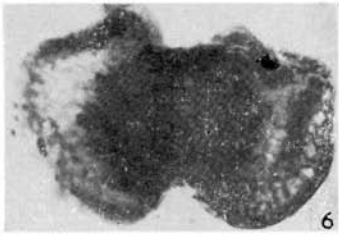
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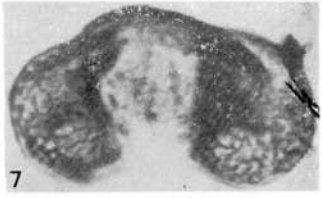
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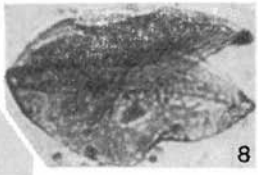
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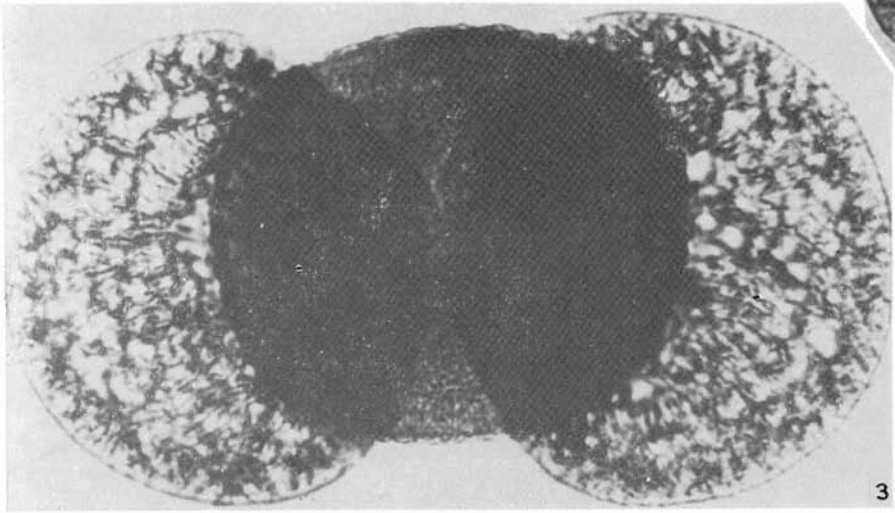

3


9


10

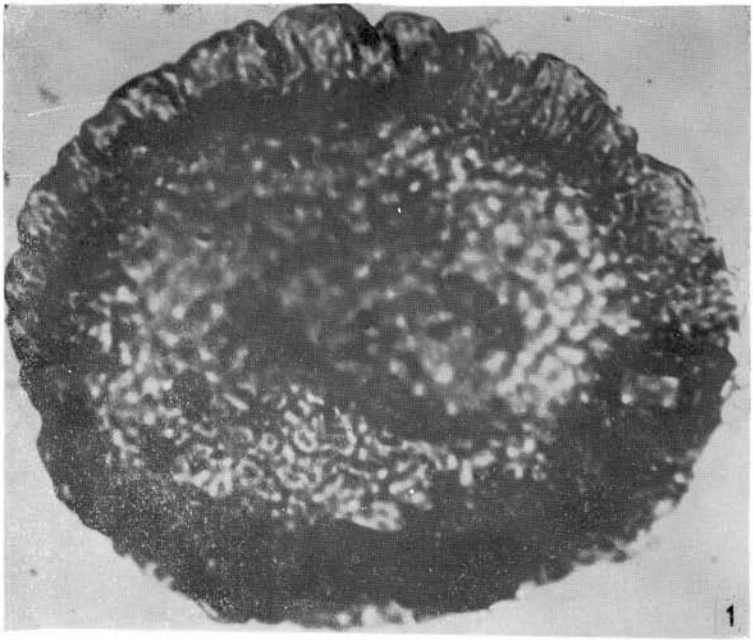
Plate V

Tablica V

× 1000

1. *Tsuga* t. *diversifolia* (Maxim.) Mast.
2. *Tsuga* t. *canadensis* Carr.

3—6. *Sciadopitys* sp.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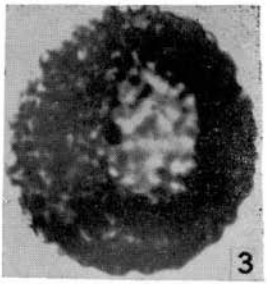
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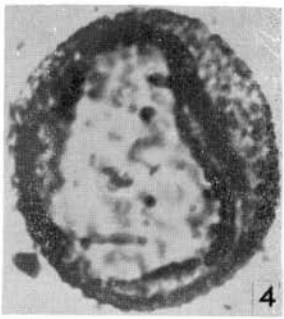
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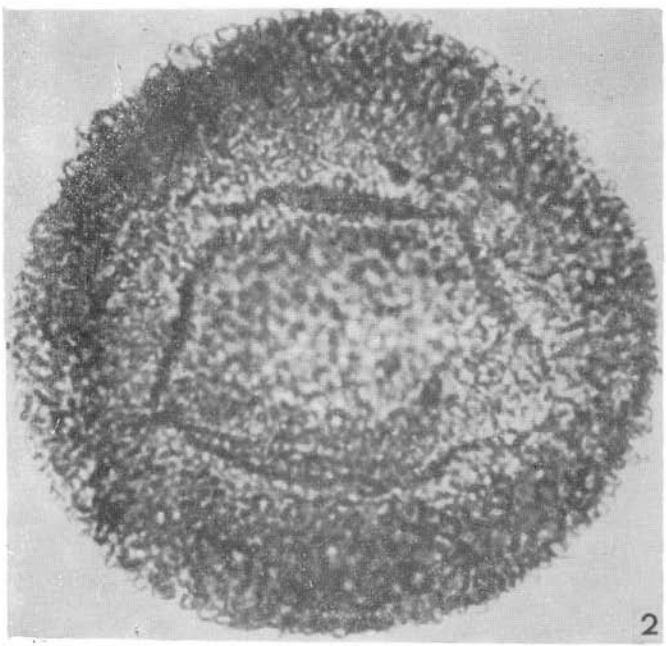
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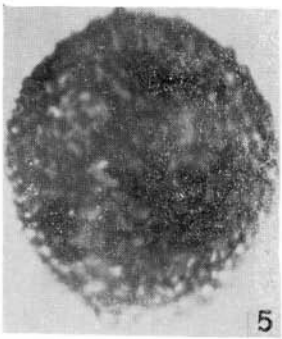

5


6

Plate VI

Tablica VI

× 1000

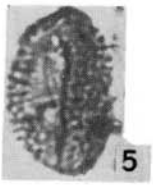
1— 5. *Salix* sp.
6— 9. *Betula* sp.
10—13. *Alnus* sp.
14—19. *Carpinus* sp.


1


2


3


4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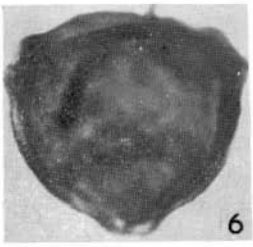
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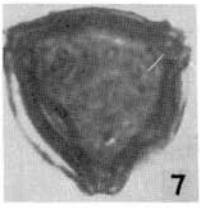
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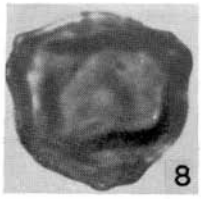
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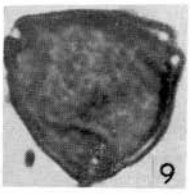
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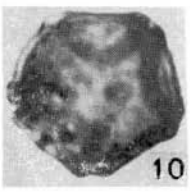
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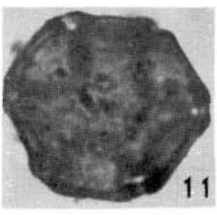
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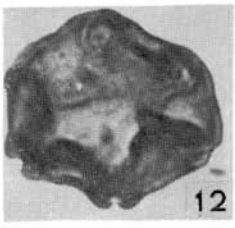
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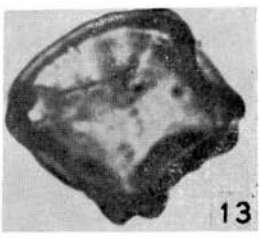
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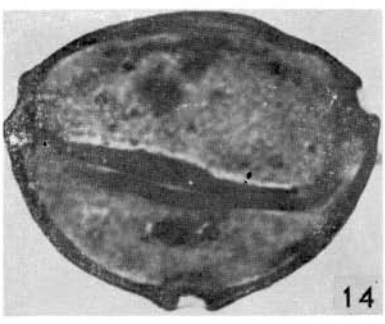
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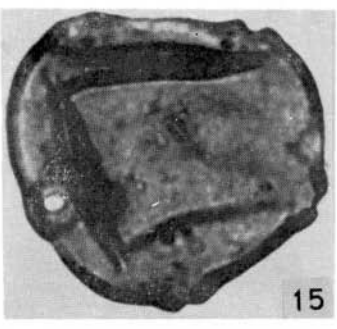
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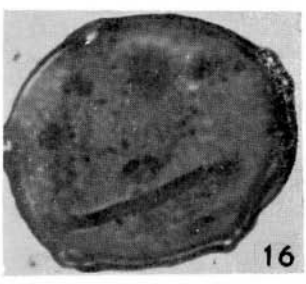
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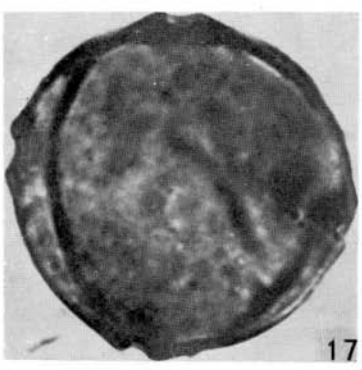
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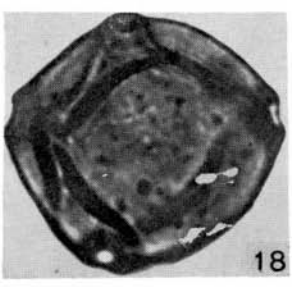
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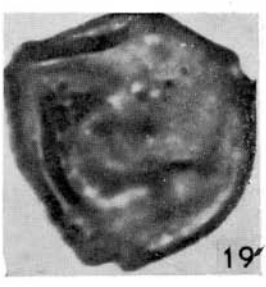
19

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Plate VII

Tablica VII

× 1000

1— 9. *Fagus* sp.
10—13. *Quercus* sp.

