EWA ZASTAWNIAK

PLIOCENE LEAF FLORA FROM DOMAŃSKI WIERCH NEAR CZARNY DUNAJEC (WESTERN CARPATHIANS, POLAND)

Plioceńska flora liściowa z Domańskiego Wierchu koło Czarnego Dunajca (Karpaty Zachodnie, Polska)

ABSTRACT

In the sediments of the Neogene age preserved at the foot of the High Tatra Mts in the Nowy Targ—Orava Basin there occur in the 228 m deep profile abundant macroscopic and microscopic plant remains (fruits, seeds, leaves, lignites etc.). The paper contains the results of investigation of leaf impressions found at two levels of the cone named Domański Wierch. On the basis of morphological features 389 specimens were determined, belonging to 14 families (*Equisetaceae, Betulaceae, Fagaceae, Juglandaceae, Salicaceae, Ulmaceae, Hamamelidaceae, Platanaceae, Aceraceae, Vitaceae, Cornaceae, Cyperaceae, Gramineae,* and *Typhaceae*), 22 genera, and 28 species, 9 of them species new to the Tertiary of Poland.

An attempt to reconstruct the vegetation led to the conclusion that the fossil material represents a mesophilous deciduous forest without conifers. The composition of the forest resembles those to be found growing to-day in the lowland and submontane zones in the region of the Talish and Elbrus Mts.

The leaf flora of Domański Wierch is considered to be Pliocene because of the small amount of older (Miocene) forms known from localities in the Slovak part of the Orava Basin. The composition of the flora is most similar to the Pliocene floras from Dřevenik and Willershausen.

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INTRODUCTION

The Domański Wierch (735 m above sea-level) is an elevation constituting the south-eastern border of the Orava part of the Nowy Targ—Orava Basin (Fig. 1). Its steep south-eastern slopes are cut by the deep Jaszczury Gorge. Here in 1947 Prof. Dr Józef Gołąb discovered a layer of clays containing numerous impressions of leaves. The results of later geological and palaeobotanical investigations carried out on Domański Wierch and in its immediate neighbourhood aroused great interest (Szafer 1950; Birkenmajer 1954, 1958). In the years 1956/57 the Institute of Geology sank a special bore-hole on Domański Wierch. The bore did not reach the bottom of Neogene sediments as it was interrupted for technical reasons at a depth of 228 m (Urbaniak 1960). The material from the boring served for the elaboration of a detailed geological profile (Urbaniak l. c.) and subsequently was put at the disposal of the Department of Palaeobotany of the Institute of Botany of the Polish Academy of Sciences, where macroscopic and microscopic examinations by the pollen analysis method were begun. The preliminary results of investigations on the fruit and seed flora were published by Łańcucka-Środoniowa (1965) and those of palynological studies by Oszast (1970).

DOMAŃSKI WIERCH IN THE LIGHT OF GEOLOGICAL INVESTIGATIONS

The geological profile of Domański Wierch was published by Birkenmajer (1954, 1958). The author distinguished in it 12 series of alternately occurring gravels and conglomerates, and shaly and sandy clays (Fig. 2).

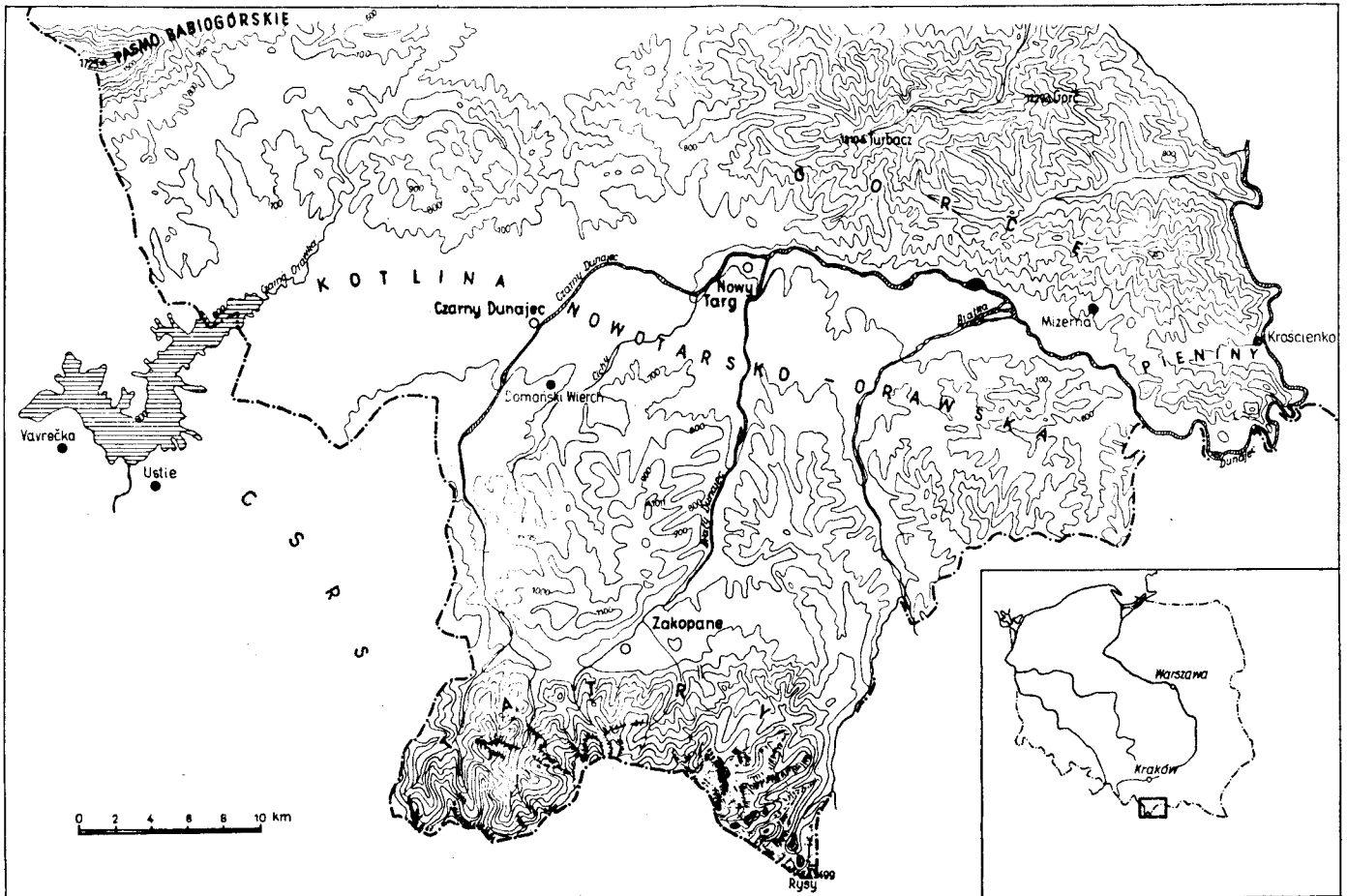

Fig. 1. Situation of Domański Wierch in the Nowy Targ–Orava Basin.
Ryc. 1. Położenie Domańskiego Wierchu w Kotlinie Nowotarsko-Orawskiej.

All clay series contain a fruit and seed macroflora and some of them a leaf flora as well.

According to Birkenmajer (1954) Domański Wierch is a cone raised in the Neogene from material brought in by a system of streams which flowed from elevations of the Podhale Flysch and the Klippen Belt Zone lying in the South and South-East. On the basis of preliminary results of geological investigations Birkenmajer (l. c.) concludes that on account of the probable relation of the Domański cone with Tortonian lignite clays covering the adjacent Orava Basin, the Tortonian can be accepted as the lowest age limit of the cone. On the basis of Szafer's (1950) stratigraphic estimate, Birkenmajer relates the particular lithological series (0—XI) with the successive Neogene stages (Upper Miocene, Mio-Pliocene and Pliocene). He determines the age of series XII about 3·30 m thick as Pleistocene.

In the profile obtained from a boring Urbaniak (1960) distinguished two parts, differing both lithologically and petrographically. In the upper part (0—14 m) clayey deposits occur, containing boulders of Tatran quartzites in the top to a depth of 2 m, whereas the lower part of the profile (14—228 m) is built of alternate clayey-shaly and gravelly-conglomeratic layers. Beginning from the depth of 142·5 m the thickness of the gravelly-conglomeratic deposits markedly increases. In the clayey layers of the profile plant remains occur (impressions of leaves, lignites) as well as macrofauna in the form of Gastropod shells or fragments of them. Urbaniak distinguished fifteen levels, twelve of which (I—III, VI—X, XII—XV) contained flora, two (IV, XI) macrofauna, and one (V) both flora and macrofauna.

In the discussion on the origin of Domański Wierch Urbaniak (l. c.) presumes that its clayey-gravelly deposits accumulated in a deep depression of the terrain, possibly of tectonic origin. This depression was first filled with rock material proceeding from the Podhale Flysch, and later, in the top part, from the Tatra Mts. The presence of numerous, well preserved fragments of plants and shells of Gastropods may, in this author's opinion, indicate accumulation in a continental fresh-water basin.

The geological profile obtained from boring did not provide sufficient evidence to determine the age of the Domański Wierch sediments. Urbaniak referring to Birkenmajer (1954), relates the highest lying in the profile (to a depth of 2 m) clayey deposits containing Tatran quartzites with sediments of the Cracovian Glaciation. The lower lying loam (2—14 m in depth) may in her opinion also be of Pleistocene age, or else it represents the final stage of sedimentation of the Neogene or its passing to the Pleistocene.

Additional data concerning the origin of the Domański cone were provided by investigations of the grain composition of its gravels by Plewa

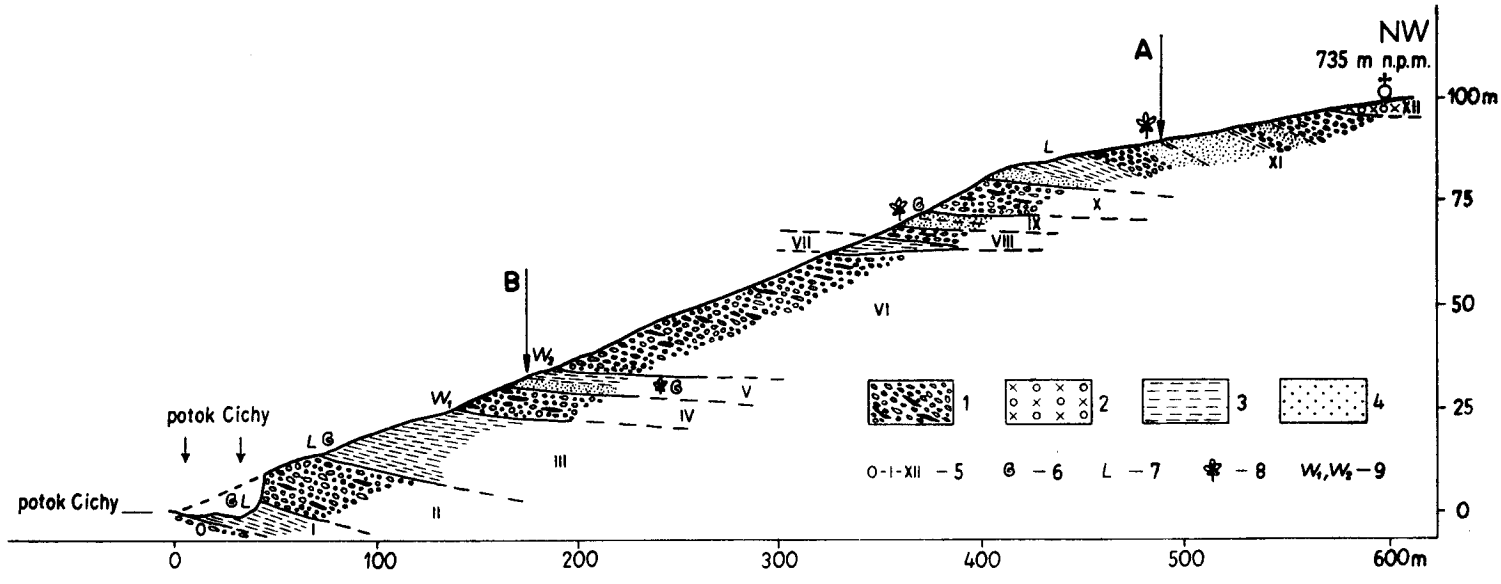

Fig. 2. Geological profile of Domański Wierch from the stream Cichy through the Jaszczury Gorge to the shrine at the top of Domański Wierch (after Birkenmajer 1958) 1 — gravels and conglomerates, sandstones with lenticles of clay slates and sandstones; 2 — loam with Tatra gravels; 3 — clays, clay slates, shales, often sandy; 4 — sands; 5 — lithological series; 6 — fauna of Gastropods; 7 — lignites and seeds; 8 — leaves; 9 — water-bearing levels. Levels of leaf flora: A — level under the wayside shrine; B — level of magnolia flora.

Ryc. 2. Profil geologiczny Domańskiego Wierchu poprowadzony od potoku Cichego przez Wąwóz Jaszczurów do kapliczki na szczycie Domańskiego Wierchu (według Birkenmajera 1958) 1 — żwiry oraz zlepieńce i piaskowce z soczewkami iłołupków i piaskowców; 2 — gliny ze żwirami tatrzańskimi; 3 — iły, iłołupki, łupki często piaszczyste; 4 — piaski; 5 — kompleksy litologiczne; 6 — fauna ślimaków; 7 — lignity i nasiona; 8 — liście; 9 — poziomy wodonośne. Poziomy flory liściowej: A — poziom pod kapliczką; B — poziom flory magnoliowej.

(1969) who corroborated the hitherto existing assumption (Birkenmajer 1954) that Domański Wierch is a cone raised from Flysch material brought in by a system of streams flowing from the SW, SSE, and ESE, gravels carried from the south-east predominating here. The occurrence of gravel series directly above clayey levels testifies to a violent change of sedimentation conditions, brought about in all probability by tectonic movements.

THE HITHERTO OBTAINED RESULTS OF PALAEOBOTANICAL INVESTIGATIONS

The first information on the occurrence of Neogene clays with lignites in the locality of Ciche near Domański Wierch was given by Raciborski (1892). They were later recorded by Halicki (1930) in the whole area of Orava. Szafer (1950), on the basis of preliminary investigations, distinguished five levels with remains of fossil flora in the profile of Domański Wierch:

Level one, in an outcrop lying above the stream Cichy beyond the Jaszczury Gorge, containing numerous lignites and a fruit and seed flora with *Magnolia, Liquidambar, Ilex, Carpinus, Tetrastigma,* and *Vitis teutonica;*

Level two, lying slightly above the outlet of the gorge, with *Diclidocarya menzelii,* and *Decodon globosus,* as well as crumbled shells of molluscs;

Level three, consisting of bedded clays, containing leaf and seed flora in which seeds of the *Magnolia* genus predominate;

Level four, clayey sands with poorly preserved flora probably composed of *Coniferae* remains;

Level five, clayey with leaf flora and lignites, lying in the top of the profile under a wayside shrine.

On the basis of plant remains found in these levels, Szafer (1950) assigned the first two levels to the Middle or Upper Miocene, the third to the Miocene or Mio-Pliocene, and the fifth, covered with Pleistocene loam, also to the Tertiary.

Further results of palaeobotanical investigations on Domański Wierch are reported in the publications of Łańcucka-Środoniowa (1963, 1965). In material proceeding from outcrops and from a geological boring she determined about 80 forms (trees, shrubs, and herbaceous plants), representing various plant communities. Some of the trees mentioned were determined on the basis of impressions of leaves (*Fagus, Liquidambar europaea, Parrotia fagifolia, Populus, Quercus, Zelkova ungeri*). Conclusions from these preliminary investigations were presented as follows by Łańcucka-Środoniowa (1965): 1. The fossil flora from Domański

Wierch provides no evidence of the existence of an open water body, though suggesting the occurrence of small and shallow bodies of water as well as of damp terrains. 2. Ecologically, this flora presumably proceeds from one zone of mountain vegetation built chiefly of deciduous trees and

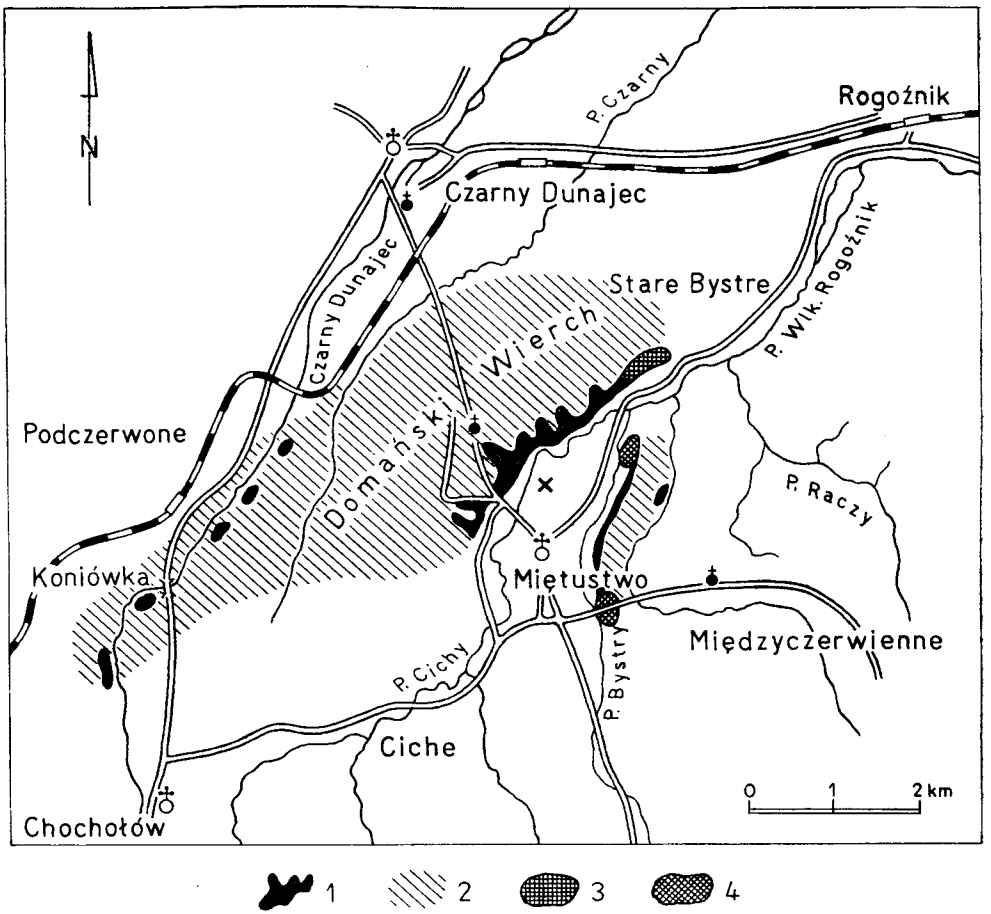

Fig. 3. Location sketch of Domański Wierch (after Birkenmajer 1958). 1 — outcrops of Neogene; 2 — neogene in shallow bedding; 3 — outcrop of the Branisko series at Stare Bystre; 4 — outcrop of the Podhale Flysch at the contact with the Neogene; x — outlet of the Jaszczury Gorge.

Ryc. 3. Szkic sytuacyjny Domańskiego Wierchu (według Birkenmajera 1958). 1 — odsłonięcia neogenu; 2 — neogen w płytkim podłożu; 3 — odsłonięcie serii braniskiej w Starem Bystrem; 4 — odsłonięcie fliszu podhalańskiego w kontakcie z neogenem; x — wylot Wąwozu Jaszczurów.

shrubs, this being evidenced by the insignificant proportion of coniferous trees. 3. From the stratigraphical point of view Łańcucka-Środoniowa considers that the lignite clays occurring in the bottom of Do-

mański Wierch are related to those of Orava, and are probably of Tortonian age, whereas the overlying clayey-gravelly layers are younger and could proceed from the Sarmatian; she also considers that in the course of further investigations younger stratigraphic stages may be distinguished.

Some new information on the fossil flora of Domański Wierch was provided by palynological investigation of the profile obtained from a geological boring (Oszast 1970). A particularly interesting result of these investigations was that the deposits of Domański Wierch were accepted as being of the Youngest Pliocene age.

Investigations on fruit and seed floras from Domański Wierch and from its immediate neighbourhood as well as from Neogene stands in the adjacent Orava, are being continued by Dr M. Łańcucka-Środoniowa. Also Dr J. Oszast and Dr L. Stuchlik are carrying out palynological investigations on materials proceeding from deep borings made by the Institute of Geology in the Czarny Dunajec and Koniówka, that is in the immediate neighbourhood of the Domański Wierch (Fig. 3). It may therefore be presumed that the joint results of the earlier and present investigations will, in the near future, provide a much better picture of the vegetation of this part of the Podhale region in the Neogene.

MATERIAL AND METHODS OF INVESTIGATIONS

The specimens of leaf flora described in the present work were collected on several occasions on Domański Wierch. They proceed chiefly from natural outcrops in the Jaszczury Gorge. In the years 1953—54 they were collected there by M. Sc. H. Bałutowa. In 1954 Dr K. Szczepanek and M. Sc. M. Wąs obtained from outcrops and diggings made along the whole profile of Domański Wierch further materials for palaeobotanical investigations, including specimens of leaf flora. The last lot of material was collected by the present author in 1964 from an outcrop in the Jaszczury Gorge. Some impressions of leaves were found in the material proceeding from boring in samples 154 (depth 79·00—79·20), 158 (depth 79·60—79·70 m), 159 (depth 79·70—79·90), and 161 (depth 80·10—80·30).

The specimens of leaves, though they proceed from several outcrops, can be related to two essential flora-bearing levels. The first of them, the so-called „level under the wayside shrine" (Fig. 2, A) is found in the top of the profile, in Birkenmajer's XIth series, at a depth of 3·3—18·2 m. In this series formed of sandy-clay-slate-gravelly sediments 14·9 m thick, layers of the yellow sands occur, lying alternately with greenish-yellow clay slates containing impressions of leaves (Birkenmajer 1958). In

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the geological profile obtained from a boring no impressions of leaves were found at this depth (Łańcucka-Środoniowa 1965). The palynological analysis made by Dr J. Oszast from a sample of clay containing impressions of leaves showed no sporomorphs.

The second flora-bearing level containing impressions of leaves, and called „level of magnolia flora" (Fig. 2, B) lies in the Jaszczury Gorge at the height of Birkenmajer's Vth series (61·60—66·40 m from the top of Domański Wierch) in natural outcrops. In the upper clayey-sandy layer of this series, of a total thickness of 4·8 m, two clayey lenticles occur, one of which 95 cm thick contains numerous impressions of leaves and magnolia seeds.

The level of magnolia flora probably corresponds to the greyish-green and greyish-bluish shaly clays, which occur at a depth of 76·80—80·60 m in the geological profile obtained from boring (Łańcucka-Środo-

Table 1

Tabela 1

Pollen spectrum of the sediment from the level of magnolia flora from Domański Wierch containing impressions of leaves (basal sum — 100 per cent AP)

Spektrum pyłkowe osadu z poziomu flory magnoliowej, zawierającego odciski liści (sumę podstawową stanowi 100% drzew)

Genus Rodzaj	%%
Abies	1·3
Picea	37·7
Pinus t. *diploxylon*	14·3
Pinus t. *haploxylon*	6·5
Taxodium	2·5
Fagus	3·9
Decodon	1·3
Alnus	23·4
Castanea	1·3
Ulmus	3·9
Carya	1·3
Betula	1·3
Stewartia	1·3
Verbenaceae, cf. *Verbena*	3·8
Cruciferae	1·3
Umbelliferae	1·3
Compositae	2·5
Osmunda cf. *claytoniana*	2·5
Botrychium	2·5
other *Filicinae*	19·8

niowa 1965). In this layer which Urbaniak (1960) calls „level VI with flora" fragments and some well preserved impressions of leaves were found, belonging, among others, to *Zelkova ungeri*, *Fagus* sp., and *Quercus* sp. (Urbaniak l. c.; Łańcucka-Środoniowa, oral information). Moreover, the present author determined from this level *Carpinus grandis* Ung., *Fagus haidingeri* Kov. sensu Knobloch, *Populus tremula* L. foss., *Populus* cf. *nigra* L., *Parrotia pristina* (Ett.) Stur, and *Platanus platanifolia* (Ett.) Knobl.

The palynological analysis of the sediment from the level of magnolia flora was carried out at the author's request by Dr J. Oszast. The pollen spectrum showed a relatively large proportion of spruce, pine, alder, and fern, other trees and herbaceous plants playing an only insignificant part here (Table 1).

The state of preservation of the leaf flora from Domański Wierch gave rise to considerable difficulties in the course of investigations, since whole and distinct impressions of leaves were few, and only fragments of them were generally found. Specimens proceeding from the level under the wayside shrine were generally better preserved than those from the level of magnolia flora. The collected material was determined exclusively on the basis of morphological features, since it did not even contain any traces of fossilized plant tissue, which would have make it possible to prepare cuticle slides. Neither did the attempts to apply the Ashby Cellulose-Film Transfer Method give positive results.

DESCRIPTION OF THE DISTINGUISHED FORMS

Equisetaceae

Equisetum parlatorii (Heer) Schimper

(Pl. XV, 3, 3a, 4, 4a, Pl. XIX, 5, 5a)

Material. Level of magnolia flora, specimens Nos 358, 401, 402; 3 impressions, one of which represents a fragment of rhizome, the other two tubers.

Description. A fragment of striated rhizome was preserved, 5 mm in breadth, widening distinctly in the nodal part. Three round protrusions about 2 mm in diameter are visible on the node, corresponding to the places where the tubers were attached. In specimen No 402 (Pl. XV, 3, 3a) one whole tuber and fragments of three others are visible, lying in the whorl. The tuber preserved whole (15·0×8·0 mm) is pear-shaped and on its surface a few, longitudinal striae are visible. Moreover, it is to be seen that the apical part of this tuber is joined to the base of the next one.

In the second specimen (Pl. XV, 4, 4a), two round tubers with dimensions of 13·0×8·0 mm and 12·0×9·0 mm were preserved, disposed one behind the other.

Comparison. The impressions found represent fragments of a rhizome and tubers of the genus *Equisetum*. This is evidenced by both the shape and disposition of the tubers and the characteristic structure of the nodal part of the rhizome. These remains correspond to the species *Equisetum parlatorii* (Heer) Schimper described by Heer (1855) under the name of *Physagenia parlatorii* (cf. Łańcucka-Środoniowa 1969). This species is known from a few Tertiary floras: from the Miocene of Switzerland (Heer l. c.), Styria (Unger 1860), and Hungary (Andreánszky 1959), and from the Neogene of the trans-Carpathians (Iliinskaja 1968) and Moravia (Knobloch 1969). Its relation to the largest living European horsetail of to-day *E. maximum* Lam. (= *E. majus* Gars. = *E. telmateja* Ehrh.) requires further investigations (cf. Łańcucka-Środoniowa 1969).

Occurrence in fossil floras of Poland. The species was hitherto unknown from the Tertiary of Poland. Fragments of horsetail shoots and rhizomes were reported from the Eocene of the Tatra Mts (Raciborski 1892), from the Pliocene of Krościenko (Szafer 1947), and the Miocene of Stare Gliwice (Szafer 1961). Impressions of tubers of *Equisetum maximum* Lam. from Miocene clays at Czernica in Upper Silesia were described by Łańcucka-Środoniowa (1969).

Betulaceae

Alnus cecropiaefolia (Ett.) Berger

(Pl. I, 1–6; Pl. II, 1; Pl. XIII, 1–4; Pl. XIV, 1, 1a, 2)

Material. Level of magnolia flora, specimens Nos 33–36, 38, 39, 40, 41 (a + b), 43–47, 50, 308 (a+b), 323, 324, 391, 393, 394, 425; 21 impressions of leaves, five of which are almost wholly preserved, in four the base of the blade is visible and in three the apex; two leaves with twin impression.

Description. Roundish leaves, rounded at the base or subcordate. The largest are about 9 cm long and 7—8 cm broad. The width of the majority of specimens ranges from 5·0 to 6·4 cm, and in the two smallest ones from 3·4 to 4·2 cm. A right or almost right angle is included between the

lowest lateral nerves and the midrib, and gradually decreases towards the top of the blade. The arrangement of the lateral nerves varies, and is generally opposite in one or two of the lowest pairs. Near the margin secondary veins 1—5 in number depart from the lateral nerves; they are usually most numerous near the base. These secondary veins, as the lateral ones, end in very small teeth, only slightly deflecting from the margin. Numerous tertiary nerves, straight or bifurcate, join the lateral nerves at a right angle.

Comparison. The impressions of leaves from Domański Wierch correspond to *Alnus cecropiaefolia* (Ett.) Berger, described from the Lower Pliocene of Laaerberg (Berger 1955, Abb. 30). The resemblance is visible in the shape of the leaves, in the close arrangement of the tertiary nerves, and in the fine dentation of leaf margins. Berger sees a relation between the fossil species and the East-Asiatic species *Alnus sibirica* Fisch., the Mexican *A. jorullensis* H. B. K., and the North-American *A. oblongifolia* Torr.

The scale of variability of *A. cecropiaefolia* (Ett.) Berger is illustrated by numerous impressions of leaves found in Sarmatian and Pannonian floras of Czechoslovakia (Knobloch 1967, 1969). According to Knobloch (1969), when comparing the fossil species with the contemporary, only the Mexican species *A. pringlei* Fern. can be taken into account. Moreover, he considers that *A. cecropiaefolia* (Ett.) Berger from Moravia probably represents the same fossil form as *A. crebrinervis* Kovács, described from the Sarmatian of Hungary (Kovács 1957; Andreánszky 1959) and the Pliocene of Rumania (Givulescu and Florei 1960). This seems to be evidenced in the approximate scale of variability of the two species, the stratigraphic limitation of their occurrence from the Sarmatian up to the Upper Pliocene, and the similar ecological requirements.

The fossil species *A. crebrinervis* Kovács was recently reported by Iliinskaja (1968) from several localities of Neogene flora of the trans-Carpathians; she related it also with the contemporary species *A. pringlei* Fern. The impressions of leaves proceeding from the trans-Carpathian flora differ from *A. cecropiaefolia* (Ett.) Berger in the different mode of dentation of the margins and in the character of tertiary nervation (with the exception of the fragment of a leaf shown in Table II, fig. 3).

The mutual relation of the two fossil species, i. e. *Alnus cecropiaefolia* (Ett.) Berger and *A. crebrinervis* Kovács, and their connexion with the contemporary alder species, requires further investigations.

Occurrence in fossil floras of Poland. A species hitherto unknown from the Tertiary of Poland. Impressions of alder leaves of similarly large dimensions and approximate morphological features, occurring in the Miocene flora of Chodzież, were described by Zabłocki (1924) by the name of *Alnus kefersteinii* (Goepp.) Ung.

Alnus feroniae (Ung.) Czecz.

(Pl. II, 3–5, 5a; Pl. XV, 5, 5a)

Material. Level under the wayside shrine, specimen No 56; level of magnolia flora, specimens Nos 28 (a + b), 85, 388; 4 impressions of fragments of leaves, one with twin impression.

Description. The impressions of leaves preserved only in fragments do not permit an exact determination of their size. They probably were 3·5—4 cm in breadth, with the exception of one specimen of a much larger leaf, where preserved fragment is 5·6 cm wide and 7·5 cm long.

The leaves were probably oval in shape with a cuneate-rounded base. 9 lateral nerves at the most are visible, but they may have been up to 11 pairs. The arrangement of these nerves at the base in asymmetric, this being marked in a greater arcuate curvature of nerves of one half of the leaf, as well as in the varying angle which they form with the midrib vein. This angle at the base is generally larger than in the upper part of the leaf.

Secondary nerves ending in small teeth depart from the lateral nerves near the margins of the leaf; sometimes their junction with each other is looplike. This is particularly clear in the impression of the largest leaf, on the margin of which two teeth are preserved. Each of them is provided with a separate, delicate nerve, departing from the lateral one. The teeth in this specimen are relatively large, standing fairly far apart, and are of a characteristic shape. Their internal margins are almost straight, directed perpendicularly to the margin of the blades, whereas the external ones run down in a gently curved line. The few little teeth visible on the other specimens are much smaller, but of a similar outline.

Comparison. Of the fossil species the most similar to the specimens described are leaves of *Alnus feroniae* (Ung.) Czecz. This is evidenced above all by the nervation of leaves: asymmetric arrangement of the lateral nerves, presence of loops of tertiary nerves near the margins of leaves, and of fine nerves departing from these loops or from the bends of tertiary nerves to the small teeth of the margin. The outline of the small teeth is also similar, while the oval shape of the leaves and their probable dimensions correspond to the data characterizing the fossil species. The only exception here is the largest leaf, much broader and with greater distances between the lateral nerves, and having much larger teeth. On account of the similar mode of nervation and shape of teeth it was included in the same fossil species.

Leaves of *Alnus feroniae* (Ung.) Czecz. were at first assigned by Unger (1847) to the genus *Fagus*, and reported under that generic name from Tertiary floras of Europe, North America, and the Far East. They were

properly classified by Czeczott (1934), who noted that the character of nervation of their blades differs from that of *Fagus* leaves, corresponding, on the other hand, to the genus *Alnus*.

This species was recently reported by Iliinskaja (1968) from the Pliocene of the trans-Carpathians.

Of the contemporary species the East-Asiatic *Alnus japonica* Sieb. et Zucc. is, according to Czeczott (1934) the nearest to *Alnus feroniae* (Ung.) Czecz. When comparing the specimens of Domański Wierch with the leaves of this present-day species it is seen that the character of their nervation is similar, especially that of the tertiary nervation. The outline of small teeth is similar, the difference between them being marked in the shape of the whole blade, which appears particularly distinctly in the specimen of the largest leaf. According to Andreánszky (1959), the leaves of the contemporary species are not only narrower but have also more densely serrate margins and a less regular lateral nervation. It should be noted here that the alder strobiles found in the investigated flora, which probably ought to be related with the leaves of *Alnus feroniae* (Ung.) Czecz. are different from the strobiles of the contemporary *Alnus japonica* Sieb. et Zucc.

Occurrence in fossil floras of Poland. The species has not been reported as yet from fossil floras of Poland.

Alnus cf. *glutinosa* Gaertn.

(Pl. II, 2; Pl. XIV, 4, 5)

Material. Level of magnolia flora, specimens Nos 30 (a + b), 49, 429, 434, 436, 437; 3 impressions of strobiles and 3 of leaves; in one specimen the base is visible, and in two the apex of the blade; one leaf with twin impression.