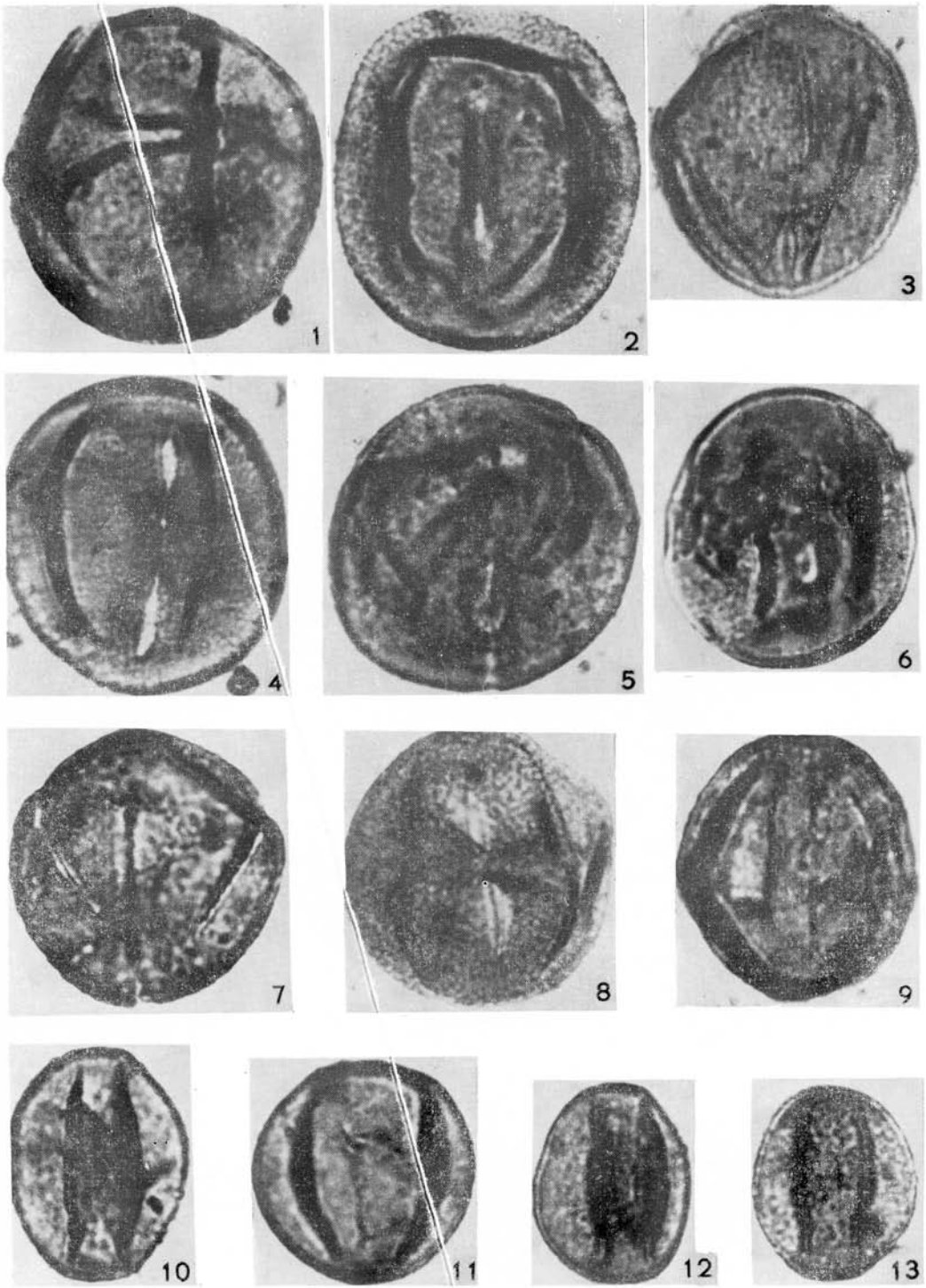
1
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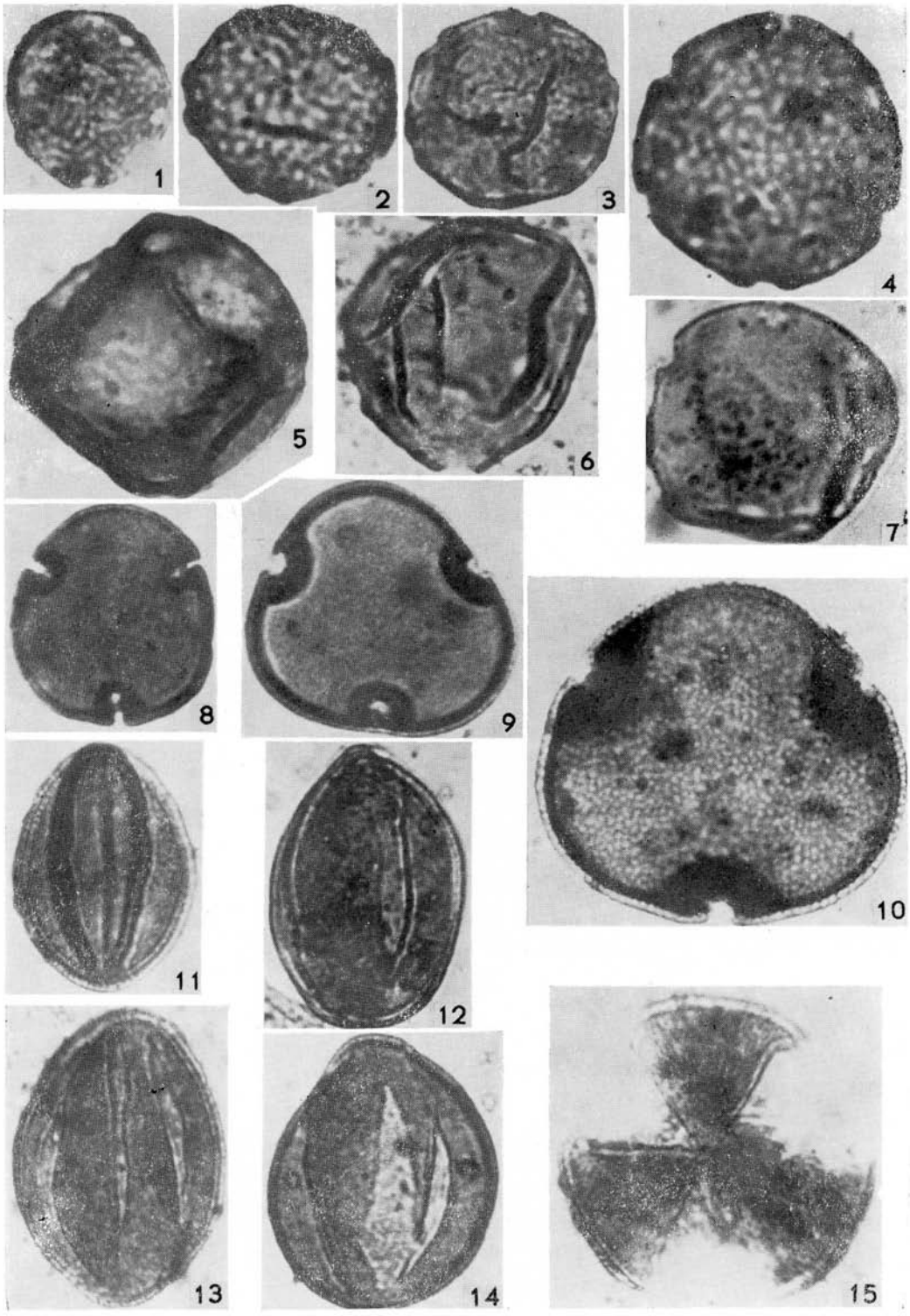
Plate VIII

Tablica VIII

× 1000

1— 4. *Ulmus* sp.
5. *Zelkova* sp.
6— 7. *Celtis* sp.
8—10. *Tilia* sp.
11—15. *Acer* sp.


1
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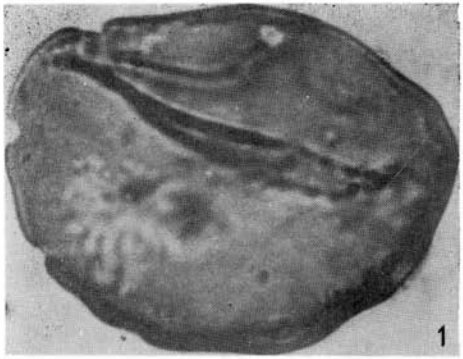
15

Plate IX

Tablica IX

× 1000

1— 4. *Juglans* sp.
5— 8. *Carya* sp.
9—13. *Engelhardtia* sp.
14. cf. *Platycaria* sp.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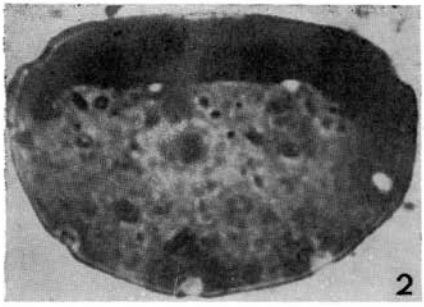
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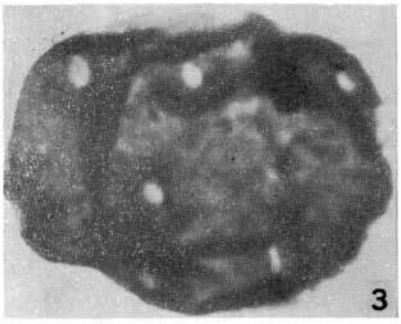
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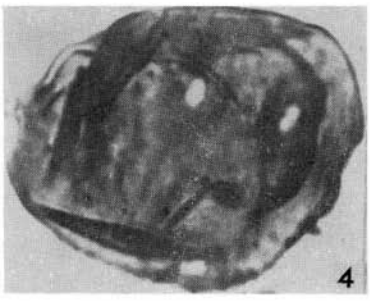
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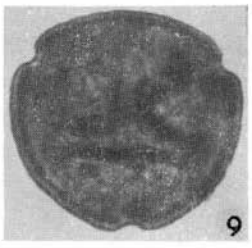
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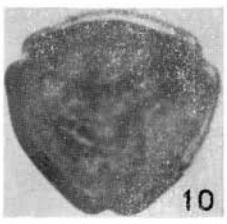
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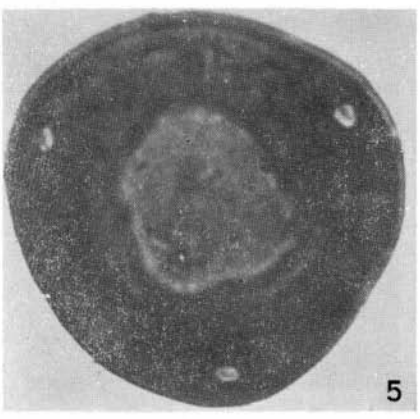
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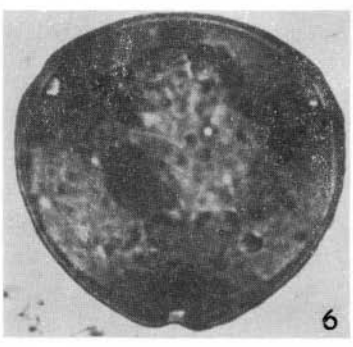
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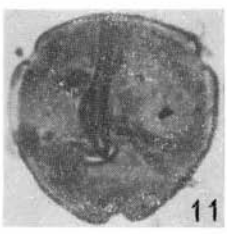
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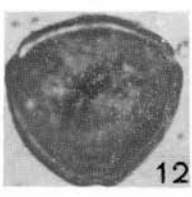
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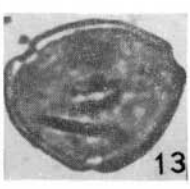
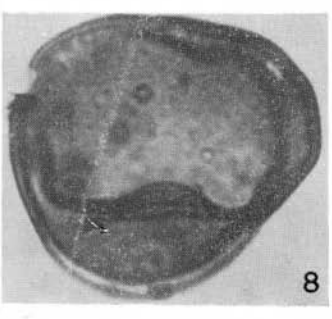