Description. One fragment represents the lower part of a large leaf with truncate base decurrent near the petiole. The dimensions of the smaller, roundish leaf were probably 4 cm in length and breadth, those of the smallest one amounting to about 1·8 cm in length and 1·6 cm in breadth. The apex is slightly retuse. The 6th and 8th pairs of lateral nerves visible are bent slightly archwise in the upper part of the blade of the smallest leaf; the bending of nerves is much more marked in the impression of the leaf of medium size. Secondary nerves depart from the lateral ones near the margins of the blade; they end in small, irregular pointed teeth with a relatively broad base. The tertiary nerves slightly bent or branched, join the lateral ones at an almost right angle.

In three impressions strobiles are visible. Arranged fairly loosely around the stalk of fruit scales (4—5 mm long), they are wedge-shaped, their longer margins being slightly concave, and have distinct radial striae on the surface.

Comparison. The morphological structure of the preserved impressions of leaves is very similar to that of the contemporary species *Alnus glutinosa* Gaertn., this appearing in the shape of the leaves and in the character of nervation. Impressions of strobiles can also be related with this contemporary species and this is evidenced by the shape and distribution of the fruit scales.

The area of distribution of *Alnus glutinosa* Geartn. covers Europe, Asia with Western Siberia, the Caucasus, Asia Minor, and North Africa. This tree grows on damp soils, on the banks of rivers and lakes.

Occurrence in fossil floras of Poland. Among the numerous Neogene floras of Poland impressions of *Alnus kefersteinii* (Goepp.) Ung. have been reported, the species was compared to the contemporary *Alnus glutinosa* Gaertn. In the Sarmatian flora of Stare Gliwice nuts of *A. glutinosa* Gaertn. foss. were found (Szafer 1961), and in the Pliocene of Krościenko nuts and male catkins of this species (Szafer 1947).

Alnus sp. — strobiles

(Pl. XIII, 5; Pl. XIV, 3)

Material. Level of magnolia flora, specimens Nos 433, 435, 439; 3 impressions of strobiles.

Description. The fruit scales 5 mm long are wedge-shaped in outline, their two longer margins being slightly convex. The fruit scales are arranged fairly closely around the stalk.

Comparison. The impressions of strobiles classified here differ from those previously described as *Alnus* cf. *glutinosa* Gaertn. in a more close arrangement of scales, in the shape of the latter, and in the more delicate striae on the surface. To relate strobiles of this type with the two other species described on the basis of leaves, presents considerable difficulty.

The strobiles of *Alnus cecropiaefolia* (Ett.) Berger, found by Knobloch (1969, Taf. XXI, fig. 5), are much larger and their fruit scales are developed in a different way. Strobiles of *Alnus feroniae* (Ung.) Czecz. have not as yet been reported. However, it is worthy of note that there

occur in the floras of Bilin (Unger 1847) and of the trans-Carpathians (Iliinskaja 1968), besides *A. feroniae* (Ung.) Czecz. leaves, also strobiles described as *Alnus gracilis* Ung. They are visible almost exclusively in the longitudinal profile, which renders impossible their comparison with the specimens from Domański Wierch. However, their fruit scales seem to be shorter. The impressions of strobiles from Domański Wierch also differ from the contemporary species *Alnus japonica* Sieb. et Zucc., with which *A. feroniae* (Ung.) Czecz. is often compared. This appears in the less close distribution of fruit scales, which are also narrower and differently striated.

Carpinus grandis Ung.

(Pl. II, 13, 14; Pl. III, 1—4, 4a, 5—13; Pl. IV, 1, 2; Pl. XV, 1, 1a; Pl. XVI, 1—5; Pl. XXX, d)

Material. Level under the wayside shrine, specimen No 54, 55, 415; level of magnolia flora, specimens Nos 29, 57—63, 66—74, 77—84, 86—88, 89 (a + b), 90 (a + b), 379, 382, 386, 389—391, 426, 427, 432, 448; boring, sample No 158, depth 79,60—79,70 m, specimens Nos 443, 446; 45 impressions of fragments of leaves.

Description. Leaves oval, longitudinally oval or ovate, roundish at the base, subcordate or cuneate, narrowing at the top into an acute apex. Their breadth amounts to 1·8—4·7 cm, while the length, which could not be exactly determined, probably varied within a wide range (from about 3·5 cm to about 8·5 cm). The small teeth, preserved in only a few specimens, are of a narrow triangular shape, they are slightly bent upwards, pointed at the top and differ from one another in size. The largest teeth are found at the ends of the lateral nerves, the smaller ones at the ends of their secondary veins, and the smallest on the external margins of the larger teeth.

The main vein is straight and distinctly marked. The full number of lateral veins of the particular leaves is unknown. In the most complete impressions of leaves it amounts to 9 pairs (in the leaf impression of 3·1 and 4·0 cm in length), to 11 pairs (when the length is 5·4, 5·9, 6·0 cm), 12 pairs (when the length is 4·7 and 6·0 cm), and 14 pairs (when the length is 6·5 cm). In some specimens there appears an arched bending of the lateral nerves in the upper part of the blade.

The angle included between the pair of lateral nerves fourth from the base and the midrib varies from 35° to 59° (most often from 40° to 50°). In numerous impressions of leaves secondary nerves are visible, multiple at the base of the blade (near the pair of lateral nerves second and third

from the base), and single or double higher, set near the margins of the leaves. The tertiary nerves, straight or less frequently bifurcate, run perpendicularly to the lateral nerves.

Comparison. The described fragments of leaves show considerable differentiation, appearing not only in the size and shape of the leaves, but also in the density of the lateral nerves (especially in the apical part of the specimens), in their straight or archwise run, in the magnitude of the angles formed by the lateral nerves and the main vein, in the frequency of occurrence of secondary nerves, and in their course (straight or slightly crenate, varying angle at which they depart from the lateral nerves). Also the degree of expression of secondary and tertiary nerves is not uniform, which seems to indicate a varying thickness of the particular nerves.

It would be difficult to determine whether these differences may be considered to fall within the bounds of intraspecific variability. The lack of complete impressions of leaves does not permit a joint analysis of all feature of the blade of the particular specimens or a possible discrimination of separate forms. On this account all the specimens were included under the common name *Carpinus grandis* Ung. usually applied to determine hornbeam leaves in Tertiary floras.

It is equally difficult to relate them to contemporary leaves. In the family *Betulaceae* the majority of species and genera are characterized by a considerable variability of leaves within one taxonomic unit, as well as by a close resemblance between leaves of various species, and even genera. *Carpinus grandis* Ung. was at first compared with the *C. caroliniana* Walt. (= *C. americana* Michx.) living to-day, while later the opinion prevailed that they were related to the contemporary *C. betulus* L. (Reimann 1917). Hornbeam leaves found in some fossil floras show the closest resemblance to *C. orientalis* Mill. (Iliinskaja 1968), *C. japonica* Bl. (Menzel 1906; Grangeon 1958; Andreánszky 1966b), or *C. yedoensis* Maxim. (Grangeon 1958). One should also take into account the possibility of the occurrence in Neogene floras of leaves of the genus *Ostrya*, which cannot be distinguished from those of the genus *Carpinus* on the basis of morphological structure.

Investigations on the fruit and seed flora of Domański Wierch carried out so far have shown the presence of a hornbeam related to the contemporary *C. betulus* L. Of the 12 nutlets examined by Jentys-Szaferowa (1961) 7 were assigned to the type *C. betulus* L., whereas the other 5 could not be determined as particulars of the anatomic structure had not been preserved. The author considers that these specimens may belong to the type *C. orientalis* Mill.

Moreover, it should be noted that Jentys-Szaferowa (l. c., p. 26 and 30) established the occurrence in the Polish Pliocene of nutlets with a structure characteristic of *C. orientalis* Mill. and *C. tschonoskii* Maxim., or *C. laxiflora* Blume.

A large number of specimens of *Carpinus grandis* Ung. from Domański Wierch undoubtedly represents the type of *C. betulus* L. leaves. They are oval, roundish at the base, with straight, not too closely spaced lateral nerves, few secondary nerves, and with an invisible or only very poorly marked tertiary nervation. After further investigations on fruit and seed flora have been carried out it will perhaps be determined what other species or even genera (*Ostrya*) the impressions of *Carpinus grandis* Ung. leaves from Domański Wierch represent.

Carpinus betulus L. occurs in central and south-eastern Europe, extending to the east up to the Caucasus. In the mountains it grows up to the altitude of about 800 m above sea-level.

Occurrence in fossil floras of Poland: Chłapowo (Heer 1869), Sośnica (Goeppert 1855), Trzebnica (Pax 1906), Brzeg Dolny, Wróblin, Kokoszyce, Zielona Góra, Stróża, Domaradz (Reimann 1917), Wołów, Parowa (Kräusel 1918), Pieruszów (Kräusel 1919), Smogorzówek (Juhnke 1931), Chodzież (Zabłocki 1924), Dobrzyń (Kownas 1956), Czernica (Raniecka-Bobrowska 1957), Stare Gliwice (Szafer 1961), and Swoszowice (Iliinskaja 1964).

Betulaceae gen. et. sp. indet.

(Pl. II, 6–12; Pl. XV, 2; Pl. XVI, 6, 7, 7a, 8)

Material. Level of magnolia flora, specimens Nos 24–27, 64 (a + b), 65, 381, 383, 385, 387; 10 impressions mostly of fragments of leaves; one leaf with twin impression.

Description. Ovate leaves with cordate, sometimes asymmetric base and pointed apex. The dimensions of two, almost wholly preserved leaves was about 2·7×2·5 cm and 5·1×3·5 cm. They have 8 and 12 pairs of lateral nerves. The breadth of the other fragments of leaves varies from 2·0 to 3·5 cm. The type of nervation is craspedodrome. The midrib is straight or wave. The angle formed by the pair of lateral nerves fourth from below with the midrib is to 43°—50°, whereas that included between the lowest pair of lateral nerves and the midrib is much larger, being 78°—95°. From the lowest pair lateral nerves several (up to three) crenate secondary nerves depart, the first of which run almost parallel to the margins of the cordate base, and depart from the lateral nerve near the midrib or at the point where the lateral nerve branches from the midrib. The secondary nerves of the higher pairs of lateral nerves are equally numerous and distinct; they are three or four near the second pair of lateral nerves and higher one or two. Tertiary nerves are very poorly visible.

Comparison. The determination of this group of impressions of leaves presents considerable difficulties. The only distinctly marked

feature is the cordate shape of the base and the numerous secondary nerves of the lowest pairs of the lateral ones. The few small teeth preserved do not permit the determination of the character of the dentation of the leaves. The lack of a full impression of the blade on the majority of the specimens makes it impossible to determine exactly the shape, the size, and the number of lateral nerves. The craspedodrome character of nervation in such a type of leaf base points to two genera of the family *Betulaceae*: *Betula* and *Carpinus*.

Leaves with a cordate base were described in three fossil species of the genus *Betula*, namely in *B. prisca* Ett., *B. macrophylla* (Goepp.) Heer, and *B. brongniarti* Ett. According to Grubov (1956), the including of leaves with cordate base among the species *B. prisca* Ett. is not correct. In this author's opinion the impression of a leaf from Kokoszyce in Reimann's work (1917, Taf. II, fig. 14) does not belong to *B. prisca* Ett. (it is a leaf of the same type as the specimens from Domański Wierch).

There is also a lack of unanimity as regards the fossil species *B. macrophylla* (Goepp.) Heer. According to Reimann (1917), fragments of leaves assigned to this species are nearest to the contemporary, North-American *B. papyrifera* Marsh. Some authors (among other, Reimann himself) apply this name to fragments of leaves inconsistent with the type of the species, of distinctly ovate shape, strongly cordate base, and characteristic course of nerves in the lower part of the blade, more similar to other contemporary *Betula* species (e. g. *B. lenta* L., Iliinskaja 1968).

The fossil species with which *B. lenta* L. was initially related is *B. brongniarti* Ett. According to the diagnosis in Menzel (1906), leaves of this species are characterized by a cordate base and the distinct secondary nerves of the lowest pairs of the lateral ones. In Menzel's opinion they resemble not only *B. lenta* L., but also the contemporary Japanese *B. grossa* Sieb. et Zucc.

However, the comparison of the specimens from Domański Wierch with leaves described as *B. brongniarti* Ett. in the literature available to the present author indicates that they differ both from the specimens from Senftenberg (Menzel 1906) and Frankfurt-am-Main (Mädler 1939) in a more cordate base and in the presence of secondary nerves of the lateral ones also near the lowest pair of lateral nerves.

On the other hand, it should be noted, that remains of leaves with a distinctly cordate base are known to have been assigned to the genus *Carpinus*, as for example specimens of *Carpinus grandis* Ung. from the Brunn-Vösendorf flora (Berger 1952), and Armawir (Kutuzkina 1964).

Interesting data were provided by the results of investigations on the variability of contemporary leaves of *Carpinus betulus* L. (Białobrzeska, in press). The above mentioned author established that the cordate shape of the base is a feature fairly often occurring within this species.

At the bottom of each dwarf- and long-shoot there are two or three leaves with more or less cordate, often asymmetric base. In these leaves the lowest pairs of lateral nerves have numerous distinct secondary ones.

Fagaceae

Castanea atavia Ung.

(Pl. IV, 8–14; Pl. XVII, 1, 1a, 2, 2a, 3, 4)

Material. Level under the wayside shrine, specimens Nos 118–127, 129–142, 146, 170, 176, 177, 180, 408, 420, [illegible]; level of magnolia flora, specimens Nos 143–145; 34 impressions of larger and smaller fragments of leaves; one specimen almost wholly preserved, in two the apex is visible, and in seven the base; the middle parts of leaves prevail.

Description. Leaves oblong-lanceolate, apex short-acuminate, base rounded or subcordate and decurrent near the petiole. The breadth of leaves in the middle part of the blade is from 3·5 to 6·0 cm. Their length could not be determined, with the exception of one, the best preserved specimen, in which it was about 11 cm, the greatest breadth being about 5 cm. Thirteen pairs of lateral nerves, arranged alternately or opposite, are preserved in the best specimen (probably there were fourteen). The distances between the places where the lateral nerves branch from the main nerve are not even, varying from 6 to 9 mm. The angle included between the main nerve and the lateral ones is about 50° in the middle part of the blade, growing markedly larger towards the base. The tertiary nerves are single or more often bifurcate. The quaternary nerves form a network with tiny multiangular areas, within which a venule reticulum is visible. The margins of leaves are provided with large teeth directed upwards. The convex external margins of teeth and the slightly concave internal ones, together with bristles of varying length at their ends and rounded sinules between the teeth, usually form the outline of the letter „S". In two specimens additional small teeth are visible.

Comparison. The systematic position of fossil leaves assigned to the genus *Castanea* is sometimes a matter of argument. The first critical analysis of leaves of the *Castanea* type was carried out by Ettingshausen (1872). This author considered that leaves described as various species of *Castanea,* as well as some of those assigned to the genera *Quercus* and *Fagus,* actually belong to only one species *Castanea atavia* Ung., which was the initial form of the contemporary *Castanea sativa* Mill. He based his contention on the immense variability of leaves of the present-day chestnut, whose various forms can be found in fossil materials, often in the same flora. Heer (1875) held a different opinion, considering that the fossil species *C. atavia* Ung., *C. ungeri* Heer, and *C. kubinyi* Kov. ought to be dealt with separately.

Reichenbach (1917) revising the leaf flora from Sośnica emphasized the fact that apart from the typical *C. atavia* Ung. leaves there also occur in this flora narrower ones, corresponding in character to *C. kubinyi* Kov.; nevertheless, he assigned all the specimens to one species.

In later years attention was frequently drawn to the resemblance of some specimens described as *Castanea atavia* Ung. to the genus *Quercus* (Schwarz 1936; Czeczott 1951; Berger 1952). Schwarz (1936) observed that leaves similar to specimens on the basis of which Unger described the species *C. atavia* are encountered more often in the genus *Quercus*, especially in its section *Gallifera* Spach. Czeczott's (1951) investigations led to the description of the species *Quercus kubinyi* (Kov.) Czecz., in which numerous impressions of leaves of *C. atavia* Ung., and *C. kubinyi* Kov., as well as of some species of *Quercus* from Miocene and Pliocene floras were included. At this time Berger (1952) also described *Quercus kubinyi*.

On the basis of the analysis of numerous and differentiated impressions of leaves of the *Castanea* type, present in the Sarmatian flora of Moldavia, Jakubovskaja (1955) corroborated the opinion of investigators who consider that in fossil floras there occurs only one species *C. atavia* Ung., characterized by a considerable variability of leaves. Krištofovič and Bajkovskaja (1965) came to the same conclusion, assigning the very numerous impressions of leaves from the Sarmatian flora of Krynka to *C. atavia* Ung. Abundant material made it possible for the authors to determine the gradual transitions in the formation of leaves, which corroborated Ettingshausen's (1872) hypothesis that there existed only one polymorphous species *Castanea atavia* Ung. in the Tertiary of Europe. According to Krištofovič and Bajkovskaja, the applying of different names to leaves of this type and assigning some of them to the genus *Quercus* is not correct, and usually results from the scarcity of fossil material and overestimation of differences in the morphological structure of fossil and contemporary leaves.