13


7


8

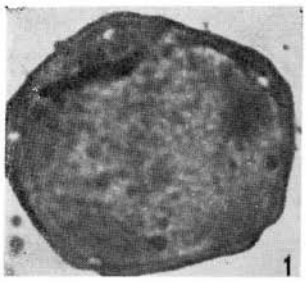

14

Plate X

Tablica X

× 1000

1—11. *Pterocarya* sp.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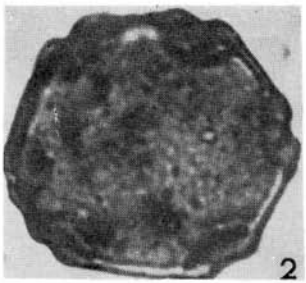
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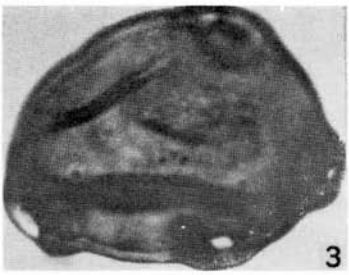
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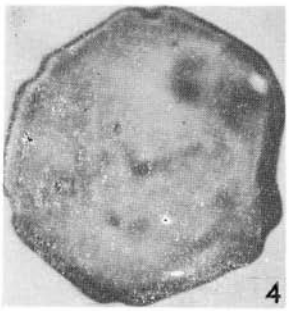
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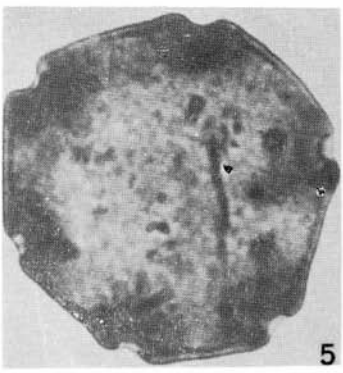
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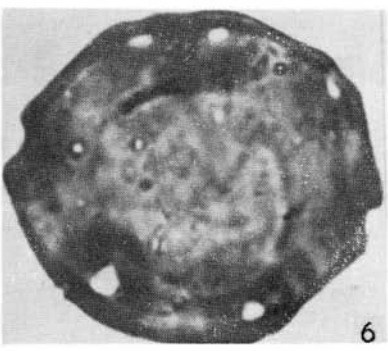
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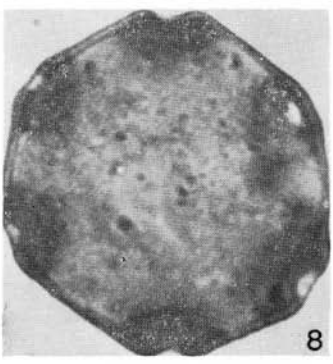
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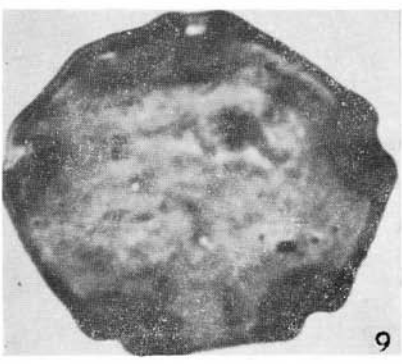
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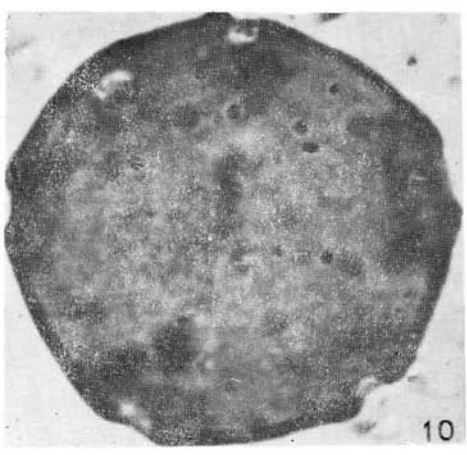
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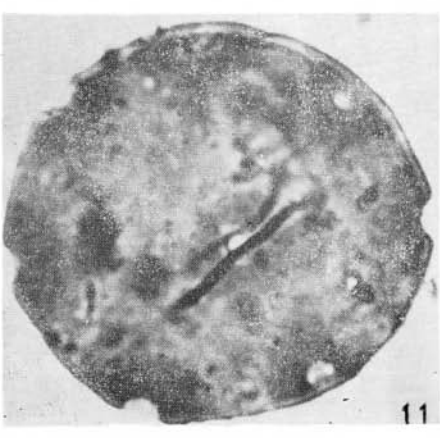
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Plate XI

Tablica XI

× 1000

1—6. *Liquidambar* sp.
7—12. *Parrotia* sp.
13. *Parrotia persica* DC., recent (współczesne)

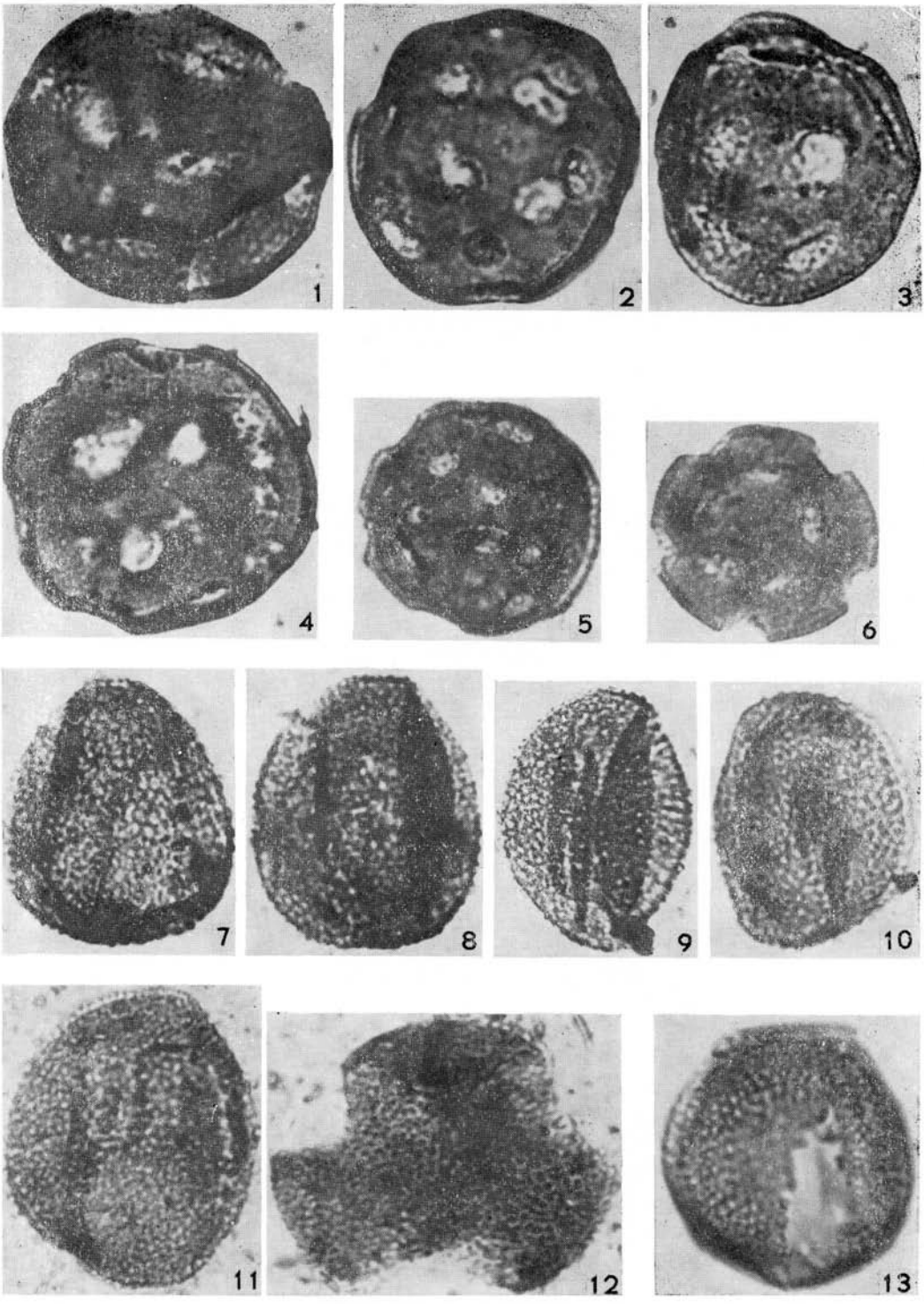
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Plate XII

Tablica XII

× 1000

1— 3. *Eucommia* sp.
4— 8. *Cercidiphyllum* sp.
9—12. *Cercidiphyllum japonicum* Sieb. et Zucc., recent (współczesne)
13—15. *Rosaceae*
16—18. cf. *Laburnum* sp.
19. *Leguminosae*
20. cf. *Decodon* sp.
21. *Nyssa* sp.
22, 23. *Rhus* sp.