Castanea sativa Mill. occurs nowadays in an area covering the western trans-Caucasus, part of Asia Minor lying on the Black Sea, and the Mediterranean countries. This species usually forms forests at an altitude of 300—700 m above sea-level. It grows for the most part on shady slopes with acid, deep, loam-sandy soils. *Castanea sativa* Mill. in the western part of the trans-Caucasus is, together with the oak and beech, the main component of the colchis forest of lower mountain areas (Jakubovskaja 1955).

Occurrence in fossil floras of Poland. Impressions of *Castanea atavia* Ung. leaves were reported from numerous stands of Miocene floras in Silesia (Goeppert 1855, Pax 1906, Reichenbach 1917, Kräusel 1918, 1919), and from Swoszowice (Iliinskaja 1964).

Fagus haidingeri Kov. sensu Knobloch

(Pl. IV, 3–7; Pl. V, 1, 1a, 2, 2a, 3, 4, 4a, 5, 6; Pl. XVII, 5, 6; Pl. XVIII, 1, 2, 2a, 3, 3a, 4, 5)

Material: Level under the wayside shrine, specimens Nos 92–112, 116, 128, 314; level of magnolia flora, specimens Nos 113–115, 117 (a + b); boring, sample No 159, depth 79·70–79·90, specimens Nos 450, 452, 454; sample No 161, depth 80·10–80·30 m, specimen No 455; 32 impressions of leaves; in fifteen specimens the whole or almost the whole blade is preserved, in nine only the middle part, in two the apex and in two base of the leaf.

Description. Leaves ovate-oblong (one obovate) with acute apex and wedge-shaped, slightly rounded base. They vary considerably in size, from about 3·5 to 10·0 cm in length and from 1·4 to 4·8 cm in breadth. The margins of the leaves are undulated and frequently provided with small teeth directed upwards, blunt or slightly acuminate. The margins of the blade between the neighbouring teeth are straight or more or less convex. The midrib is often bent in the shape of the letter „S", this being particularly marked in the upper part of the blade. The straight lateral nerves 7—13 in number run parallel, departing alternately from the midrib at an angle of 40°—55°. They end craspedodrome in the teeth or bifurcate not attaining the margin, the stronger branch curving along the margin while the weaker one enters the tooth. The tertiary nerves departing perpendicularly from the lateral ones join in the middle of the distance between the two neighbouring lateral nerves, while the venules form a network of tiny multiangular areas.

Comparison. The beech leaves described under various names from fossil floras of the Younger Tertiary of Europe were compared chiefly with three contemporary species: the North American *F. grandifolia* Ehrh. (= *F. ferruginea* Ait.), the European *F. silvatica* L., and the Asia Minor *F. orientalis* Lipsky.

Kolakovski (1960), after investigating the dentation and nervation of margins of leaves of various contemporary species, came to the conclusion that these are fairly regular specific features and may be of help in determining fossil leaves. On this basis he divided the fossil species *Fagus* into two groups. The first includes species, whose leaves have quite entire or toothed margins, and nervation in some degree brochidodrome. Species closely similar to the contemporary *F. orientalis* Lipsky, thus, *F. antipovii* Heer, *F. pliocenica* Sap., and *F. orientalis* Lipsky foss. Krysht. belong to this group. The second group, including species which always have toothed leaves and craspedodrome nervation (*F. attenuata* Goepp. and *F. pristina* Sap.), corresponds to the contemporary *F. grandifolia* Ehrh.

Tralau (1962), investigating the genus *Fagus* in the Upper Pliocene flora from Willershausen, assigned the leaves occurring in it to the group *F. silvatica* L. (considering also *F. orientalis* Lipsky and a number of East

Asiatic species to be approximate to contemporary species) and partly to the group *F. grandifolia* Ehrh. According to this author, a similar division can also be carried out in other Neogene floras of Europe.

A different conception was advanced by Švareva (1964) who, in investigating beech leaves from the Lower Sarmatian stand on the Kortumowa Mt in Lvov, carried out a comparative study on leaves of three contemporary species: *F. silvatica* L., *F. orientalis* Lipsky, and *F. grandifolia* Ait. She considers that the remains of beech leaves from the Kortumowa Mt, as well as of many Neogene floras of Europe, given various names (among others, *Fagus pliocenica* Sap., *F. attenuata* Goepp., *F. orientalis* Lipsky var. foss.), represent one species with a large scale of variability, for which Iliinskaja (1962) introduces the name *Fagus herthae* (Ung.). Morphologically this species closely resembles the contemporary *F. orientalis* Lipsky, being also characterized by a very large scale of variability. Some differences between *F. herthae* (Ung.) Iliinsk. and *F. orientalis* Lipsky concern the greater variability of the number of lateral nerves and the shape of leaves in the fossil species. Apart from the predominant number of forms typical of *F. orientalis* Lipsky, there occur in *F. herthae* (Ung.) Iliinsk. specimens similar to *F. grandifolia* Ehrh.

Kolakovski and Ratjani (1967) declared in favour of introducing a new, common name for *Fagus* leaves from the Tertiary described hitherto under various names. They considered, however, that to determine the relation between fossil forms and elucidate their affinity with the contemporary species it was necessary to analyse closely the morphological features of leaves, especially the shape of the margins of the blade and the character of nervation.

Knobloch (1969) has recently applied the biometric method in investigating leaves of *F. haidingeri* Kov. from the Neogene of Moravia, as well as those of the contemporary species *F. orientalis* Lipsky, *F. silvatica* L., and *F. grandifolia* Ehrh. On the basis of the statistical analysis of the shape of leaves, their size, and the number of lateral nerves he established that its fossil form varies both from the above mentioned contemporary and fossil species (*F. silvatica* L. foss. and *F. orientalis* Lipsky foss.) and from the species *F. attenuata* Goepp.; it also differs from *F. herthae* (Ung.) Iliinsk., having as a rule narrower leaves which are only seldom toothed. *F. haidingeri* Kov. sensu Knobloch are, among others, synonims for *Fagus pliocenica* Sap. from some stands of the Neogene of Europe (cf. Knobloch 1969, p. 79). The relation of this fossil form to the present-day beech species has not as yet been definitively determined.

The leaves from Domański Wierch are differentiated with regard to both their size and formation of margins. Large and relatively broad leaves are not numerous, they are mostly narrow and small. The margins of blades are toothed or wavy, or else provided with small teeth. The described remains represent the same fossil flora as *Fagus haidingeri* Kov.

sensu Knobloch from the Neogene of Czechoslovakia (Sitár 1968; Knobloch 1969).

Occurrence in fossil floras of Poland. A species not previously been reported from the Tertiary of Poland.

Quercus pseudocastanea Goepp.

(Pl. VI, 1, 2; Pl. VII, 1–4, 5a, 5b, 6; Pl. XIX, 1, 1a, 2, 3, 4a, 4b)

Material. Level under the wayside shrine, specimens Nos 147–166, 305, 421–423; 24 impressions of leaves; fourteen specimens with preserved fragments of various size of the middle part of the blade, three with upper part with apex preserved, and five with the lower part and base of the leaf.

Description. Leaves of obovate outline with cuneate base and petiole about 1·5 cm long. The greatest breadth of the leaves amounts to about 6 cm; their length could not have been less than 6 cm. Margins of leaves toothed. The upper and lower margins of big teeth are rounded, their ends being mostly sharp, and sometimes mucronate. Rounded sinuses between the teeth. Within the lowest pairs of lateral nerves the base of the leaf is entire, the pair of lateral nerves third from below end in small, sharp teeth.

The lateral nerves are straight or slightly arcuate, arranged more or less alternately. They end in teeth, with the exception of the lowest two pairs, which are thinner, and form looplike junctions with the higher nerves near the margins of the base of leaves. In two specimens a minor lateral vein is visible, not ending in a tooth. It bends at a small distance from the margins of the leaf (near the sinus between the teeth) and gradually passes into the venule reticulum. The lateral nerves depart from the midrib in the middle part of the leaves at an angle of about 45°. The tertiary nerves are usually bent, departing from the lateral ones at a right angle and joining each other near the margin of teeth. The quaternary nerves form tiny angular areas of network varying in size and shape. A venule reticulum is also visible.

Comparison. Leaves of similar morphological features, occurring in Tertiary fossil floras, have generally been assigned to *Quercus pseudocastanea* Goepp. However, the finding among contemporary species of a most approximate form presented considerable difficulties, since many species belonging to various sections of the genus *Quercus* are characterized by leaves very much alike as regards shape and nervation. *Q. pseudocastanea* Goepp. was compared to oaks from the sections *Cerris* Loud. (*Q. castaneaefolia* C. A. Mey.), *Robur* Reichb. (among others, *Q. hartwissiana* Stev.), and *Prinus* Loud. (*Q. prinus* L., *Q. dentata* Thunb., *Q. muhlenbergii* Engelm.).

The fragments of blades of *Q. pseudocastanea* Goepp. from Domański Wierch can also be compared with contemporary species belonging chiefly

to two sections: *Robur* Reichb. (*Q. canariensis* Willd., *Q. macranthera* Fisch. et Mey., *Q. petraea* (Mattuschka) Lieblein (= *Q. sessilis* Ehrh.), *Q. hartwissiana* Stev.), and section *Prinus* Loud. (*Q. prinus* L., *Q. mongolica* Turcz., and *Q. dentata* Thunb.). It is not possible to choose one of the species mentioned and state that it is related to *Q. pseudocastanea* Goepp. from Domański Wierch as similar forms of leaves occur in many contemporary species.

Occurrence in fossil floras of Poland: Malczyce (Goeppert 1852), Sośnica, Kokoszyce, Brzeg Dolny (Reichenbach 1917), Trzebnica (Kräusel 1918), Pieruszów (Kräusel 1919), Czernica (Raniecka-Bobrowska 1957).

Quercus kubinyi (Kov. ex Ett.) Berger

(Pl. IV, 15; Pl. V, 7, 8, 8a; Pl. XXI, 1, 1a, 1b, 2, 2a, 3)

Material. Level under the wayside shrine, specimens Nos 168, 169, 171; one impression of an almost the whole leaf and two of small fragments of the upper part of the blade.

Description. Specimen No 168 represents a leaf about 6·5 cm long and 2·8 cm wide, of oblong-obovate shape, acuminate apex, and widely cuneate base. The teeth at the margins of leaves end in a long bristle. The lower margins of teeth are usually concave, and only occasionally slightly convex, the upper ones always being concave. 8 pairs of straight lateral nerves run from the midrib to the margin of the blade, seven of them passing into a bristle at the ends of teeth, and one pair, the lowest, with a camptodrome ending near the base. The highest lateral nerve constitutes a pair for the midrib bent from the site of branching. The tertiary nerves branch and join each other midway between the lateral nerves. The quaternary nerves form a fairly distinct network of tiny, irregular angular areas, within which a venule reticulum is visible.

The other two impressions show small fragments of the upper part of a narrow blade with distinct teeth whose both margins are concave, the teeth ending in a long bristle.

Comparison. The specimens from Domański Wierch correspond most closely with the remains of *Quercus kubinyi* (Kov. ex Ett.) Berger, described from the Pliocene of Brunn-Vösendorf (Berger 1952, Abb. 47). Another fossil form consists of remains of *Q. kubinyi* (Kov.) Czecz. leaves, reported from the Miocene flora of Zaleśce (Czeczott 1951), recently assigned to the genus *Castanea* (Knobloch 1969). The fossil species *Q. kubinyi* (Kov. ex Ett.) Berger shows a close resemblance to the contemporary *Q. libani* Oliv. (cf. Berger 1952).

Q. libani Oliv. occurs in the south-eastern and eastern part of Asia Minor and in the neighbouring areas of Iraq and Syria. It grows on loam,

calcareous, and warm soils of mountain terrains at the altitude of 900—1500 m above sea-level.

Occurrence in fossil floras of Poland. The species *Q. kubinyi* (Kov. ex Ett.) Berger has not previously been reported from the Tertiary of Poland. According to Czeczott (1951; in Szafer 1961), *Q. kubinyi* (Kov.) Czecz. compared to the contemporary *Q. libani* Oliv., occurred in the flora of Swoszowice, of Brzeg Dolny, Pogalewo Wielkie, and Stare Gliwice. Recently the prevailing opinion is that this type of leaves ought to be related to the genus *Castanea*. Iliinskaja (1964) assigned the specimen from Swoszowice to *Castanea atavia* Ung., while Knobloch (1969) considered the specimens from Swoszowice and Stare Gliwice to be *Castanea kubinyi* Kov. ex Ett.

Quercus pontica miocenica Kubát

(Pl. VI, 3–6; Pl. XX, 1, 1a, 2, 3)

Material. Level under the wayside shrine, specimens Nos 173, 174 (a+b), 175, 178; 4 impressions of fragments of leaves, on one of them the greater part of the blade with the apex is visible, and three represent the middle part of the leaf; one leaf with twin impression.

Description. The best preserved specimen (Pl. VI, 6, Pl. XX, 1) represents a relatively large fragment of the middle and upper part of an acuminate blade. The length of the leaf cannot be determined; its greatest breadth is over 6 cm. The 12 preserved lateral nerves depart from the midrib at uneven intervals from 3 to 8 mm. The angle included between the midrib and the lateral nerves amounts to 50° in the upper part of the blade, increasing in the lower to 70°. On the margins of the leaf several small, bristle-tipped teeth were preserved, whose external margins are concave or slightly convex, the internal ones always being concave. The tertiary nerves are very numerous; there are about 9 tertiary nerves to 1 cm of the lateral nerve. They are perpendicular to the lateral ones, more or less parallel, and often bifurcating.

The other fragments belong to large leaves, this being evidenced by the considerable distances (up to 17 mm) between the branching points of the lateral nerves which are straight or slightly bent downwards. The angle included between the midrib and the lateral nerves varies from 55° to 65° in the middle part of the blade. The partly preserved margin of the blade indicates the presence of large teeth. In some specimens near the margins of leaves secondary nerves are visible, departing from the lateral ones towards the base; their presence suggests the occurrence of additional small teeth (Pl. VI, 3, Pl. XX, 2). The tertiary nerves are numerous, more or less parallel, and sometimes bifurcating.

Comparison. *Quercus pontica miocenica* was described by Kubát (1955) from the Sarmatian flora of Felsötárkány in Hungary. Its leaves are usually large, up to 22 cm in length and 11 cm in breadth, obovate, being widest at 1/3 of the length counting from the apex of the blade. The base of the leaves is narrow rounded or narrow cordate; the apex is narrow and acuminate. Large teeth are found at the margins, ending in tipped bristles 3—4 mm long. The midrib is distinct and straight and the lateral nerves are relatively numerous (15—20). Sometimes single secondary nerves ending in additional small teeth depart from the lateral nerves near the margins. Between the lateral nerves tertiary nerves run more or less parallelly within a distance of 1·5 mm from each other. According to Kubát (l. c.), the fossil species is a homologue of the contemporary *Q. pontica* K. Koch, this being evidenced by the similarity of many features, especially the presence of additional teeth, provided by branching of lateral nerves, and the approximate type of tertiary nervation. The only difference between the leaves of the fossil species and the contemporary one is the teeth, which in *Q. pontica* K. Koch are slightly thicker and devoid of bristles at the ends.

The name *Q. pontica miocenica* Kubát was used by Iliinskaja (1968) for numerous impressions of *Quercus* leaves occurring in Pannonian floras of the trans-Carpathians. The abundant material enabled this author to complement Kubát's diagnosis; however, some morphological differences, accentuated by the lack of additional teeth, led her to draw different final conclusions. According to Iliinskaja, the comparing of the fossil species to *Q. pontica* K. Koch is incorrect, since it is more approximate to the East-Asiatic species *Q. griffithii* Hook. f. et Th., *Q. aliena* Bl., and *Q. major* Nakai from the subsection *Diversipilosae* Schneid.

The majority of fossil stands of *Q. pontica miocenica* Kubát were noted in Hungary, where it is known from a number of Sarmatian leaf floras (Kubát and Bubik 1955; Józsa 1955; Andreánszky 1959, 1964, 1966a). According to Andreánszky (1959), *Q. pontica miocenica* Kubát occurs in the Miocene flora of Zaleśce (sub *Castanea* cf. *mollissima* Bl., Czeczott 1951, Taf. III, fig. 16. Taf. IV, fig. 2—6). The list of stands of this species was enlarged by the investigations carried out by Iliinskaja (1968), who included in it the localities Szanto in Hungary and Liescha in Austria (on the basis of Unger's and Zwanziger's revised determination), as well as several stands in the trans-Carpathians. The occurrence of *Q. pontica miocenica* Kubát in the Pliocene flora of Derna in Rumania was reported by Maxim and Petrescu (1968), and the presence of the oak, to which *Q. pontica* K. Koch may be related, was mentioned by Knobloch (1967) in his description of Czechoslovakian floras of Sarmatian and Pannonian age. This species was also reported late by Sitár (1968) from the Mio-Pliocene flora of the Turiec Basin.

The remains of *Q. pontica miocenica* Kubát leaves from Domański

Wierch correspond in the character of their serration of the margins to the specimens found in Hungary, and show, as the latter do, a considerable affinity with *Q. pontica* K. Koch. However, it should be noted that leaves with similar morphological features also occur in some oaks of the section *Cerris* Loud.

The area of distribution of *Q. pontica* K. Koch covers the western part of the trans-Caucasus and the north-western Anatolia. It grows at an altitude of 1300—2100 m above sea-level.

Occurrence in fossil floras of Poland. *Quercus pontica miocenica* Kubát has not previously been reported from fossil floras of Poland.

Quercus sp.