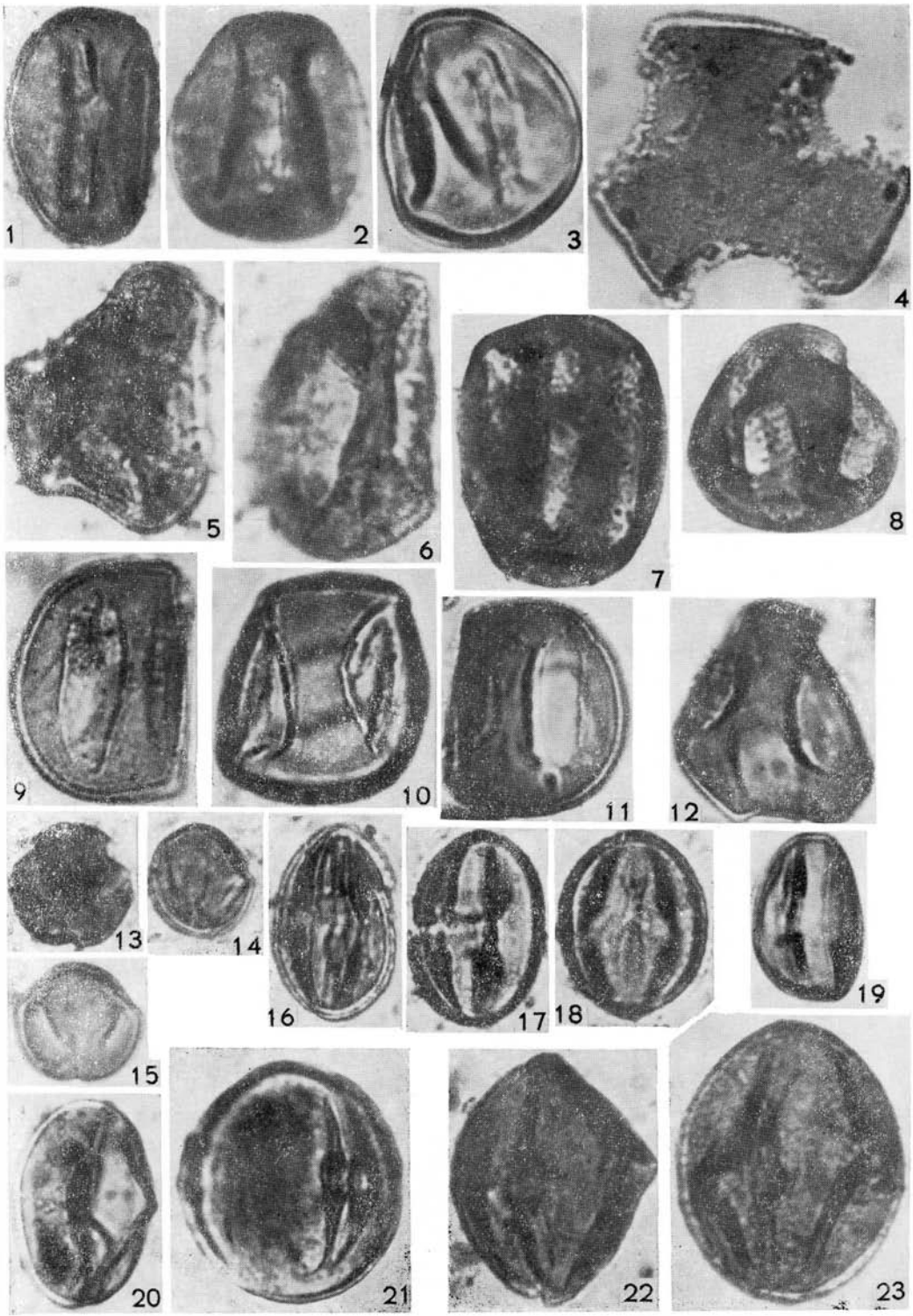
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Plate XIII

Tablica XIII

× 1000

1, 2. *Ilex* sp.
3, 4. *Staphylea* sp.
5. cf. *Zizyphus* sp.
6. *Rhamnaceae*
7— 9. *Vitis* sp.
10. *Partenocissus* sp.
11—15. *Reevesia* sp.
16. *Reevesia longipetiolata* Merril et Chur., recent (współczesne)
17. *Reevesia thyrsoidea* Lindl., recent (współczesne)
18. *Reevesia pubeccens* Mast., recent (współczesne)
19. *Cornus* sp.
20, 21. *Hedera* sp.

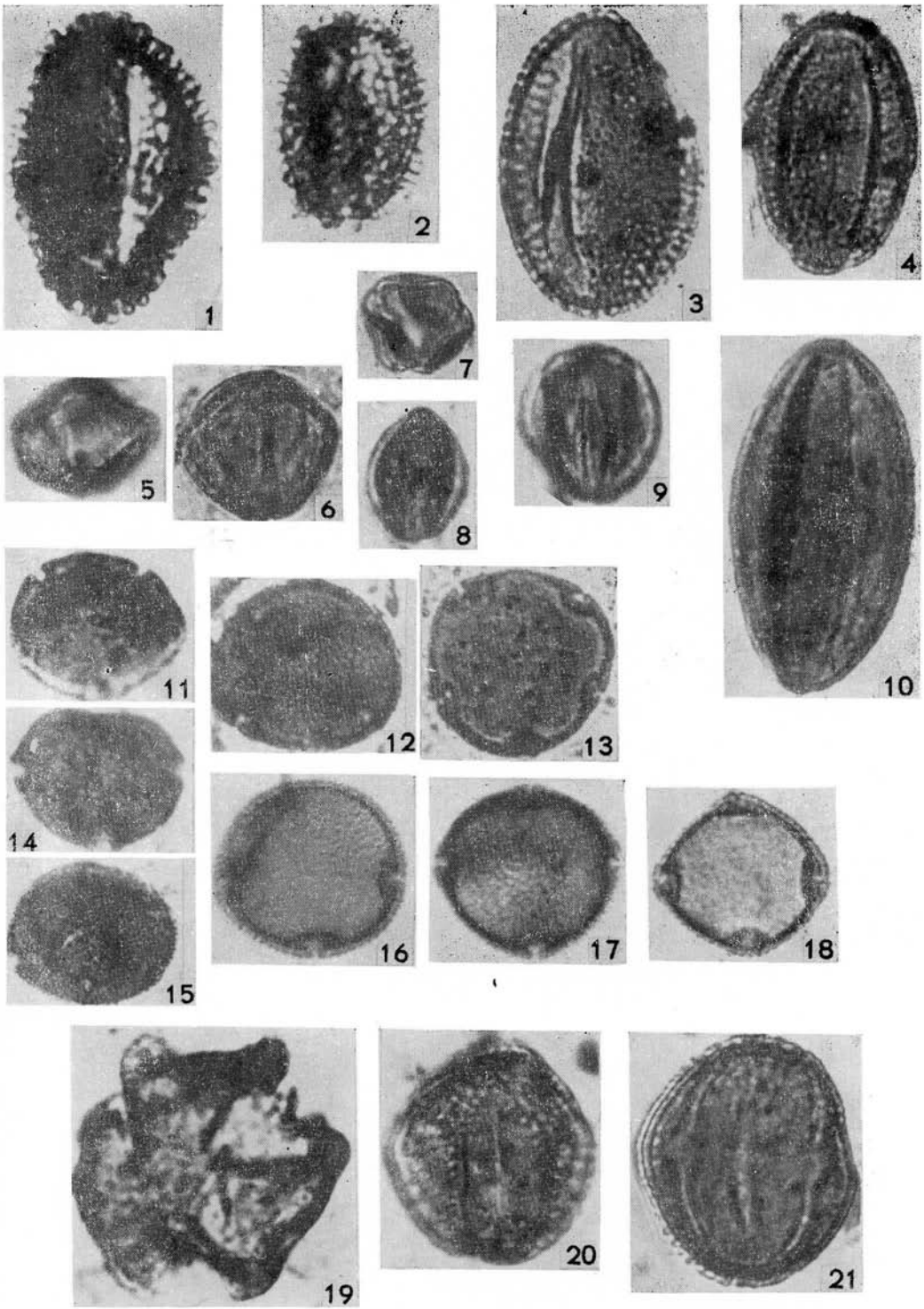

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Plate XIV

Tablica XIV

× 1000

1— 3. *Araliaceae-Cornaceae*, t. *Tricolporopollenites edmundi* (R. Pot.) Th. et Pf.
4, 5. *Symplocos* sp.
6, 7. *Bignoniaceae*
8, 9. *Fraxinus* sp.
10—13. *Oleaceae*
14—15. *Lonicera* sp.
16—18. *Caprifoliaceae*, cf. *Viburnum* sp.

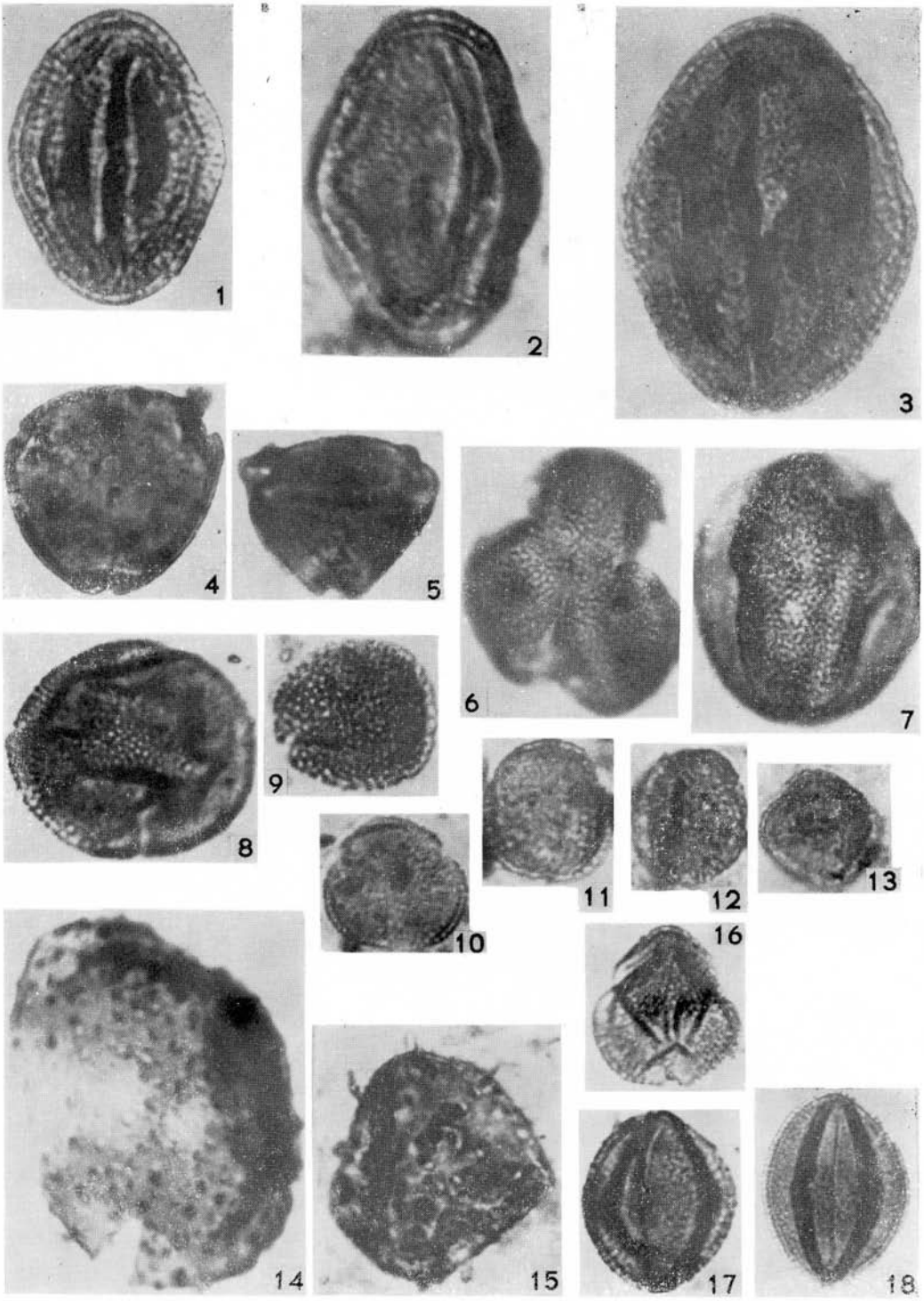
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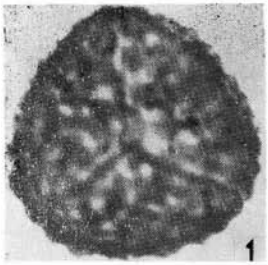
Plate XV

Tablica XV

× 1000

1, 2. *Lycopodium* sp.
3. *Polygonum* t. *persicaria* L.
4, 5. *Oenotheraceae*
6. *Centaurea* sp.
7. *Compositae* subfam. *tubuliflorae*
8, 9. *Gramineae*
10. cf. *Stratiotes* sp.
11. *Sparganium* sp.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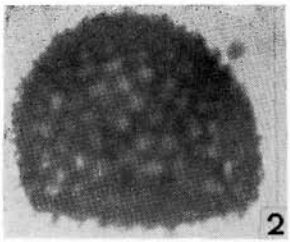
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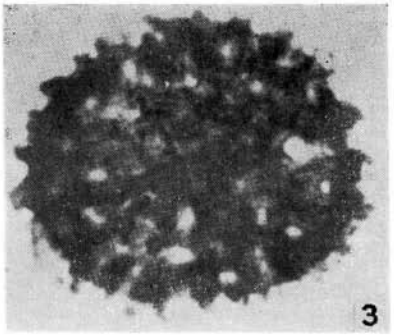
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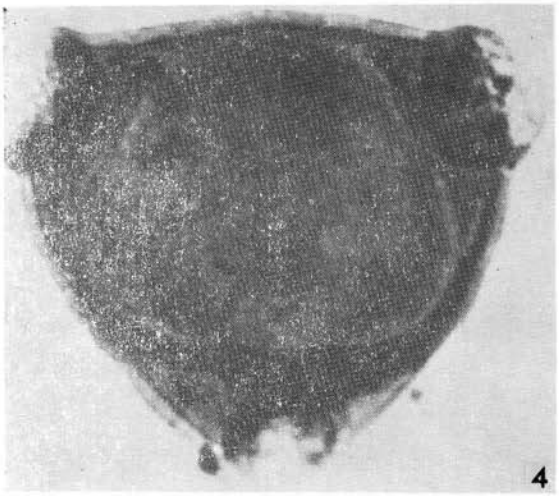
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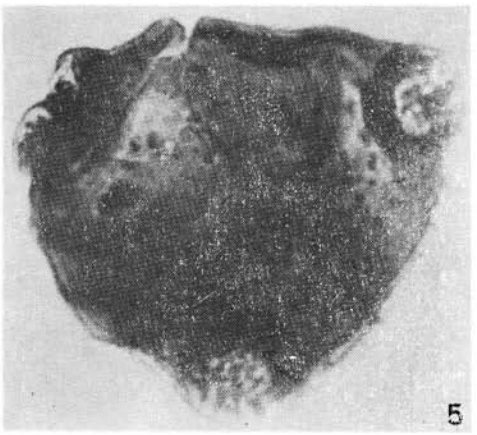
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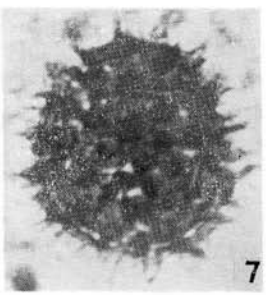
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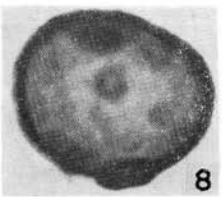
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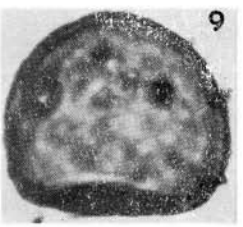
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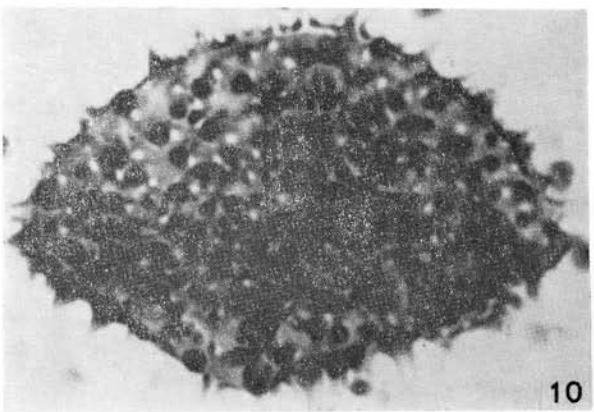
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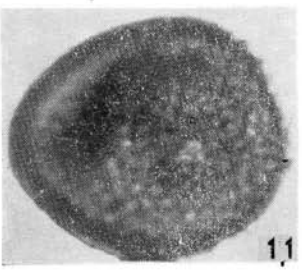
11

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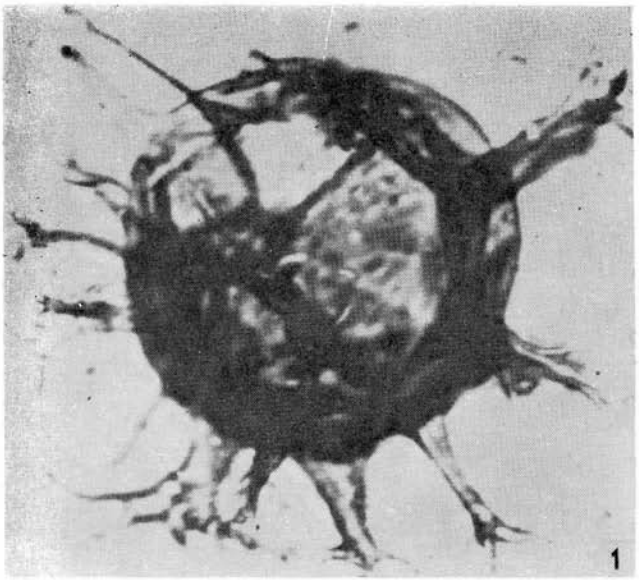
Plate XVI

Tablica XVI

× 1000

1—6. *Hystrichosphaerideae*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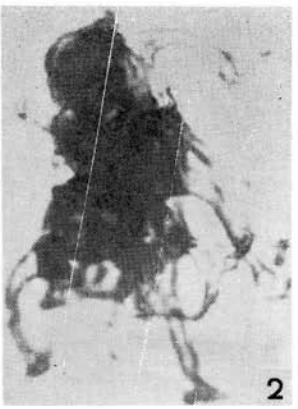
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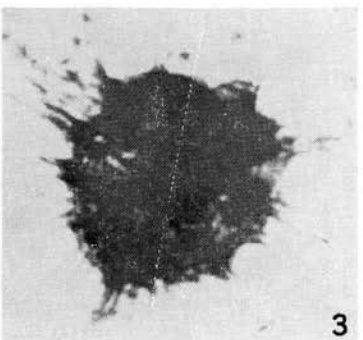
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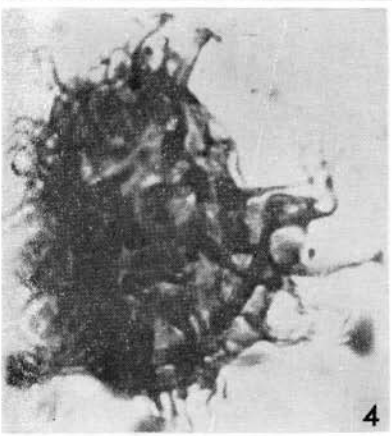
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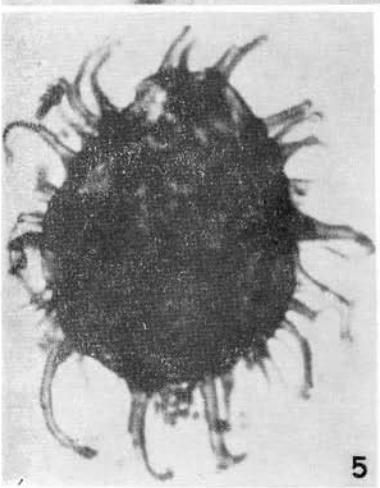
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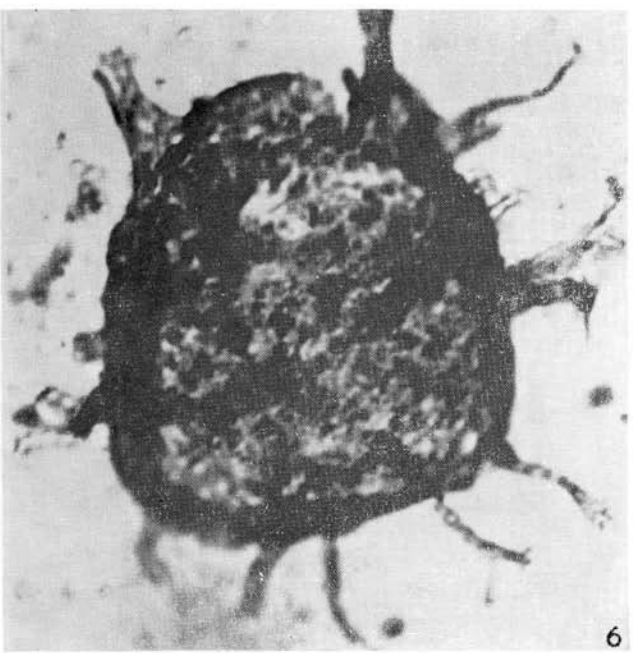
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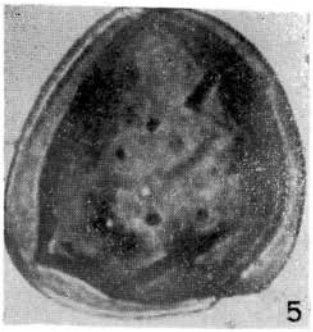
Plate XVII