(Pl. VI, 7; Pl. XX, 4)

Material. Level under the wayside shrine, specimen No 405; impression of a cup fragment.

Description. Convex impression of a fragment of cup with some ten visible radially arranged upper scales. The scales are narrow triangular, acute, about 1 cm long and 3 mm wide near the base. The impression of the cup is about 3·5 cm in diameter.

Comparison. Impressions of similarly built *Quercus* cups have frequently been found in European Tertiary floras, among others, in the Miocene of Lower Lusatica (sub *Nephelium sapperi* Menzel, Menzel 1933; Kutuzkina 1964), in the Pliocene of the neighbourhood of Sofia (Stefanoff and Jordanoff 1935), Borsec (Pop 1936) and Kodor (Kolakovski 1964), as well as in the Sarmatian of Moldavia (Jakubovskaja 1955) and Hungary (Andreánszky 1959, 1963, 1964). All these remains, with the exception of the specimen from Borsec, are assigned to the section *Cerris* (Spach) Oerst. The cup found in the Pliocene flora of Frimmersdorf (Kilpper 1959) and determined as *?Castanopsis sapperi* (Menz.) May (*Nephelium sapperi* Menz.) also belongs to the genus *Quercus*.

The specimen from Domański Wierch resembles most the impression of a cup from the stand Bánfalva-Patakos in Hungary (Andreánszky 1963). This resemblance is marked both in the size of the cup and in the arrangement of the upper scales which, however, are slightly narrower in the specimen from Domański Wierch. The cup from Bánfalva-Patakos was found on a piece of rock together with three impressions of leaves of *Quercus pontica miocenica* Kubát for which reason Andreánszky (l.c.) used this name for the cupola as well, stressing, however, that this does not signify any affinity of the remains described with the Pontian oak. According to this author, the cup from Bánfalva-Patakos resembles most those of the contemporary *Q. libani* Oliv. It seems, however, that the fairly marked differences in the formation of the upper scales, which in *Q. li-*

bani Oliv. are very narrow, almost filamentous, whereas in the specimen from Hungary they are lanceolate and fairly broad, exclude such a comparison.

It seems that there is no possibility of determining the species or even the section to which the cup from Domański Wierch belongs, since in the preserved fragment only the upper scales are visible, whereas the scales of the middle and lower part of the cup which are systematically equally important are lacking. It is also difficult to accept with absolute certainty as characteristic the arrangement of the upper scales appearing on the impression. This could have undergone some change under the effect of presence of the surrounding material.

Cups of large dimensions with similarly formed upper scales often occur in oaks of the section *Cerris* Loud. and *Suber* Reichb. being also encountered in some species of the section *Prinus* Loud. (*Q. macrocarpa* Michx., *Q. dentata* Thunb.).

In relating of the cup of the oak found on Domański Wierch with one of the species distinguished on the basis of leaves considerable difficulties are encountered. In *Q. pontica* K. Koch from the section *Robur* Reichb., to which *Q. pontica miocenica* Kubát is compared, the cups are much smaller and devoid of distinct upper scales (C a m u s 1934). Cups of *Q. libani* Oliv. (section *Cerris* Loud.), considered to be a form related to the fossil *Q. kubinyi* (Kov. ex Ett.) Berger, are also differently developed. It would be possible to relate the cup with the leaves of *Q. pseudocastanea* Goepp. only if these fossil leaves were assigned to the section *Prinus* Loud. [1]).

Juglandaceae

Juglans sp.

(Pl. VII, 7, 8, 8a; Pl. XXI, 4, 4a)

M a t e r i a l. Level of magnolia flora, specimens Nos 22, 428; 2 impressions of the lower part of leaflets.

D e s c r i p t i o n. In one of the preserved fragments the markedly inequilateral base of a leaflet is visible. The blade is 3 cm wide at the place where it is broken. The margin of the leaf is sparsely serrate and the small teeth only slightly bent, with a convex external margin, beginning at a small distance from the base of the leaflet.

The lowest lateral nerves depart alternately from the midrib at an angle

[1] In distinguishing the sections the author took as her basis the division of the genus *Quercus* reported by R e h d e r (1956) in the „Manual of Cultivated Trees and Shrubs"; it differs from the division accepted in „Derevija i kustarniki SSSR" (Trees and Shrubs of the USSR, S o k o l o v red. 1951), where section *Cerris* (Spach) Oerst, includes some species of the section *Suber* Reichb.

of 90°, and higher this angle diminishes to 70°. The nervation is of the brochidodrome type. The lateral nerves are joined by parallel and closely running, sometimes bifurcate, tertiary nerves. The quaternary nerves form a poorly visible reticulum with tiny multiangular areas.

Comparison. A fragment of a leaflet of similar nervation and similar small teeth is represented in Heer's (1859, Taf. CXXXI, fig. 7) work, being described as *Pterocarya denticulata* (Weber) Heer. Iliinskaja (1953) raised this question, maintaining that the leaves of *P. denticulata* (Weber) Heer from Oeningen do not belong to this genus at all. It may be that, as in the case of the analysed impressions from Domański Wierch, these leaves were *Juglans*. This is evidenced by the angle between the midrib and the lateral nerves being greater than in *Pterocarya*, the different shape of the loops joining the neighbouring lateral nerves, and the much more numerous and more distinctly parallel tertiary nerves.

The basal parts of leaflets described from Senftenberg as *Juglans sieboldiana* Maxim. foss. Nath. (Menzel 1906, Taf. I, fig. 17) and from Dobrzyń as *J. cinerea* L. foss. Braun (Kownas 1956, Fig. 10) are characterized by similar features of morphological structure.

When comparing the impressions from Domański Wierch with the contemporary *Juglans* species it is readily observed that an analogous nervation characterizes leaves of both the East-Asiatic (*J. sieboldiana* Maxim., *J. mandshurica* Maxim., and *J. cordiformis* Maxim.) and the North-American species (*J. cinerea* L. or *J. rupestris* Engelm.). It is thus impossible to determine the investigated fragments more exactly.

Occurrence in fossil floras of Poland. Leaves of two species of the genus *Juglans* were described from Neogene floras: *J. acuminata* A. Br. reported from Sośnica (Meyer 1917), Ruprechtów (Kräusel 1919) and Krywałd (Raniecka-Bobrowska 1957), and *J. cinerea* L. foss. Braun from Dobrzyń (Kownas 1956).

Pterocarya paradisiaca (Ung.) Iliinsk.

(Pl. VI, 8; Pl. VII, 9; Pl. VIII, 1a, 1b, 2, 3; Pl. XXII, 1, 2, 2a)

Material. Level of magnolia flora, specimens Nos 16 (a+b), 17—21; 6 impressions of fragments of leaflets; in two of them the base is visible; one specimen with twin impression.

Description. Leaflets oblong-lanceolate, with cuneate or rounded-cuneate asymmetric base, 2·0 to 3·5 cm wide. The largest specimen was probably 6 cm long. In one impression of the leaflet the petiole 7 mm long is visible. The lateral nerves depart from the main vein at uneven intervals, at an angle of 50°—55° in the middle part of the blade. They are strongly bent archwise, ascending near the margins and joined to one another in distinct loops. The tertiary nerves depart from the lateral ones at an almost right angle. They branch forming more or less longitudinal

fields filled with a tiny venule reticulum. Distinct small, sharp teeth with a convex external border are visible at the margins. In one case fragments of two leaflets were preserved (specimens Nos 19 and 20), set at an angle of 75° in relation to each other. They probably belong to one pinnate leaf.

Comparison. Remains of leaves of this type, found fairly often in Tertiary floras, were given various names and even assigned to various genera, such as *Salix, Juglans, Carya, Myrica, Prunus* (Unger 1849; Goeppert 1855; Stur 1867; Mčedlišvili 1956). In later years other authors corrected these designations, determining the leaves mentioned as *Pterocarya castaneifolia* (Goepp.) Schlecht. In a monograph of the genus *Pterocarya* Iliinskaja (1953) included a critical review of remains assigned to this genus, reported from fossil floras of Europe, Asia, and North America. In later years Iliinskaja (1962, 1964) introduced in place of *P. castaneifolia* (Goepp.) Schlecht. the name *P. paradisiaca* (Ung.) Iliinsk. She suggests the application of this name as the most appropriate for the species *Pterocarya* found in Tertiary floras of Europe, Southern Siberia, and Kazakhstan, since leaves of this type were described for the first time by Unger (1849) from the flora of Swoszowice as *Prunus paradisiaca* Ung.

The contemporary homologue of the Tertiary *Pterocarya paradisiaca* (Ung.) Iliinsk, is *Pterocarya pterocarpa* Kunth. (= *P. fraxinifolia* (Lam.) Spach = *P. caucasica* C. A. Mey.), occurring to-day in the trans-Caucasus, in eastern Turkey, and Lazistan, and in the provinces of Astrabad, Mazandaran, and Gilan in North Iran. In the mountains this tree is found to an altitude of up to 600 m above sea-level, growing most readily on alluvial, and sometimes even swampy soils. The climate in the whole area of occurrence of *P. pterocarpa* Kunth. is characterized by a mild winter, with an absolute minimum of —15°C, and a relatively high air humidity throughout the year.

Occurrence in fossil floras of Poland. Leaves described by the name *Pterocarya castaneifolia* (Goepp.) Schlecht.: Sośnica (Meyer 1917), Wołów (Kräusel 1918), Turów (Czeczott and Skirgiełło 1961). Leaves described as *P. paradisiaca* (Ung.) Iliinsk.: Swoszowice (Iliinskaja 1964).

Salicaceae

Salix varians Goepp.

(Pl. VIII, 10; Pl. XXII, 4)

Material. Level of magnolia flora, specimen No 9; 1 impression of the upper part of a blade.

Description. The preserved fragment about 6 cm in length belongs to an oblong-lanceolate leaf over 2·0 cm wide, with a long acuminate apex. At the margin of the leaf several tiny single teeth are visible. The

midrib is well marked and relatively thick. The much more delicate lateral nerves are bent archwise, joining each other near the margins. Apart from them, minor lateral veins are visible not reaching the margins of the blade. No minor veinlets are visible.

Comparison. With regard to shape, nervation, and formation of small teeth the preserved fragment of the leaf corresponds to *Salix varians* Goepp., a species often encountered in Tertiary floras. Of the contemporary willows *Salix fragilis* L. has similar leaves, its area of distribution covers almost the whole of Europe and a large part of Asia. *S. fragilis* L. grows mainly on the banks of rivers and lakes.

Occurrence in fossil floras of Poland. Malczyce (sub *Salicites dubius* Goepp., Goeppert 1852; Meyer 1917), Sośnica (sub *S. varians* Goepp., *S. wimmeriana* Goepp., *S. arcuata* Goepp., *S. acutissima* Goepp., *S. arguta* Goepp., Goeppert 1855; Meyer l. c.), Trzebnica (Pax 1906), Kokoszyce, Ruprechtów, and Stróża (Kräusel 1918), Pieruszów, Pogalewo Wielkie, Smogorzówek (Juhnke 1931), Dobrzyń (Kownas 1956), and Stare Gliwice (Szafer 1961).

Salix angusta A. Br.

(Pl. VIII, 4–9; Pl. XXII, 3, 3a)

Material. Level of magnolia flora, specimens Nos 10–15; 6 fragments of leaves, three of which represent the basal part of the leaf, one its apical part, and two the middle part.

Description. Fragments of linear-lanceolate blades were preserved, 1·1—2·0 cm in breadth, acuminate towards the apex and cuneate at the base. The margin of the leaves is entire. From the strongly marked midrib lateral nerves generally, poorly visible, depart at an angle of 50°—60°. They are arched, joining each other camptodrome near the margins. On some specimens minor lateral veins are visible.

Comparison. That the described specimens belong to the genus *Salix* is beyond any doubt. Leaves of similar shape and nervation are described as *Salix angusta* A. Br., a species approximate to the contemporary *S. viminalis* L. (cf. Kownas 1956).

The area of distribution of *Salix viminalis* L. covers almost the whole of Europe and Asia. It grows on the banks of rivers.

Occurrence in fossil floras of Poland. Sośnica (Meyer 1917) and Dobrzyń (Kownas 1956).

Populus balsamoides Goepp.

(Pl. VIII, 11–17; Pl. IX, 1, 1a, 2; Pl. XXII, 6, 6a; Pl. XXIII, 1, 2, 2a, 3, 3a, 4, 5, 5a)

Material. Level under the wayside shrine, specimens Nos 1–4, 6–8, 52, 53, 295, 315, 317, 410; 13 impressions of small fragments of leaves; in one specimen the base of the blade was preserved.

Description. Little can be said about the shape and size of the leaves on the basis of the fragments found. The largest width of the leaves was probably up to 10 cm. The base of the blade preserved in one specimen is subcordate. The margins of leaves are dentate; the small teeth, beginning at some distance from the base of the petiole, are very small, directed upwards and slightly bent at the rounded ends. In the upper part of the blade they are slightly larger, have a wider base and a more triangular shape.

The lateral nerves, bent more or less archwise, depart from the main vein at an angle of 40°—50°. The lowest pair of lateral nerves form a right angle with each other. From this pair of nerves numerous (up to 7) secondary nerves depart at an angle of almost 50°; at first they are parallel and almost straight, and later bent archwise. As can be observed in many preserved fragments of leaves, the secondary nerves, as the lateral nerves themselves, often bifurcate near the margins, forming loops between each other. In turn smaller nerves depart from these loops, and form small loops or else end in teeth. The tertiary nerves, sometimes bifurcate run perpendicularly to the lateral ones, separating elongated, generally rectangular fields.

In one specimen (Pl. IX, 2) two relatively large, rounded traces of dark basal glands are visible on both sides of the petiole. On some other fragments of leaves the ends of small teeth show traces of small glands (Pl. IX, 1a, Pl. XXII, 6a; Pl. XXIII, 2a).

Comparison. The including of these fragments of blades in the genus *Populus* is determined by the character of dentation, the nervation of leaves, and the traces of glands. Fossil leaves with traces of glands at the base were found by Heer (1856) in the flora from Oeningen and described by him as *Populus glandulifera.* Hantke (1954) included *P. glandulifera* Heer in *P. balsamoides* Goepp. on the basis of the considerable concordance of the morphological features of leaves of the two fossil species. The occurrence of glands at the ends of *P. balsamoides* Goepp. leaves was also reported by Iliinskaja (1968).

Populus balsamoides Goepp. until quite lately was compared with the contemporary species *P. balsamifera* L. and *P. candicans* Ait., belonging to the section *Tacamahaca* Spach (Hantke 1954). Andreánszky (1959), however, questioned the relation of the fossil species to *P. balsamifera* L., and recently so did Iliinskaja (1968), who is inclined to

relate the fossil species to the contemporary Chinese poplar, *P. lasiocarpa* Oliv. from the section *Leucoides* Spach.

The comparison of leaves of the contemporary *P. lasiocarpa* Oliv.[1] with fragments of blades from Domański Wierch corroborates Iliinskaja's suggestion. On the leaves of this poplar small glands occur at the ends of the teeth and two relatively large glands at the base.

Occurrence in fossil floras of Poland. Stróża (sub *P. platyphyllus* Goepp., Goeppert 1852; Meyer 1917), Sośnica (sub *P. balsamoides* Goepp., *P. emarginata* Goepp., *P. eximia* Goepp. p. p., *P. ovalis* Goepp., Goeppert 1855; Meyer 1917), Trzebnica (Pax 1906), Malczyce and Ruprechtów (Kräusel 1918), Koronowo (Menzel 1910), Chodzież (Zabłocki 1924), Konin (Raniecka-Bobrowska 1954), Dobrzyń (Kownas 1956), and Stare Gliwice (Szafer 1961).

Populus tremula L. foss.

(Pl. IX, 3, 4)

Material. Level under the wayside shrine, specimen No 5; boring, sample No 158, depth 79·60—79·70, specimen No 445; one impression of the upper and one of the lower part of the blade.

Description. One fragment represents the lower part of a leaf with truncate base and partly preserved petiole. The leaf is 4·2 cm wide. Its margin is crenate-dentate. From the distinctly marked midrib a pair of delicate basal nerves runs near the base of the leaf. From the higher pair of lateral nerves, forming an angle of 100° with each other, numerous secondary nerves depart which, directly or after bifurcating, enter the teeth of the margin.

In the second specimen the upper part of the blade is visible with a not deeply crenate margin. From the slightly bent midrib distinct lateral nerves depart, joined by straight or branched tertiary nerves.

Comparison. The shape of the margins of leaves and arrangement of nerves within the base is very much the same as in the specimen of *Populus tremula* L. from the Miocene flora of Rochessauve (Grangeon 1958) and in the leaves of the contemporary species.

The area of distribution of *Populus tremula* L. covers Europe and the greater part of Asia.

Occurrence in fossil floras of Poland. Leaves of *P. tremula* L. have not before been reported from the Tertiary fossil floras of Poland. The fossil species *P. crenata* Ung., usually compared with *P. tre-*

[1] The comparative material of *Populus lasiocarpa* Oliv. proceeded from the Arboretum in Kórnik.

mula L., is known from Sośnica and Malczyce (sub *P. crenata* Ung., *P. eximia* Goepp. p. p., Goeppert 1855; Meyer 1917), Wołów (Kräusel 1918), Dobrzyń (Kownas 1956), and Stare Gliwice (Szafer 1961).

Populus cf. *nigra* L.

(Pl. IX, 5, 6; Pl. XXII, 5)

Material. Level under the wayside shrine, specimen No 51; boring, sample No 154, depth 79·00—79·20, specimen No 442; 2 impressions of the blades base.