Tablica XVII

× 1000

1—9. Plankton


1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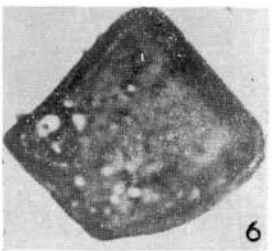
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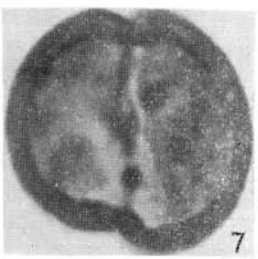
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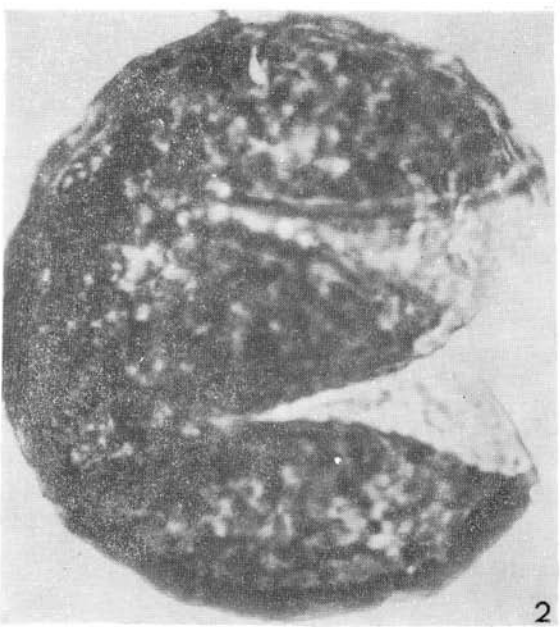
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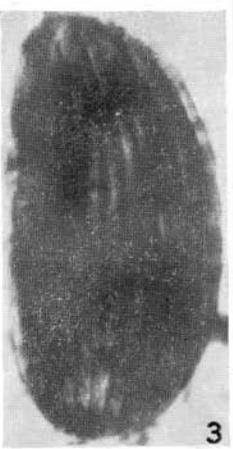
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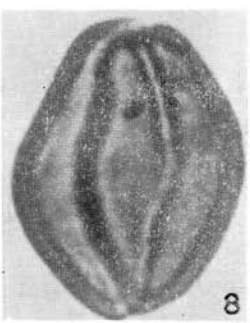
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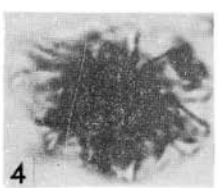
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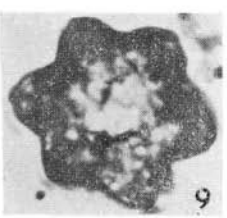
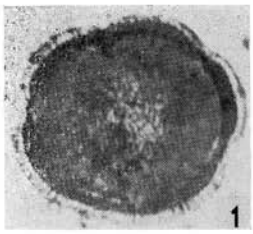

9

Plate XVIII

Tablica XVIII

× 1000

1—19. *Indeterminatae*
1— 7. *Polyporopollenites baculatus* n. spm.
10, 11. *Rosaceae?*
12, 13. *Cornaceae?*
16. *Caprifoliaceae? Rutaceae?*
17. cf. *Bignoniaceae*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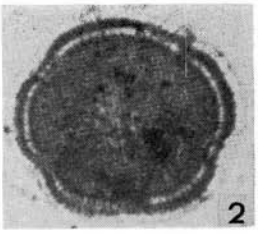
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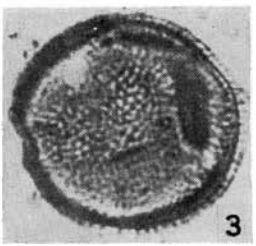
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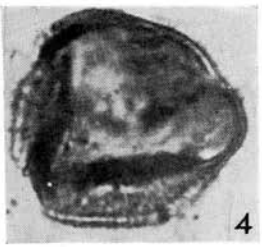
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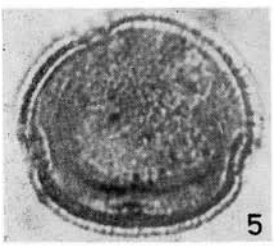
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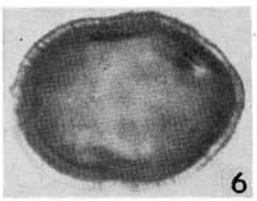
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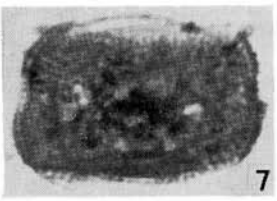
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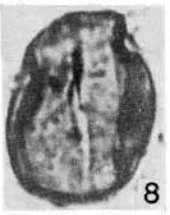
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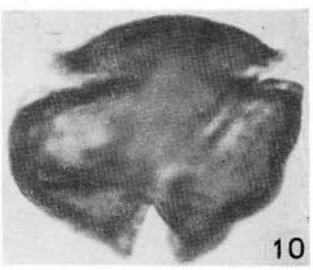
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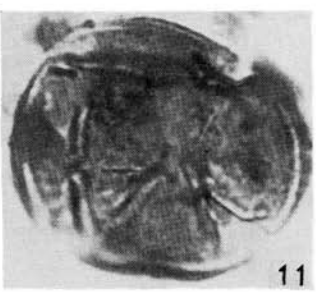
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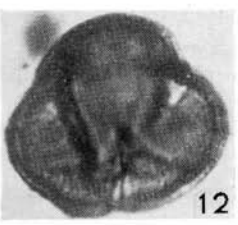
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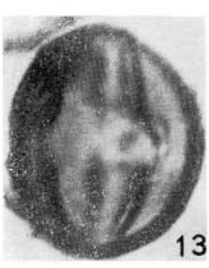
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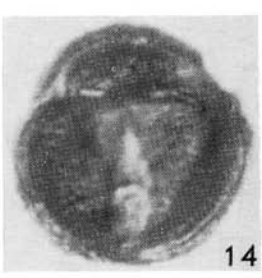
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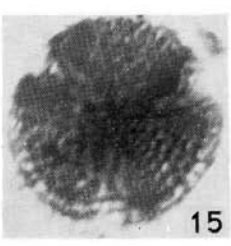
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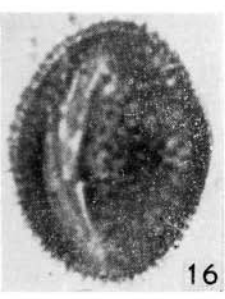
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17


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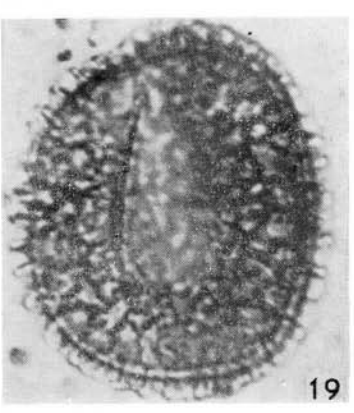
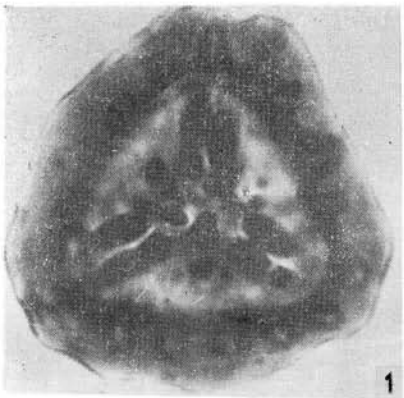

19

Plate XIX

Tablica XIX

× 1000

1—16. *Indeterminatae* rebedded from the older deposits
1—16. *Indeterminatae* namyte ze starszych osadów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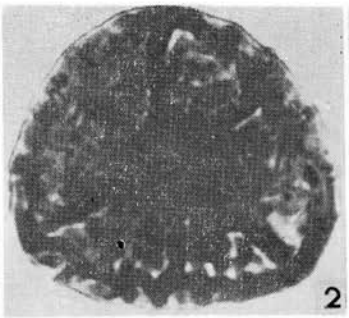
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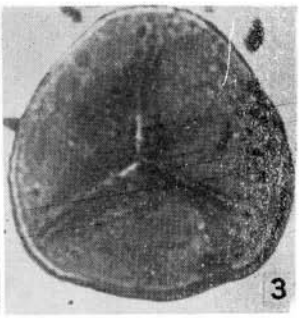
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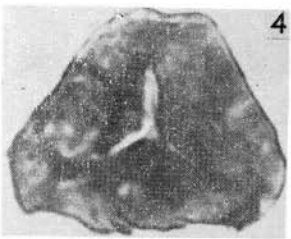
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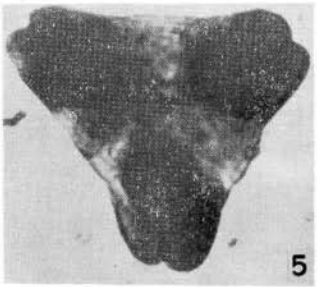
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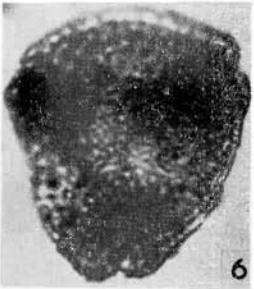
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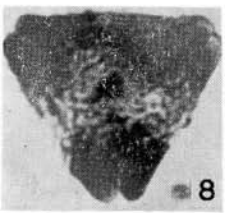
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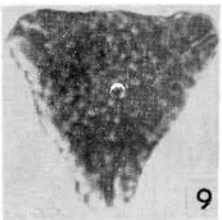
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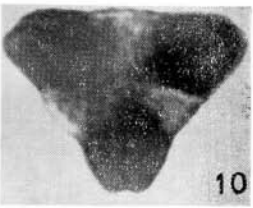
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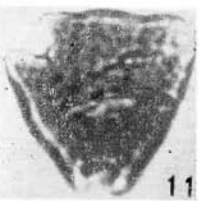
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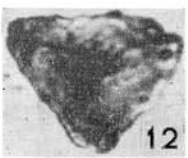
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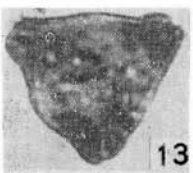
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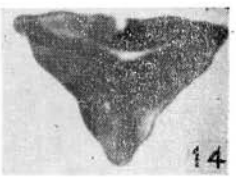
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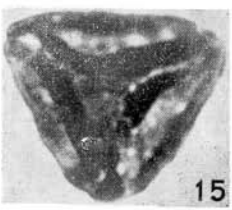
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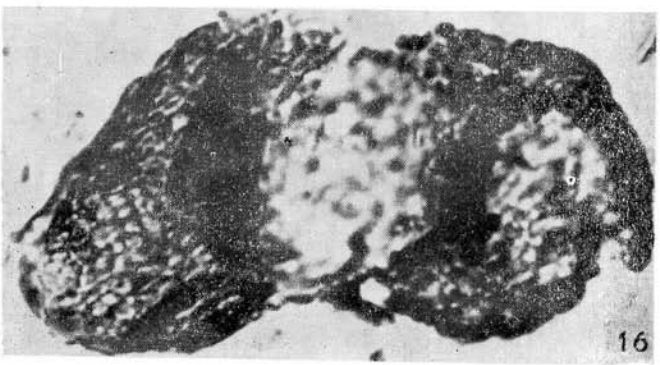
16