Description. The breadth of the preserved fragments of leaves with a broad-cuneate or truncate base amounts to 4·5 and 9·5 cm. The teeth at the margins of leaves, more or less bent at the ends, begin at some distance from the petiole. The pair of lateral nerves departing from the midrib near the base form an angle of 90° with each other (the smaller leaf) and 115° (the larger leaf). From this pair of nerves numerous (4 visible) secondary nerves depart on the external side, and not reaching the margins bifurcate once more ending in the small teeth of the margins.

Comparison. The shape of the base, the run of nerves within it, and the dentation of the margins of the blade indicate that we have to do with a form similar to the contemporary species *P. nigra* L., growing to-day in Europe and Western Asia. Fossil leaves of *P. nigra* L. were found in the Pliocene and Lower Pleistocene of Bulgaria (after Kitanov 1956), and those of *Populus* cf. *nigra* L. in the Pliocene of Dernbach (Müller-Stoll 1938) and Dřeveník (Němejc 1967).

Occurrence in fossil floras of Poland. Leaves of *Populus nigra* L. have not previously been reported from Tertiary floras of Poland.

Ulmaceae

Ulmus sp. div.

(Pl. IX, 7—15; Pl. XXIII, 6; Pl. XXIV, 1, 1a, 2, 2a, 3—6; Pl. XXV, 1—3; Pl. XXX a, b)

Material. Level under the wayside shrine, specimens Nos 181—183, 189—210, 212, 214—217, 306, 307, 407; 33 impressions mostly of blade fragments.

Description. Leaves obovate or ovate, acuminate and rounded-cuneate, with a more or less asymmetric base. The size of the small leaves varies from 1·9 to 2·2 cm in length and 1·4 to 1·8 cm in breadth; the length of the larger leaves is to up to 7 cm and their breadth to 5 cm. The margins of the larger leaves have small serrate or biserrate teeth which are triangular, somewhat blunt and directed slightly upwards, have a convex external margin and straight or slightly concave, much shorter inter-

nal one. The small leaves have simple serrate teeth, which are narrow and rounded at the ends in the basal part and triangular higher up, sometimes with a tiny protuberance, as if the trace of a smaller tooth on the external margin.

The midrib is straight, while the lateral nerves distinctly bent archwise and usually set alternately (11—13 pairs in number) depart from the main vein at an angle of 45°—50°. Sometimes they bifurcate at a varying distance from the margins of the leaf then entering into the two neighbouring larger teeth. Near the margins of the leaf secondary nerves depart, penetrating into the sinuses between the teeth. The tertiary and quaternary nerves are distinctly visible.

Comparison. The characteristic feature of *Ulmus* leaves according to Reimann (1917) is the presence of secondary nerves running into the sinuses between the teeth. Moreover, leaves of the genus *Ulmus* are distinguished by a falcate deflection of teeth, an upwards bending of the ends of lateral nerves, and frequently occurring furcate nerves. The other characteristic traits of the majority of *Ulmus* species were enumerated by Němejc (1949). They are an asymmetry of the rounded or cordate base, the disposition of the largest breadth in the middle or slightly above the middle of the blade, and the close and almost parallel arrangement of the lateral nerves.

While the assignment of impressions of leaves found in Tertiary floras to the genus *Ulmus* aroused no doubt, the determination of the species gave rise to many contradictory opinions (cf. Reimann 1917; Němejc 1949; Andreánszky 1959; Kotlaba 1963). This is connected with the occurrence in the majority of Neogene floras of Europe of various forms of leaves, often not clearly distinct from one another. The presence of remains of leaves with intermediate features, making it difficult to determine the boundaries of variability of fossil forms, inclined the majority of authors to interpret the fossil species within a wide range (Reimann 1917; Němejc 1949; Hantke 1954; Jung 1963).

One of the characters whose diagnostic value in determining fossil species of the elm has often been discussed is the character of serration of the blade margins. Some authors (Unger 1847, Goeppert 1855; Heer 1856; Krištofovič and Bajkovskaja 1965; Kotlaba 1963; Iliinskaja 1968) assigned serrate and bisserate leaves to separate species. Others, among which were Menzel (1906), Reimann (1917), Kolakovski and Ratjani (1967), held a different opinion, stressing the considerable variability of the margins, especially of those of small leaves of some elm species, where, in addition to double teeth single ones also occur, as well as intermediate stages in the form of tiny protuberances at places where additional small teeth must probably have been.

Considerable differentiation concerning, among features, the mode of

serration of margins characterizes the remains of *Ulmus* leaves from Domański Wierch. Some of them, with double teeth (Pl. IX, 13, 14; Pl. XXIV, 6; Pl. XXV, 1), correspond to *U. carpinoides* Goepp. The course of nervation and narrowing of the blade in the apical part, visible in some specimens (Pl. IX, 8; Pl. XXV, 2), also suggest relating them with this fossil species, in spite of some simple teeth visible in the upper part of the blade. The damaged state of the specimens makes it impossible to examine the whole serration, which may have been double in the middle part of the leaf (cf. *U. braunii* Heer aff. *U. campestris* L., Grangeon 1958, Planche-texte XXII).

The fragment of the largest leaf with double teeth (Pl. IX, 15; Pl. XXIV, 3) represents another type, this being evidenced by the multiple bifurcations of the lateral nerves and the large angle which they form with the main nerve (60°, 65°) in the middle part of the leaf.

The smallest leaves with simple teeth at the margins (Pl. IX, 9, 12; Pl. XXIII, 6; Pl. XXIV, 5) correspond to the species *U. minuta* Goepp., included by Reimann (1917) in the range of *U. carpinoides* Goepp. forms.

Specimens with relatively narrow, simply serrate leaves are reminiscent of some *Ulmus plurinervia* Ung. leaves (Unger 1847, Taf. XXV, fig. 1; Heer 1856, Taf. LXXIX, fig. 4; Berger 1955, Abb. 91; Iliinskaja 1968, Tabl. VII, fig. 12, Tabl. XVI, fig. 3, 4). Němejc (1949) and Berger (1955) relate this type of elm leaves with species of *U. carpinoides* Goepp., whereas Iliinskaja (1968) stresses the separateness of *U. plurinervia* Ung., marked by the presence of simple rounded teeth and closely running lateral nerves.

The diversity of forms of *Ulmus* leaves appearing in the flora of Domański Wierch seems to corroborate the opinion of those authors who accept greater specific differentiation in this genus in the Tertiary. However, as only fragments of leaves have for the most part been preserved, they serve as a basis for differentiating the particular species; attempts to relate the fossil forms with contemporary species would also be insufficiently documented. It can only be presumed that these are forms approximate to such present-day elm species as the European-Asia Minor (*U. campestris* L., *U. scabra* Mill.) and the East Asiatic (*U. pumila* L., *U. parvifolia* Jacq.).

Occurrence in fossil floras of Poland. The most numerous stands of *U. carpinoides* Goepp. are: Sośnica (Goeppert 1855; Reimann 1917), Trzebnica (Pax 1906), Pszów and Brzeg Dolny (Reimann 1917), Ruprechtów and Pieruszów (Kräusel 1918), Chodzież (Zabłocki 1924), Smogorzówek (Juhnke 1931) and Swoszowice (Iliinskaja 1964). The impressions of leaves described as *Zelkova ungeri* Kov. from Stare Gliwice may belong to the genus *Ulmus* (probably species *U. plurinervia* Ung.) (Szafer 1961, Tab. XIII, 9, 10).

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

(Pl. IX, 16; Pl. X, 1–3; Pl. XXV, 4, 5, 6, 6a)

Material. Level under the wayside shrine, specimens Nos 184, 187, 188; level of magnolia flora, specimens Nos 186; boring, sample No 161, depth 80·10–80·30 m, specimen No 456; 5 impressions, two of which represent the whole or almost whole blade.

Description. Leaves oblong to oblong-ovate, the broadest in the middle or slightly above the middle of the blade; distinctly narrowing in the upper part, slightly asymmetric near the base, cuneate rounded or subcordate. The length of the leaves varies from 5 to about 8 cm and their breadth from 3 to 4 cm. The petiole preserved on one specimen is 6 mm long. The teeth are thick, slightly rounded, acute or blunt at the ends. Their external edge is more convex and a little longer than the internal one. The lateral nerves (about 11 pairs), straight in the lower and bent archwise in the upper part of the blades, reach the ends of teeth. The arrangement of the lateral nerves is sometimes irregular; at times they branch at a varying distance from the midrib, ending in separate teeth. Near the margins secondary nerves depart to sinuses between the teeth, forming a prolongation of the internal edge of each tooth. The tertiary nervation is not visible.

Comparison. The shape and nervation of leaves, as well as the characteristic serration of their margins indicates that the examined specimens belong to the genus *Zelkova*. This genus, common in the Neogene floras of Europe, is chiefly represented by *Zelkova ungeri* (Ett.) Kov. (= *Z. zelkovaefolia* (Ung.) Bůžek et Kotlaba). This species is not very uniform as regards the morphology of leaves, a fact noted by many investigators among others, Mädler 1939; Berger 1952; Tralau 1963). Apart from specimens approximate to the contemporary species *Z. carpinifolia* K. Koch (= *Z. crenata* Spach) occurring in the trans-Caucasus, in the Talish Mts, and in North Iran, forms are found which are nearer to the East Asiatic species *Z. serrata* Mak. (= *Z. acuminata* Planch.). These two forms, differing in shape, size, and number of lateral nerves, are often found in the same fossil flora (Grangeon 1958; Andreánszky 1959; Walther 1964). Apart from typical forms corresponding to the contemporary species mentioned, specimens of leaves with intermediate features were also assigned to *Z. ungeri* Kov. (= *Z. zelkovaefolia* (Ung.) Bůžek et Kotlaba. That is why there is a discrepancy in the estimate of the systematic position of the investigated forms. Thus, some investigators retained the name *Z. ungeri* Kov. for the whole of the material, distinguishing only the forms *Z.* aff. *carpinifolia* K. Koch and *Z.* aff. *serrata* Mak. (Grangeon 1958). Other authors (Berger 1952; Andreánszky 1959) kept the name *Z. ungeri* Kov. for remains of

the type *Z. carpinifolia* K. Koch, describing the specimens resembling *Z. serrata* Mak. by the name *Z. praelonga* (Ung.) Berger.

Tralau in 1963 undertook the task of analysing the fossil material of the genus *Zelkova*. According to this author, among impressions of Tertiary leaves there are to be found forms similar to all contemporary species of this genus. The whole, abundant fossil material of to-day, was divided by Tralau into three groups. To the first, designated as *Z.* aff. *carpinifolia* K. Koch, he assigned specimens approximate to this species and to that nearest to it in range *Z. abelicea* Boiss. (= *Z. cretica* Spach). To the second group, included in the name *Z.* aff. *serrata* Mak., belongs forms related with East Asiatic species, such as *Z. serrata* Mak., *Z. sinica* Schneid., and *Z. schneideriana* Handel-Mazzetti. To the third group Tralau assigned intermediate forms and uncertain determinations. In his opinion the Tertiary *Z. ungeri* Kov. was a polymorphous species combining features of all the contemporary ones. Forms approximate to *Z. carpinifolia* K. Koch are known from Europe up to the Lower Pleistocene, thus, the two contemporary species (*Z. carpinifolia* K. Koch and *Z. abelicea* Boiss.) would be Tertiary relicts within their present areas of distribution.

According to the latest suggestions of Czech authors, the name *Z. zelkovaefolia* (Ung.) Bůžek et Kotlaba ought to be applied instead of *Z. ungeri* Kov., since remains of this type were described for the first time by Unger as *Ulmus zelkovaefolia* (Kotlaba 1963).

Zelkova leaves from Domański Wierch are slightly larger as compared to *Z. carpinifolia* K. Koch, have more lateral nerves and a longer petiole (cf. Table 2). Berger (1952) compared smaller leaves (1·5—4·0 cm long) with 5—8 lateral nerves and blunt apex to *Z. carpinifolia* K. Koch, and larger leaves (6—10 cm in length) with 10—12 lateral nerves and acuminate apex to *Z. serrata* Mak., stressing that the boundaries of variability of these two species partly overlap. Since such features as the position of the greatest width of the blade, the density of nervation, and especially the shape and size of teeth in the fossil specimens from Domański Wierch are very much the same as in *Z. carpinifolia* K. Koch, their relation with this contemporary species seems most probable (cf. Table 2).

Zelkova carpinifolia K. Koch occurs nowadays in the Western trans-Caucasus, in the Talish Mts and in North Iran. It grows on damp soils to the altitude of 300 m above sea-level in the trans-Caucasus and up to 1200 m in Lenkoran.

Occurrence in fossil floras of Poland: Sośnica — sub *Zelkova ungeri* Kov., *Quercus subrobur* Goepp., *Castanea atavia* Ung. p. p. — Goeppert 1855; Kräusel 1917; by the name *Z. ungeri* Kov. — Chłapowo (Heer 1869), Trzebnica (Pax 1906), Pieruszów (Kräusel 1918), Ruprechtów (Kräusel 1919), and Stare Gliwice (Szafer 1961).

Comparison of the characters of *Zelkova carpinifolia*, *Zelkova serrata*, and *Zelkova zelkovaefolia* leaves

Zestawienie cech liści *Zelkova carpinifolia*, *Zelkova serrata* i *Zelkova zelkovaefolia*

Species Gatunek	Morphological characters of leaves Cechy morfologiczne liści	Number of lateral nerves Liczba nerwów	Length of leaves in cm Długość liści w cm	Breadth of leaves in cm Szerokość liści w cm	Length of petiole in mm Długość ogonka w mm
Zelkova carpinifolia K. Koch (Čerepanov 1957)	greatest breadth of the leaf in the middle of the blade or slightly higher największa szerokość liścia w połowie blaszki lub nieco powyżej apex: acute wierzchołek: ostry teeth: large, rounded, acute or blunt at the ends zęby: duże, zaokrąglone, na końcach ostre lub przytępione	6—9	(1·5)2—6(7)	1—3(3·5)	0·5—1·5(2)
	leaves on sterile shoots liście na pędach płonych	12	12	—	4(5)
Zelkova serrata Mak. (Čerepanov 1957)	greatest breadth of the leaf in the upper half of the blade największa szerokość liścia w górnej połowie blaszki liściowej apex: acuminate wierzchołek: długo zaostrzony teeth: smaller, directed upwards, acuminate zęby: mniejsze, skierowane ku górze, długo zaostrzone	(8)10—15(18)	(2)—3—8·5	(1)1·5—3	1·5—3(4)
	leaves on sterile shoots liście na pędach płonych	—	12·5	6·5	8(10)
Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba from Domański Wierch	greatest breadth of the leaf in the middle of the blade or slightly higher największa szerokość liścia w połowie blaszki lub nieco powyżej apex:? teeth: large, rounded, acute or blunt at the ends zęby: duże, zaokrąglone, na końcach ostre lub przytępione	9—11	ca. 5 — ca. 8	3—4	6

Hamamelidaceae

Liquidambar europaea A. Br.

(Pl. X, 10, 11; Pl. XXVI, 3, 3a)

Material. Level of magnolia flora, specimens Nos 23 and 218; 2 impressions of incomplete blade.

Description. Leaves palmately 5-lobed with finely serrate margins, 8—10 cm in breadth and truncate base. The main nerves, running through the middle of the particular lobes, branch out from one place near the base of the blade. The angle included between the nerves of the middle and of the neighbouring lobes is 45°—50°, and that between the nerves of the middle and the lowest lobes 75°—90°. The nerves of the lowest lobes are slightly bent archwise.

Comparison. *Liquidambar europaea* A. Br. often occurs in many Tertiary floras of Europe and is characterized by a considerable variability of the morphological structure of leaves. In fossil materials there may be distinguished forms approximate to three contemporary species: *Liquidambar styraciflua* L., *L. orientalis* Mill., and *L. formosana* Hance. The most frequently found are remains similar to the North American species *L. styraciflua* L. They are 5—7-lobed (exceptionally 3-lobed) leaves, serrate at the margin (among others Pop 1936; Andreánszky 1959; Kolakovski 1964). Impressions of leaves of the *L. orientalis* Mill. type have been a less frequently reported. They are known from the Miocene of Rochessauve (Grangeon 1958) and the Sarmatian of Hungary as *L. protensa* Ung. and *L. pseudoprotensa* Andr. (Andreánszky, Kovács-Sonkodi 1955; Andreánszky 1959).

However, it should be noted that leaves of the Asia Minor species *L. orientalis* Mill. are characterized by a considerable variability. They generally have five oblong-ovate, deeply incised lobes, each of which has 2 or 3 additional geminate lobes or thick teeth. Sometimes leaves closely resembling in shape leaves of *L. styraciflua* L. (Makarova 1957) also occur in this species.

Investigations on Tertiary fruit and seed floras from Poland showed the presence of fructifications of *Liquidambar*, similar to *L. orientalis* Mill. They were found in the Lower Miocene flora of Turów and Wieliczka (Czeczott and Skirgiełło 1959), as well as in the Tortonian flora of the Gdów Bay (Łańcucka-Środoniowa 1966).

The two remains of *Liquidambar* leaves found in the flora of Domański Wierch are morphologically nearest to the species *L. styraciflua* L.

Liquidambar styraciflua L. occurs on riverain and seaside lowlands subject to spring floating, situated in that part of the United States of North America lying on the Atlantic coast.

Occurrence in fossil floras of Poland: Sośnica (Goeppert 1855), Dzierżysław, Pieruszów, Kokoszyce, Pogalewo Wielkie (Kräusel 1918), and Swoszowice (Iliinskaja 1964).

Parrotia pristina (Ett.) Stur

(Pl. X, 4–9; Pl. XI, 9–11; Pl. XXV, 7–10; Pl. XXVI, 1, 2; Pl. XXXc)

Material. Level under the wayside shrine, specimens Nos 254, 271–291, 409–503; level of magnolia flora, specimens Nos 219, 220, 221 (a+b), 222 (a+b), 223–253, 255–270, 292, 304, 310, 311, 430, 431; boring, sample No 158, depth 79·60–79·70, specimen No 444; 82 impressions of whole leaves or fragments of them; specimens Nos 221, 222 have twin impressions.

Description. Leaves 2·5—7·5 cm long and 1·2—5·0 cm wide, oval to obovate-oblong, broadest in the middle of their length or at one third of it counting from the apex. The base of the blade is often asymmetric, rounded-cuneate or cuneate, sometimes rounded or even subcordate, the apex being acuminate or obtuse. The margins of leaves near the base are entire, coarsely crenate-dentate from the middle or slightly higher. The lateral nerves, 5 to 7 in number on each side of the midrib, run more or less parallel; they are straight or slightly bent archwise. The arrangement of the lateral nerves is alternate, with the exception of the lowest pair, which departs from the midrib at the same level or at a small distance from each other. The margins of leaves begin above the points of branching of the lowest pair of lateral nerves. The angle included between the midrib and the first pair of lateral nerves varies from 20° to 30°, not being the same for the two sides of the leaf. The lateral nerves of the second and third pair depart at an angle of 40°.

Comparison. Leaves of this type, known from numerous Neogene floras of Europe, were most often described under the name of *Parrotia fagifolia* (Goepp.) Heer, but lately the name *P. pristina* (Ett.) Stur has been applied, as it was earlier introduced by Ettingshausen (Iliinskaja 1959).

P. pristina (Ett.) Stur is compared to the Irano-Turanian species *P. persica* C. A. Mey. In spite of their considerable polymorphism, the leaves of these two species show a great similarity. The differences between them concern only the mean size of the leaves, which in *P. pristina* (Ett.) Stur is one and a half times less than in *P. persica* C. A. Mey., and the shape of blades which is more elongated in the fossil species (Iliinskaja 1959).

The relation of *P. pristina* (Ett.) Stur with *P. persica* C. A. Mey. is accepted by the majority of investigators, although leaves of a similar type also occur in the family *Hamamelidaceae* in the genera *Fothergilla* and *Hamamelis*. On account of this similarity Tralau (1963), when comparing the hitherto existing determinations of leaves of this type, questioned the

occurrence of genus *Parrotia* in the European Tertiary. According to this author, the presence of fossil remains of *P. persica* C. A. Mey. was proved only by Baas (1932), who established the presence of fruits of *Parrotia persica* C. A. Mey. in Plio-Pleistocene sediments from Schwanheim. *Parrotia* leaves were found in Miocene (chiefly Sarmatian) fossil floras, less numerous stands being known from the Pliocene up to the Lower Pleistocene (Czeczott 1951; Iliinskaja 1959; Geissert 1967).

The present-day area of distribution of *Parrotia persica* C. A. Mey. covers the provinces of northern Iran and the Talish Mts. It grows there on seaside lowlands and in the lower altitudinal belts of mountains up to the altitude of 700 m above sea level, single specimens being found up to 1200 m.

Occurrence in fossil floras of Poland: Sośnica — sub *Quercus fagifolia* Goepp., *Q. triangularis* Goepp., and *Q. undulatus* Goepp.; Goeppert 1855; by the name *Parrotia fagifolia* (Goepp.) Heer — Sośnica (Kräusel 1917) and Stare Gliwice (Szafer 1961).

Platanaceae

Platanus platanifolia (Ett.) Knobl.

(Pl. XII, 4, 5; Pl. XXVII, 1, 1a)

Material. Level under the wayside shrine, specimen No 294; boring, sample No 154, depth 79·00—79·20 m, specimen No 441; 2 impressions; in one of them the lower part of the blade is visible.

Description. One fragment represents a broadly cuneate, almost truncate base of the leaf with two teeth preserved, one of which has a rounded external edge. The lowest, delicate pair of basal nerves runs almost parallel to the base. The numerous nerves departing from it form small loops, with the exception of the nerve entering the tooth and ending in it craspedodrome. The strongly marked, straight lateral nerves form an angle of about 40° with the midrib; numerous secondary nerves depart from the lowest pair in a horizontal direction towards the external side of the leaf.

In the second specimens 8×8 cm in dimensions (the leaf itself was a little larger) the outline of the entire blade is lacking. The visible nervation is characteristic of *Platanus* leaves. From the strongly marked main vein two lobe nerves depart at an angle of 30°—40°; from these nerves in turn numerous secondary nerves depart in a horizontal direction towards the external side of the leaf. The lateral nerves straight or bent slightly archwise, are joined by distinct, sparsely distributed tertiary nerves.

[1] Since *Cissus platanifolia* described by Ettingshausen (1851) is according to many authors a synonym for *Platanus aceroides* Goepp., Knobloch (1968a) considers that the specific name *Platanus platanifolia* (Ett.) Knobl. ought to be used.

Comparison. The shape of the leaf base and character of nervation permits the assignment of the two described remains to the species *Platanus aceroides* Goepp. [1]. This plane-tree, known from numerous Tertiary floras of Europe, was compared with the contemporary species *P. occidentalis* L. (North America), *P. orientalis* L. (Balkan Peninsula, eastern coast of the Mediterranean, and western part of Asia Minor), and *P. acerifolia* Willd., which is a cross between *P. occidentalis* L. and *P. orientalis* L. (Europe, Central Asia).

On the basis of an analysis of numerous remains of *P. aceroides* Goepp. leaves from the Lower Pliocene from Laaerberg, Berger (1955) expressed the opinion that it is impossible to delimit Tertiary leaves of this genus. Both fossil leaves and those of contemporary trees show an immense variability and, apart from forms typical of the particular species, there occur a considerable number of intermediate forms. Many authors, among them Berger (1955) and Andreánszky (1959), considered *P. aceroides* Goepp. to be an initial form for *P. occidentalis* L. and *P. orientalis* L., on account of the morphological features of the leaves and the distribution of the fossil species, joining the disjunctive areas of occurrence of the two contemporary species. However, the majority of investigators relate the fossil species with *P. occidentalis* L.

It is difficult to compare the fragments of leaves found in the flora of Domański Wierch with one of the contemporary species; nevertheless, it seems that the arrangement of nerves points to a similarity with *P. occidentalis* L.

Today *Platanus occidentalis* L. grows on the banks of rivers and lakes in the Atlantic part of North America.

Occurrence in fossil floras of Poland. By the name *Platanus aceroides* Goepp.: Sośnica (Goeppert 1855), Trzebnica (Pax 1906), Domaradz (Kräusel 1917), Dierżysław, Kokoszyce, Pieruszów, Wołów (Kräusel 1918), Czernica (Raniecka-Bobrowska 1957), and Swoszowice (Iliinskaja 1964).

Aceraceae

Acer vindobonense (Ett.) Berger

(Pl. XI, 5–7; Pl. XXVII, 2)

Material. Level of magnolia flora, specimens Nos 302, 412 (a+b), 413; 3 impressions of fragments of leaves; specimen 412 with twin impression.

Description. The dimensions of the leaves are difficult to reconstruct on the basis of the fragments preserved. The smallest of them was about 6×4 cm; the two other specimens must have been a little larger, judging by the breadth of the bases of the central lobes and the size of the lower ones. The blades have seven radially disposed central nerves and smaller or larger parts of lobes are preserved. The lobes are oblong

lanceolate, acuminate. Small teeth are visible on their margins, especially in the upper part (Pl. XI, 7). The sinuses between the lobes are acute and deep. The lowest pair of nerves is strongly bent downwards. The delicate secondary nerves depart from the central nerves of the lobes at an almost right angle, which diminishes in the upper part of the lobes.

The impression of the smallest leaf is the most complete (Pl. XI, 5) with visible fragments of six lobes. In another specimen (Pl. XI, 7) one lobe with small teeth and the lower part of the other was almost entirely preserved. Of the relatively large leaf represented in Pl. XI, 6, only the central part of the blade with the lowest lobe has been preserved.

Comparison. Leaves of this type, found in Tertiary floras, are assigned to the section *Palmata* Pax and described by various names: *Acer polymorphum* Sieb. et Zucc. *miocenicum* Menzel, *A. polymorphum* Sieb. et Zucc. *pliocenicum* Sap., *A. nordenskiöldi* Nath., *A. sanctae-crucis* Stur, and *A. vindobonense* (Ett.) Stur. Some of them were already included by Menzel (1906) in *A. polymorphum* Sieb. et Zucc. *miocenicum,* this author considering that in spite of some differences in the character of serration of the margins, these species correspond to the contemporary, polymorphous *A. palmatum* Thunb. (= *A. polymorphum* Sieb. et. Zucc.). Berger (1955) held a different opinion, maintaing that. *A. nordenskiöldi* Nath., *A. sanctae-crucis* Stur, and *A. vindobonense* (Ett.) Stur are separate species. According to Berger, only the first of them, i. e. *A. nordenskiöldi* Nath. approximates *A. polymorphum* Sieb. et Zucc. *miocenicum* Menzel and *A. polymorphum* Sieb. et Zucc. *pliocenicum* Sap., and may be compared to *A. palmatum* Thunb.

A. polymorphum Sieb. et Zucc. *pliocenicum* Sap. and *A. vindobonense* (Ett.) Stur were also discriminated by Andreánszky (1959) in the Sarmatian floras of Hungary. The comparison of the former to the contemporary species *A. japonicum* Thunb. and *A. circinatum* Pursh. from the section *Palmata* Pax is not sufficiently substantiated. Andreánszky (1959), like Berger (1955), gives no relate form for the species *A. vindobonense* (Ett.) Stur, on account of the lack of small teeth occurring at the margins of leaves of all contemporary species of the section *Palmata* Pax [1].

Leaves of this type were also found in the Pliocene of the trans-Carpathian by Iliinskaja (1968), who determined them as *A. sanctae-crucis* Stur, by comparison to *A. palmatum* Thunb. This author presumes that both *A. polymorphum* Sieb. et Zucc. *pliocenicum* Sap., and *A. nordenskiöldi* Nath., as well as *A. sanctae-crucis* Stur can be assigned to the same range of forms corresponding to *A. palmatum* Thunb.

Impressions of maple leaves with seven sparsely serrate or even entire lobes, similar to *A. vindobonense* (Ett.) Stur from Laaerberg (Berger

[1] *Acer vindobonense* (Ett.) Stur from Laerberg (Berger 1955, Abb. 140) has, however, distinct, though not numerous small teeth at the margins.

1955), also occur in the Neogene of Moravia. Knobloch (1969) determined them as *A. vindobonense* (Ett.) Berger non Stur, since the fragment of a leaf originally described as *Sterculia vindobonensis* had not been unequivocally recognized as *Acer* by Stur (cf. Knobloch l. c., pp. 127—129), but only by Berger (1955). According to Knobloch, the majority of leaves of this type, described as *A. nordenskiöldi* Nath., *A. sanctae-crucis* Stur, *A. polymorphum* Sieb. et Zucc., or *A. palmatum* Thunb., variable as regards the serration of the margins of lobes, may represent the same fossil species; at the same time he stresses that it is difficult to discern any close relation of this fossil form with the East Asiatic species *A. palmatum* Thunb., on account of the differences in the shape of lobes, the character of their serration, and the occurrence of leaves with entire lobes.

The leaves from Domański Wierch are similar to the specimens of *A. vindobonense* (Ett.) Berger from Laaerberg and Moravská Nová Ves. Like this fossil species, they are also similar to the majority of 7-lobed maple leaves described as *A. polymorphum* Sieb. et Zucc. *pliocenicum* Sap., *A. nordenskiöldi* Nath., and *A. sanctae-crucis* Stur. These species probably belong to one polymorphous form, whose relation with the contemporary species has not been definitively elucidated. Of the contemporary species belonging to the section *Palmata* Pax, only the East Asiatic *A. palmatum* Thunb. is characterized by a similar morphological structure of the blade; however, it has much more numerous and more closely distributed teeth at the margins of lobes.

Occurrence in fossil floras of Poland. The species has not previously been reported from the Tertiary of Poland. Only one leaf of *A. polymorphum* Sieb. et Zucc. *miocenicum* Menzel is known which was found in the Miocene of Ruprechtów in Silesia (Kräusel 1919), and recognized by Knobloch (1969) to be *Acer vindobonense* (Ett.) Berger.

Acer firmianoides Andreánszky

(Pl. XII, 8)

Material. Level of magnolia flora, specimen No 297.

Description. A fragment of the middle and lateral lobe of a 3-lobed leaf with distinctly cordate base is visible in the specimen. The size of the whole leaf is about 7×7 cm, and the length of the middle lobe about 4 cm. The lower part of the middle lobe is slightly narrowed, the apex being markedly acuminate. The margins are entire; in the upper part of the middle lobe the outline of a large tooth is visible. The lateral lobe is broader than the central one, it is asymmetric (the external part being more developed), with an elongated apex. The sinus between the lobes is rounded and relatively narrow. Because of the deformation of the impression, only the angle included between the central and main nerve of the non-pre-

served lobe is regular; it is 65°. Higher, it diminishes on account of the archwise bending of the nerves. Parallel to the margins of the cordate base run pair of nerves, not entering into the separate lobes. The tertiary nervation is poorly marked, however, distinct loops are visible in the lateral lobe.

Comparison. The determination of the species of the preserved leaf fragment presents great difficulties on account of the poor state of preservation of the specimen. The distinctly 3-lobed leaf and run of the tertiary nervation distinguishes it from the other specimens belonging to *Acer subcampestre* Goepp.

Leaves of *A. obtusilobum* Ung. from the Neogene of Moravia are of a similar character (Knobloch 1969, Abb. 294, Taf. LXVII, Fig. 6, Taf. LXIX, fig. 8). However, as compared with the holotype of this species (Unger 1847, Tab. XLIII, Fig. 12), the specimen from Domański Wierch has more elongated and narrowing apices of lobes, and a distinctly 3-lobed leaf. According to Knobloch, the synonyms of *A. obtusilobum* Ung. are some forms of *A. subcampestre* Goepp. and *A. pseudocampestre* Ung. (cf. Knobloch 1969, pp. 137—138) while of the contemporary species *Acer campestre* L. is nearest to it. Knobloch's opinion does not seem to be correct. Admittedly, the specimens from Moravia do not represent whole leaves, but the author determines them as 3-lobed, whereas *A. subcampestre* Goepp. and *A. pseudocampestre* Ung. have in principle 5-lobed leaves. Also the holotype *A. obtusilobum* Ung. has a 5-lobed blade, although it is poorly marked.

Acer firmianoides Andreánszky from the Sarmatian of Hungary is a fossil species with three entire lobes, a cordate base, long narrow endings of the lobes, relatively narrow interlobar sinuses, and a distinctly camptodrome tertiary nervation. A fragment of a leaf from Domański Wierch was assigned to this species.

The relation of this fossil form with the contemporary *Acer* species has not been determined. Andreánszky (1959) relates it with the group *A. campestre* L. and *A. monspessulanum* L. especially with *A. persicum* A. Pojark. from the group *A. monspessulanum* L.

Occurrence in fossil floras of Poland. The species has not previously been reported.

Acer platanoides L. foss.

(Pl. XI, 8; Pl. XXVI, 6)

Material. Level under the wayside shrine, specimen No 293; 1 impression of a leaf fragment.

Description. The two lowest lobes of a multilobed leaf are visible in the specimen. The leaf must have been fairly large since the lobe second from below is about 7 cm long and 3·5 cm wide. Two distinct large teeth

are visible in it, the lower being markedly elongated. The margin between the teeth is deeply incised. The preserved fragment of the margin of the base indicates that it was of subcordate shape. The nervation in places is very well marked.

Comparison. The fragment of the leaf described is in all respects concordant with the corresponding part of the blade of the contemporary species *A. platanoides* L. Leaves of this species are known from a few stands of Tertiary floras, among others, from the Upper Pliocene of Willershausen (Straus 1930) and Frimmersdorf (Kilpper 1959), and also as *Acer* cf. *platanoides* L. from the Lower Pliocene flora of Dřeveník (Němejc 1967), and *Acer* sp. cf. *A. platanoides* L. from the Sarmatian flora of Krynka (Krištofovič and Bajkovskaja 1965). Many Quaternary stands occur in southern Europe (cf. Mastrorilli 1965).

Acer platanoides L. usually grows nowadays as an admixture in deciduous and mixed forests of central and northern Europe, of the European part of the USSR, and of the western part of Asia Minor. In the Caucasus it is a component of forests growing at the altitude of 600—1800 m above sea level (Pojarkova 1933).

Occurrence in fossil floras of Poland. Fruits of *Acer platanoides* L. foss. occur in the Pliocene of Krościenko and Mizerna (Szafer 1946, 1947, 1954). A 3-lobed leaf from the section *Palaeoplatanoidea* Pax was described from the Miocene of Silesia (Kokoszyce, Kräusel 1918). Fruits of this species are known from Quaternary floras.

Acer subcampestre Goepp.