Sośnica. Absolute numbers of sporomorphs - Absolutne ilości sporomorf

Table 1
Tabela

Sample Nr / Próbka	Depth / Głębokość m	Pinus t. diploxylon	Pinus t. haploxylon	cf. Pseudolarix	Abies	Keteleeria	Picea	cf. Larix	Tsuga t. diversifolia	Tsuga t. canadensis	cf. Podocarpus	Sciadopitys	Taxodiaceae - Cupressaceae	Salix	Betula	Alnus	Ostrya	Carpinus	Corylus	Fagus	Quercus	Myrica	Ulmus	Zelkova	Celtis	Tilia	Acer
1	0.00-0.05	41	28	-	3	-	1	-	-	-	-	1	27	21	12	27	1	156	3	34	37	3	54	2	3	4	12
2	0.05-0.10	96	36	-	5	-	2	-	-	-	-	-	6	12	9	26	-	193	4	24	22	3	34	-	1	-	2
3	0.10-0.15	60	24	-	1	-	-	-	1	-	-	1	5	5	12	27	-	173	6	9	36	-	74	-	-	4	4
4	0.15-0.20	30	16	-	1	-	-	-	-	-	1	-	10	5	28	34	1	145	-	12	45	-	57	-	-	1	-
5	0.20-0.25	36	26	-	1	-	1	-	-	-	1	3	11	15	36	29	-	188	1	39	35	3	51	3	-	-	8
6	0.25-0.30	42	34	-	2	-	-	-	-	-	1	2	6	4	3	13	-	110	2	8	36	-	46	1	-	8	-
7	0.30-0.35	42	13	-	2	1	-	-	-	-	-	1	4	8	36	13	1	100	1	13	56	1	73	1	-	8	2
8	0.35-0.40	23	8	1	2	-	-	1	-	-	-	-	2	17	33	17	-	140	2	25	50	2	61	3	1	6	7
9	0.40-0.45	39	15	-	-	-	-	1	2	-	1	-	8	35	5	11	1	77	-	16	57	-	96	2	-	1	7
10	0.45-0.50	46	18	1	2	-	-	-	-	2	-	2	15	15	25	23	-	80	8	9	39	4	75	5	-	-	4
11	0.50-0.55	50	25	-	2	-	1	-	2	-	-	2	10	20	15	10	-	70	2	20	50	-	70	3	-	-	10
12	0.55-0.60	29	15	-	1	-	-	-	-	-	1	-	3	8	3	6	-	12	2	3	9	1	36	-	-	-	2
13	0.60-0.65	54	30	-	5	-	-	-	1	-	1	1	1	13	15	9	-	76	1	10	50	1	87	1	1	-	4
14	0.65-0.70	75	30	-	5	-	-	-	1	-	1	2	6	20	15	18	-	20	1	27	65	5	94	-	1	4	5
15	0.70-0.75	72	51	-	5	-	-	-	1	-	1	1	13	17	24	10	-	60	4	15	40	5	25	-	2	5	11
16	0.75-0.80	100	68	-	8	-	2	-	1	-	1	4	9	15	27	9	1	80	5	31	26	10	48	1	2	5	10
17	0.80-0.85	133	115	-	16	3	1	-	1	2	2	-	10	5	67	19	1	67	6	31	35	2	40	1	9	5	11
18	0.85-0.90	109	77	-	11	1	5	-	1	2	4	4	8	5	99	22	-	57	12	21	13	2	78	17	-	3	5
19	0.90-0.95	85	90	-	8	2	1	-	4	-	2	2	13	8	21	14	-	10	6	6	20	-	73	1	3	5	2
20	0.95-1.00	75	39	-	10	-	-	-	3	-	5	-	3	8	30	5	-	12	4	4	8	-	29	-	1	2	-
21	1.00-1.05	116	74	-	9	-	2	-	2	2	1	-	8	2	89	6	-	7	6	10	31	1	30	-	1	2	-
22	1.05-1.10	142	87	1	14	-	1	-	5	1	4	1	9	-	23	8	-	13	2	20	23	1	27	-	1	8	4
23	1.10-1.15	88	68	1	4	-	1	-	1	1	-	3	5	5	25	13	2	34	3	13	16	7	34	-	1	6	2
24	1.15-1.20	104	70	2	6	-	-	-	1	1	2	2	4	3	19	7	1	23	3	9	16	5	34	-	-	10	-
25	1.20-1.25	68	116	-	5	-	1	-	3	2	2	2	7	4	20	6	-	22	1	5	20	-	24	-	1	8	-
26	1.25-1.30	78	120	-	2	-	1	-	1	1	4	1	11	6	29	6	2	15	3	10	19	-	21	-	7	6	-
27	1.30-1.35	117	146	1	6	-	-	-	1	2	8	2	6	1	17	7	2	23	5	11	29	-	25	-	2	4	-
28	1.35-1.40	107	136	-	14	-	-	-	2	1	7	6	10	12	18	2	-	17	4	6	16	4	16	-	-	5	1
29	1.40-1:45	89	165	-	7	-	-	-	1	2	2	3	3	8	21	2	-	8	2	8	13	8	23	-	5	4	-
30	1.45-1.50	102	120	-	6	1	3	-	2	2	4	3	4	8	17	15	-	17	3	5	23	6	36	-	7	4	1
31	1.50-1.55	98	161	-	5	-	-	-	1	6	4	1	2	8	17	6	1	14	4	6	17	-	14	-	3	7	1
32	1.55-1.60	108	121	1	8	-	1	-	7	4	4	1	11	5	24	6	-	13	2	9	11	-	21	-	1	8	-
33	1.60-1.65	105	111	-	10	1	-	-	2	3	2	4	1	11	29	9	-	11	7	7	14	2	12	-	8	3	2
34	1.65-1.70	105	80	1	7	-	-	-	1	2	4	3	1	9	30	7	-	4	4	11	11	2	19	-	4	6	5
35	1.70-1.75	126	136	2	6	2	1	-	1	3	4	5	-	3	22	7	-	7	3	3	13	-	21	-	2	4	1
36	1.75-1.80	64	31	-	1	-	-	-	1	1	-	-	-	-	10	3	-	2	2	4	1	-	12	-	2	6	1
37	1.80-1.85	108	51	-	7	-	1	-	1	1	1	1	3	5	15	5	-	4	3	3	9	-	13	-	2	3	-
38	1.85-1.90	70	78	1	6	-	-	-	-	1	1	1	6	3	13	4	-	4	5	5	15	-	21	-	6	4	-
39	1.90-1.95	120	104	3	7	-	-	-	1	1	2	4	6	4	17	10	-	6	4	3	6	1	20	-	1	2	-
40	1.95-2.00	134	128	1	9	-	1	-	3	-	3	1	3	2	9	2	-	4	3	1	6	-	28	-	1	-	1
41	2.00-2.05	138	189	3	20	-	3	-	5	2	5	-	1	-	16	4	-	9	4	4	10	-	30	-	2	2	-
42	2.05-2.10	54	82	3	7	-	1	-	-	-	3	-	1	-	6	4	-	-	-	1	2	-	14	-	2	-	-
43	2.10-2.15	82	79	-	4	2	2	-	1	1	5	1	4	-	2	-	-	-	1	-	1	-	5	-	-	-	-
44	2.15-2.20	70	86	4	2	-	1	-	-	-	-	-	4	-	5	-	-	-	2	1	4	-	12	-	-	-	-
45	2.20-2.25	108	120	-	4	2	-	-	2	-	1	1	1	-	9	-	-	2	3	2	3	-	17	-	-	1	-
46	2.25-2.30	147	87	-	5	-	-	-	1	-	-	6	-	-	4	2	-	1	-	-	-	-	19	-	2	-	-
47	2.30-2.35	152	148	3	5	-	-	-	-	-	3	1	4	-	4	4	-	1	1	-	-	1	33	-	1	-	-
48	2.35-2.40	85	86	-	6	-	1	-	-	-	1	-	1	1	3	-	-	-	1	1	-	-	7	-	-	-	-

Sample Nr / Próbka	Juglans	Carya	Pterocarya	Engelhardtia	cf. Platycarya	Eucommia	Platanus	Arceuthobium	Liquidambar	~~Corylopsis~~	Parrotia	Itea	Cercidiphyllum	cf. Berberidaceae	cf. Menispermaceae	cf. Moraceae	Rosaceae	cf. Laburnum	Leguminosae	cf. Thymelaceae	Decodon	Punica	Nyssa	Rutaceae
1	2	11	13	12	1	1	2	-	36	-	18	1	-	-	-	1	3	-	9	-	-	-	3	-
2	-	10	11	15	-	-	-	-	49	-	36	-	-	-	-	-	-	-	1	-	-	-	1	-
3	4	11	16	16	-	-	1	-	53	-	45	-	1	-	-	-	2	-	1	-	-	-	2	-
4	-	9	7	4	-	-	1	-	45	-	40	-	-	-	-	-	2	-	3	-	-	-	-	-
5	1	11	17	11	-	2	1	-	35	-	23	-	-	-	-	-	-	-	2	-	-	-	1	-
6	1	4	13	7	1	-	-	-	31	-	4	-	-	-	-	-	2	-	1	-	-	-	3	-
7	1	9	25	14	1	1	-	-	35	-	23	-	-	-	-	-	2	-	8	-	-	-	1	1
8	-	4	12	5	-	-	1	-	38	-	13	-	1	-	-	-	4	-	-	-	-	-	-	-
9	4	7	12	34	1	-	5	-	26	-	16	-	1	-	-	-	1	-	6	-	-	-	-	-
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12	5	22	13	8	-	-	-	-	9	-	2	-	-	-	-	-	-	-	1	-	-	-	1	-
13	8	11	39	22	-	-	1	-	36	-	8	-	-	-	-	-	1	-	3	-	-	-	-	-
14	6	11	26	12	-	-	-	-	25	-	16	1	-	1	-	-	-	-	-	-	-	-	-	-
15	-	16	36	21	-	-	-	-	23	-	23	-	-	-	-	-	1	-	2	-	-	-	-	-
16	3	16	33	11	-	-	1	-	27	1	18	-	-	-	-	-	1	-	6	-	-	-	-	-
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25	-	22	15	19	-	-	-	-	10	-	1	-	-	-	-	-	3	-	3	-	-	-	1	1
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36	-	7	8	5	-	-	-	-	5	-	-	-	-	-	-	-	-	-	6	-	-	-	1	-
37	-	7	15	9	-	-	-	-	2	-	-	-	-	-	-	-	1	-	3	-	-	-	-	1
38	-	15	10	6	-	-	-	-	6	-	-	-	1	-	-	-	2	-	-	-	-	-	2	-
39	-	28	9	23	1	-	-	-	5	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
40	-	12	8	15	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-	2	-
41	1	19	9	8	-	1	-	-	3	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
42	1	4	4	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
43	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
44	-	4	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	3	2	1	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	8	7	3	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	11	7	7	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
48	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sample Nr / Próbka	Meliaceae	Rhus	Anacardiaceae	Ilex	Staphylea	Cyrillaceae	Rhamnaceae	Vitis	Partenocissus	Reevesia	Tamarix	Cornaceae	Hedera	Araliaceae	Araliaceae - Cornaceae	cf. Styrax	Ericaceae	Symplocos	Bignoniaceae	Olea	Fraxinus	Ligustrum	Oleaceae	Rubiaceae	Lonicera	Sambucus	Viburnum	Caprifoliaceae	Sphagnum	Botrychium	Lycopodium	cf. Selaginella	Osmunda	Filicinae
1	-	1	-	1	1	-	-	3	-	-	1	-	-	-	-	2	-	3	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	7
2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	5
3	-	-	-	2	1	-	-	3	1	-	-	1	-	-	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	5
4	-	-	-	2	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	-	1	-	-	3	-	-	3	-	1	-	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-	1	-	-	-	2	-	-	5
6	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	6
7	-	-	-	2	-	-	1	5	-	-	-	-	-	1	-	-	-	1	-	-	1	-	1	-	-	-	1	-	-	-	-	-	1	2
8	-	-	-	-	1	-	-	5	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1
9	-	-	1	-	-	-	-	5	-	1	-	1	-	-	-	-	-	2	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	6
10	-	2	-	1	-	-	-	1	-	-	1	-	-	-	-	-	1	1	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-	7
11	-	1	-	2	-	-	-	-	-	-	-	1	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
12	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4	-	-	-	-	-	-	-	1	-	-	8
13	-	1	-	2	1	2	-	-	-	-	1	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	5
14	-	3	-	2	-	-	-	-	-	-	1	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	5
15	-	-	-	4	-	-	-	-	-	-	1	1	2	-	3	-	-	-	-	-	3	-	1	-	-	-	-	-	3	-	1	-	-	28
16	-	-	-	6	-	-	-	-	-	1	1	2	-	-	3	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	1	1	-	37
17	1	1	-	6	1	-	1	-	-	-	1	-	-	-	7	-	1	2	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	28
18	-	-	-	4	-	-	-	-	-	-	1	-	2	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	29
19	-	-	-	6	1	-	1	1	-	-	-	4	-	2	7	-	-	1	-	-	1	-	3	1	-	-	2	-	-	-	3	-	-	50
20	-	-	-	3	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-	25
21	-	-	-	5	-	-	-	1	-	-	-	1	1	-	5	-	1	1	-	-	1	-	3	-	-	-	-	-	-	-	-	-	1	56
22	-	1	-	7	1	-	1	-	-	-	-	-	-	-	3	-	2	2	-	-	-	1	2	-	-	-	-	-	2	-	1	-	-	37
23	-	4	-	10	2	-	1	-	-	1	1	2	-	3	6	-	3	-	1	-	2	-	2	-	1	-	-	2	1	-	-	-	-	21
24	-	4	-	5	1	-	-	2	-	-	-	1	-	2	10	-	1	1	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	16
25	-	3	-	1	-	-	1	1	-	-	-	-	-	2	1	-	-	1	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	35
26	-	-	-	5	-	-	1	-	-	1	-	1	-	2	8	-	-	-	-	-	1	-	3	-	-	-	1	-	-	-	1	-	-	63
27	-	-	-	3	2	1	-	-	-	-	-	1	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	58
28	-	1	-	6	1	-	1	1	-	2	-	-	1	2	6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	48
29	-	2	-	8	-	-	-	-	-	-	-	2	-	-	5	-	1	-	-	-	-	-	6	-	-	-	-	-	1	1	1	-	1	60
30	-	-	-	-	-	-	1	-	-	-	-	2	-	2	6	-	1	2	-	-	-	-	1	-	-	-	1	1	1	-	1	-	-	44
31	-	4	-	6	-	-	1	-	-	-	-	2	-	1	6	-	2	3	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	69
32	-	2	-	11	1	-	1	1	-	-	-	1	2	2	8	-	2	1	-	-	-	-	2	-	1	-	-	-	1	-	-	-	-	77
33	-	4	-	7	1	-	-	3	-	1	1	1	-	1	5	-	-	3	1	-	-	-	2	-	1	-	-	1	-	-	-	-	-	50
34	-	9	-	8	1	-	1	2	-	-	-	-	-	5	13	-	2	3	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	39
35	-	4	-	10	1	-	1	1	-	1	-	-	-	6	13	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	1	-	-	47
36	-	1	-	7	1	-	1	-	-	-	-	-	-	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
37	-	2	1	6	-	-	-	1	-	-	-	-	-	1	5	-	2	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	26
38	-	-	-	1	1	-	-	-	-	-	-	1	-	2	1	-	1	-	-	-	-	-	2	-	-	-	-	1	-	-	1	-	-	17
39	-	-	-	-	-	-	-	1	-	1	-	3	-	-	2	-	1	1	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	27
40	-	-	-	2	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	3	-	-	-	-	1	-	-	-	-	-	12
41	-	-	-	1	1	-	-	1	-	-	-	-	-	1	-	-	-	1	-	-	2	-	2	-	-	-	1	-	-	-	1	-	-	12
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	9
43	-	-	-	1	-	-	-	-	-	-	-	1	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	5
44	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
45	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	3
47	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	1	-	-	27
48	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	6

Sample Nr / Próbka	Polygonaceae	Chenopodiaceae	Caryophyllaceae	Papaveraceae	Oenotheraceae	Umbelliferae	Labiatae	Plantaginaceae	Artemisia	Centaurea	Compositae	Butomus	cf. Stratiotes	Potamogeton	Liliaceae	Cyperaceae	Gramineae	Sparganium	Typha	Monocotyledones indeterminatae	Pollenites laesus	Polyporopollenites baculatus n. spm.	Indeterminatae	Indeterminatae of older sediments ze starych osadów	Triceratium	Hystrichosphaeridae	Plankton indeterminatae
1	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	2	-	3	-	1	-	-	36	2	-	6	-
2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	2	-	1	1	-	34	4	-	-	-
3	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	24	-	-	1	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	4	-	1	-
5	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	23	-	-	1	-
6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	11	4	-	2	-
7	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	1	-	-	1
8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	20	6	-	1	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	4	-	10	-	-	33	4	-	3	-
10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	11	3	-	1	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	23	4	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	30	34	-	-	-
13	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-	27	14	-	-	-
14	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	17	19	-	-	-
15	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	2	-	-	1	-	1	35	26	-	1	-
16	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-	30	17	-	1	-
17	-	-	-	-	1	-	-	-	-	-	3	-	2	2	-	-	2	-	-	1	-	-	24	3	-	5	-
18	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	1	-	-	4	-	-	21	6	-	22	1
19	-	-	-	-	1	-	-	1	-	1	1	-	1	-	-	-	4	2	-	3	-	1	28	6	-	29	-
20	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	21	16	-	30	-
21	-	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	7	-	-	-	-	-	38	6	-	44	-
22	-	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	4	1	32	9	-	35	-
23	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1	4	-	-	2	2	4	54	40	-	9	1
24	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	1	-	1	25	30	-	4	-
25	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	2	-	-	45	39	1	8	-
26	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4	-	-	2	-	4	34	17	-	2	-
27	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	2	-	1	-	1	52	19	-	3	-
28	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	-	-	2	1	-	44	18	-	4	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	1	5	27	7	-	8	-
30	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3	-	1	-	-	5	48	5	-	2	-
31	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	1	-	-	-	3	-	6	31	20	-	4	-
32	-	-	-	-	1	-	1	-	-	-	1	-	-	-	3	-	1	1	-	3	-	7	28	19	-	13	-
33	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	1	-	4	27	16	-	-	-
34	-	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	2	-	7	-	10	17	3	-	6	-
35	-	-	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	5	-	15	20	6	-	7	-
36	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	10	10	5	-	2	-
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	6	26	13	-	-	-
38	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3	-	6	27	4	-	1	-
39	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	2	-	-	1	-	6	19	1	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	21	2	-	-	-
41	-	-	-	1	-	-	1	-	-	-	1	-	-	-	-	-	2	-	-	1	1	-	20	1	-	1	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	4	8	3	-	1	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	9	2	-	1	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5	2	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-
46	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	9	1	-	-	-
47	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	5	35	5	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	3	-	-	-

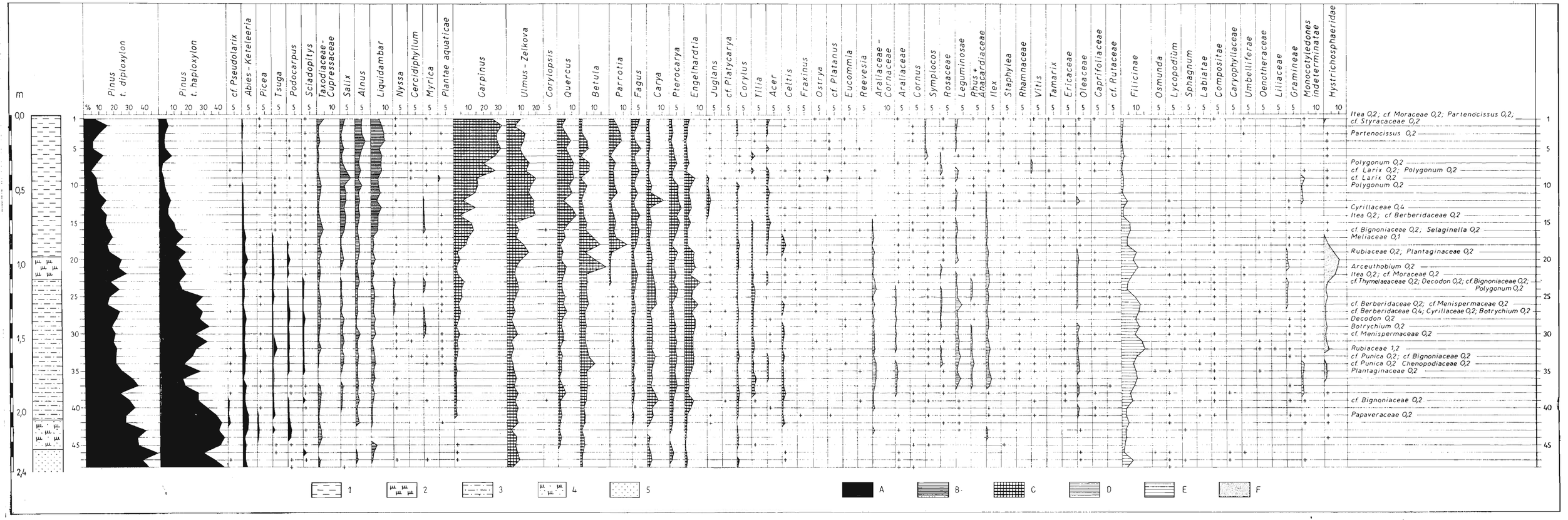

Fig. 4. Sośnica, pollen diagram. 1 — grey clay; 2 — dusty mud; 3 — sandy grey clay; 4 — sandy mud; 5 — fine-grain sand with admixture of clay. A — *Coniferae* (excluding *Taxodiaceae* and *Cupressaceae*); B — plants of wet habitats; C — plants of drier and dry habitats; D — shrubs; E — herbaceous plants; F — *Hystrichosphaeridae*

Ryc. 4. Sośnica, diagram pyłkowy. 1 — ił szary, 2 — mułek pylasty; 3 — ił szary zapiaszczony; 4 — mułek pylasty z domieszką piasku; 5 — piasek pylasty z domieszką iłu. A — drzewa szpilkowe (z wyłączeniem grupy *Taxodiaceae-Cupressaceae*); B — roślinność siedlisk wilgotnych; C — roślinność siedlisk suchszych i suchych; D — krzewy; E — rośliny zielone; F — *Hystrichosphaeridae*