(Pl. XI, 1—4; Pl. XXVI, 4, 5)

Material. Level under the wayside shrine, specimen No 298; level of magnolia flora, specimens Nos 299 (a+b), 300, 301; 4 impressions of leaf fragments; in one specimen the base of the blade is visible; one specimen with a twin impression.

Description. The approximate dimensions of the leaves are about 6 cm in length and breadth, the smallest leaf being about 4·5 cm wide and 4 cm long. The blade is 5-lobed with a subcordate base; the central acuminose lobe has elongated teeth a little above half of its length, rounded at their ends, disposed almost symmetrically on both sides of the lobe. The margins of the central lobe narrow below the teeth. The nervation is radiate. The secondary nerves in the particular lobes are slightly bent archwise. The venula reticulum is irregular.

Comparison. The resemblance of the investigated remains of leaves to *Acer subcampestre* Goepp., described many a time from the Tertiary of Europe, is unquestionable.

Acer campestre L. is the nearest contemporary species. Its area of distribution covers southern and central Europe, the European part of the USSR, the Caucasus, Crimea, the northern Iran, the northern part of Asia Minor, Tunisia, and Algeria. In Europe it grows up to the altitude of 1700 m above sea level and in the Caucasus up to 1800 m. It is found chiefly on damp soils, a bushy form of it also occurs on high, dry, and insolated slopes (Pojarkova 1933).

Occurrence in fossil floras of Poland. Leaves of *Acer subcampestre* Goepp. are hitherto known from Sośnica (Goeppert 1855). Fruits of *A. campestre* L. foss. were described from the Pliocene of Krościenko and Mizerna (Szafer 1946, 1954), and those of *A.* cf. *campestre* L. from the Miocene of Stare Gliwice (Szafer 1961).

Vitaceae

Vitis sp.

(Pl. XII, 1–3; Pl. XXVII, 4, 4a)

Material. Level under the wayside shrine, specimens Nos 185, 296; level of magnolia flora, specimen No 447; 3 fragments of leaves.

Description. A fragment of the blade 6 cm long represents the middle part of a leaf narrowing towards the apex. Three preserved teeth have convex edges and end in a short bristle. The lateral nerves depart from the midrib at an angle of 35°—40°, at first alternately, and near the apex oppositely. They end craspedodrome in the teeth. The tertiary nerves, disposed parallelly, form a right angle with the lateral nerves.

Another fragment represents part of a blade with a deeply cordate base and long petiole.

Comparison. A similar, deeply cordate base of the blade, approximate mode of nervation and shape of teeth occur in some species of the genus *Vitis*. The incompleteness of the specimens preserved does not permit an exact determination.

Occurrence in fossil floras of Poland. Impressions of leaves of two species of the genus *Vitis* are known, these being *Vitis teutonica* A. Br. from Sośnica (sub *A. strictum* Goepp., Goeppert 1855; Meyer 1917), Ruprechtów and Pieruszów (?) (Kräusel 1919), and *Vitis* cf. *inconstans* Miq. from Turów (Czeczott and Skirgiełło 1959). The specimens from Domański Wierch cannot be assigned to either of these species.

Cornaceae

Cornus cf. *mas* L.

(Pl. XII, 6; Pl. XXVII, 3)

Material. Level of magnolia flora, specimen No 303; 1 impression of an almost whole leaf.

Description. Blade (8×4 cm) of elliptic shape, acuminose apex, and rounded base. From the strongly marked midrib 5 pairs of lateral nerves depart, running in a wide arch almost parallel to the margins of the leaf lacking serration. The arrangement of the lowest pair of lateral nerves is probably opposite, whereas the higher pairs of these nerves depart alternately from the midrib at an angle of 30°—35°. The tertiary nerves run horizontally.

Comparison. The features of nervation of the leaf, such as the small distance between the lowest pairs of lateral nerves, the considerable distance between the place of branching of the highest pair of these nerves and the apex, the character of the archwise bending of the lateral nerves, and their number, as well as the presumable shape and size of the blade, point to the close resemblance of the fossil specimen and the contemporary *Cornus mas* L.

The species *C. graeffii* was described by Hantke (1954) from the Upper Miocene of Switzerland on the basis of remains assigned earlier by Heer (1859) to *Rhamnus graeffii* Heer. Hantke compared this species with *C. mas* L., stressing at the same time that leaves of similar type also occur in *C. sanguinea* L., *C. racemosa* Lam., *C. foemina* Mill., and *C. asperifolia* Michx. The specimen from Domański Wierch differs from the leaves described as *C. graeffii* (Heer) Hantke in the rounded shape of the base and its different nervation, but, on the other hand, is very similar to *Cornus* cf. *mas* L. from the Quaternary leaf floras of Italy (Follieri 1958, Tav. XXVII, Fig. 63; Mastrorilli 1965, Pag. 168, Fig. 24).

The area of distribution of *Cornus mas* L. covers southern Europe, the western Ukraine, Moldavia, Crimea, the Caucasus, and Asia Minor. It grows in the underwood of chiefly oak- and hornbeam-forests in mountain areas of low and medium altitude, and in shrubby thickets on slopes of mountains and in river walleys.

Occurrence in fossil floras of Poland. Endocarps of *Cornus mas* L. foss. were described by Szafer (1961) from the Miocene of Stare Gliwice.

Cornus sp.

(Pl. XII, 7; Pl. XXVIII, 1, 1a)

Material. Level under the wayside shrine, specimen No 313; 1 impression of the middle part of the blade.

Description. The preserved fragment (6×4 cm) forms part of an elliptic leaf with an entire margin. From the midrib 5 pairs of strongly archwise bent lateral nerves depart. They become thin and more wavy towards the top, and with the tertiary nerves form loops joining the two neighbouring lateral nerves. In the middle part of the blade the lateral nerves are disposed alternately, forming an angle of 50° with the midrib. The tertiary nerves, straight or sometimes bifurcating, numerous and distinctly marked, run horizontally, i. e. perpendicularly to the midrib.

Comparison. The preserved impression of the leaf of a general type of nervation characteristic of the genus *Cornus*, differs from the earlier described *Cornus* cf. *mas* L. in the wider angle of branching of the lateral nerves, whose course is more rounded and wavy at the top, and by a distinct, close tertiary nervation. The fossil species with a similarly close tertiary nervation is *Cornus distans* N. Boulay aff. *macrophylla* Wallich, reported from the Miocene of France (Grangeon 1958). This species, however, as well as the contemporary *C. macrophylla* Wallich, is characterized by a larger number of lateral nerves (6—8). A similar course of strongly archwise bent lateral nerves is also visible in the fragment of a leaf described from Dobrzyń by the name *C. büchi* Heer (Kownas 1956, Pl. XIV, Fig. 2), though — as can be seen from the description — the tertiary nerves are very delicate and sparsely distributed.

The comparison of the described fragment of a leaf with one of the numerous contemporary species presents great difficulties. Although the leaves of some species, such as e. g. *C. controversa* Hemsl., or *C. bretschneideri* L. Henry are characterized by a similar tertiary nervation, the number of lateral nerves in the two species is larger, their course less arcuate, and the angle included between the midrib and the lateral nerves smaller. On the other hand, species of similar lateral nervation, such as *C. stolonifera* Michx. or *C. sanguinea* L., have less numerous and less marked tertiary nerves.

Occurrence in fossil floras of Poland. A fairly similar but not identical is the leaf of *C. büchi* Heer (= *C. studeri* Heer), found at Dobrzyń (Kownas 1956).

Cyperaceae

Scirpus cf. *silvaticus* L.

(Fig. 4a; Pl. XXVIII, 4, 4a)

Material. Level of magnolia flora, specimen No 337; 1 impression of a leaf fragment.

Description. The leaf is strap-shaped, 14 mm wide, with a more distinctly marked middle nerve, on both sides of which are 18 distinct, parallel nerves. Near the margins of the leaf they are more close and in the middle part of the blade run at even intervals of 0·46 mm. Between these nerves no parallel, more delicate nerves occur. The anastomose nerves, perpendicular to the longitudinal ones or slightly diagonal, are distributed at intervals of about 1·5—2 mm from one another.

Comparison. Leaves of a similar nervation were described as *Cyperus reticulatus* by Heer (1855), who observed that only the presence of more delicate nerves between the distinct ones does not permit the relating of this species with *Scirpus silvaticus* L. *Cyperus reticulatus* (Heer) Schimper was also reported by Iliinskaja (1968) from the Pliocene of the trans-Carpathians. Leaves of this flora, like the specimen from Domański Wierch, have no more delicate nervation, but are broader with much more numerous and closer running, identically marked nerves.

The comparison of the nervation of the leaf found in the flora of Domański Wierch with leaves of the contemporary species of the genus *Scirpus*, shows its close resemblance to *Scirpus silvaticus* L.

Occurrence in fossil floras of Poland. Remains of *Scirpus* leaves have not previously been reported from the Tertiary of Poland. One fruit of *Scirpus* cf. *silvaticus* L. was described by Łańcucka-Środoniowa (1966) from the Miocene flora of the Gdów Bay. Fruits of *S. silvaticus* L. are common in Quaternary floras.

Carex sp.

(Fig. 4f; Pl. XXIX, 4, 4a)

Material. Level under the wayside shrine, specimens Nos 338, 339; 2 fragments of leaves.

Description. Strap-shaped leaves, 4 mm wide, with a convex rib running through the middle of the blade. On both of its sides there are slightly concave striae. 5 distinct nerves run between the margins of leaves and the lateral striae, and 6 nerves between the lateral striae and the rib. The nerves occur at intervals of about 0·2 mm being joined by sparsely distributed anastomoses.

Comparison. Similar impressions of leaves judging by photographs of them, were reported by Iliinskaja (1968, Tabl. XXIX, fig. 5, 6) from the Pliocene of the trans-Carpathians under the name of *Cyperacites deucalionis* (Heer) Schimper. Iliinskaja related this name to *Cyperites deucalionis* Heer from the Miocene of Switzerland (Heer 1855). The accepting of this name both for the leaves of the trans-Carpathians and for the specimens from Domański Wierch does not seem to be correct, since *Cyperites deucalionis* Heer, according to Heer's diagnosis, is characterized by a lack of anastomoses. Their presence, accompanied at the same time by the lack of a more delicate nervation, distinguishes, in Heer's (l. c., p. 80) opinion, leaves of the genus *Carex*.

Cyperacites rechsteineri (Heer) Schimper

(Pl. XXIX, 2)

Material. Level of magnolia flora, specimens Nos 343, 344, 417; 3 fragments of leaves.

Description. Impressions of fragments of leaves 5—6 mm wide, with a strongly developed rib running through the middle. On both its sides the blade is slightly concave and provided with about 11 parallel, identical nerves occurring at intervals of about 0·4 mm. Traces of 3—4 more delicate nerves can sometimes be observed between them.

Comparison. The characters of the fragments of leaves described correspond to the diagnosis of *Cyperites rechsteineri* Heer, a species reported by Heer (1855) from the Miocene of Switzerland. It is characterized by an approximate number of distinct nerves (ca. 12) and the presence of several, poorly marked nerves between them.

Schimper (1870—1872) changed the name *Cyperites* to *Cyperacites* on account of the possibility of a resemblance of remains of this type to various genera of the family *Cyperaceae*.

Occurrence in fossil floras of Poland. The species has not been reported as yet from fossil floras of Poland.

Cyperacites sp. div.

(Fig. 4d, 4e; Pl. XXIX, 1)

Material. Level of magnolia flora, specimens Nos 341, 365—374; 11 fragments of leaves.

Description. The best preserved leaf (Fig. 4d; Pl. XXIX, 1) is a fragment of a blade 1 cm wide. A strongly marked rib runs through the middle of it, and parallel to it on each side a distinctly marked stria. In cross-section the blade has the outline of a flattened letter „W". Three

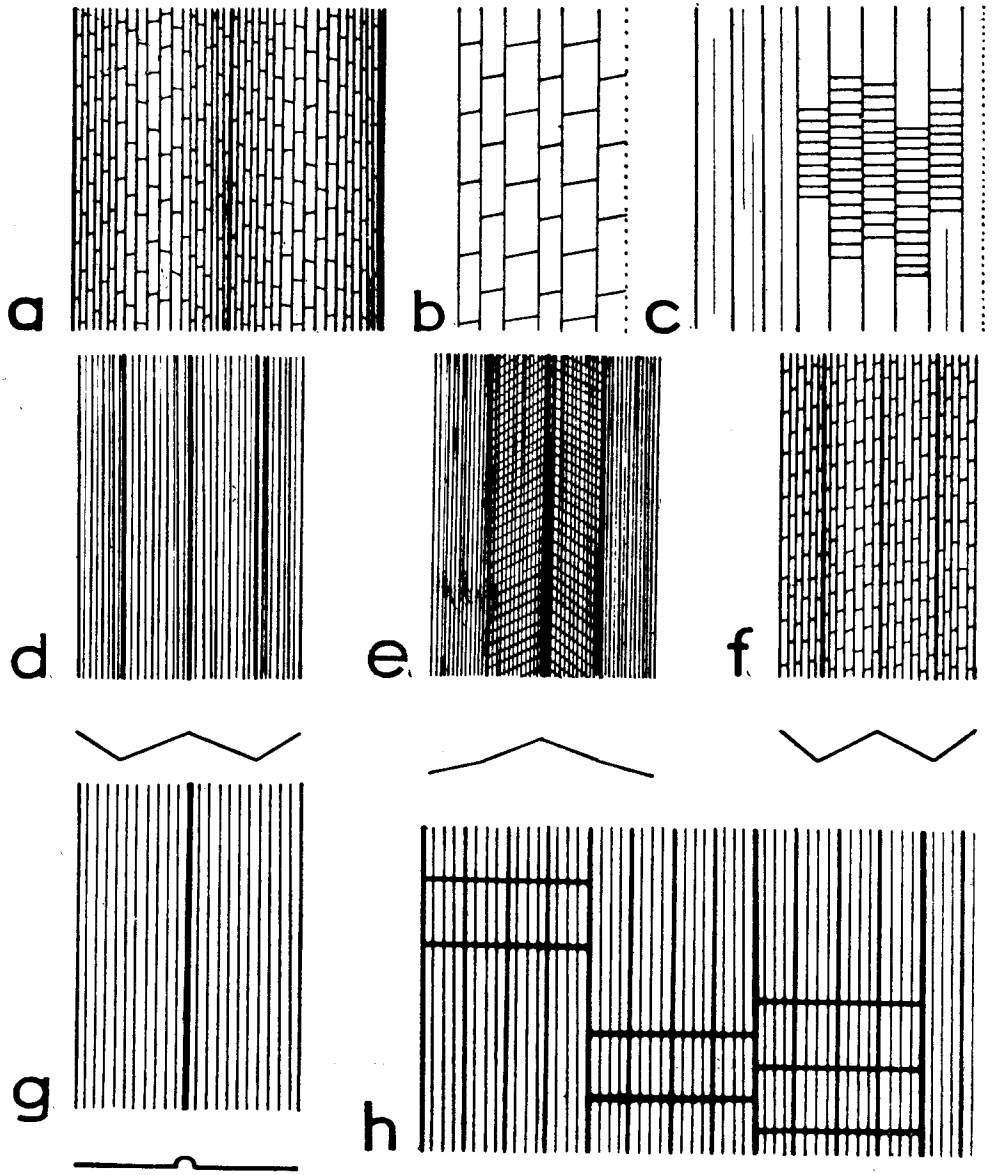

Fig. 4. The schematic drawings of nervation of leaves of monocotyledonous plants a — *Scirpus* cf. *silvaticus* L., specimen No 337; b — *Monocotyledones* gen. et. sp. indet., specimen No 357; c — *Monocotyledones* gen. et sp. indet., specimen No 360; d — *Cyperacites* sp. div., specimen No 365; e — *Cyperacites* sp. div., specimen No 341; f — *Carex* sp., specimen No 338; g — type *Gramineae*, specimen No 342; h — *Typha latissima* A. Br. specimen No 334.

Ryc. 4. Schematyczne rysunki nerwacji liści roślin jednoliściennych, a — *Scirpus* cf. *silvaticus* L., okaz nr 337; b — *Monocotyledones* gen. et sp. indet., okaz nr 357; c — *Monocotyledones* gen. et sp. indet., okaz nr 360; d — *Cyperacites* sp. div., okaz nr 365; e — *Cyperacites* sp. div., okaz nr 341; f — *Carex* sp., okaz nr 338; g — *Gramineae* typ, okaz nr 342; h — *Typha latissima* A. Br., okaz nr 334.

nerves run on its external folds and four on the internal ones. Between these distinct nerves running at intervals of 0·7 mm, single delicate nerves are found.

Another fragment of leaf (Fig. 4e), also 1 cm in breadth, has a more convex middle part, forming a keel. On both sides of the middle rib run 13 distinct nerves, disposed at intervals slightly less than 1 mm, while between them are single, delicate nerves.

The particulars of the nervation of the other specimens could not be determined on account of the poor state of preservation.

Comparison. Triplicate leaves characterized by the presence of tiny nerves and the lack of anastomoses, were assigned by Heer (1855) to the genus *Cyperites*, within which, on the basis of a varying number of nerves, this author distinguished several species. However, the specimens from Domański Wierch correspond to none of them. Although *C. custeri* Heer has the same number of distinct nerves on each side of the rib (7—8) as the specimen No 365 (Fig. 4d; Pl. XXIX, 1), the tiny nerves running between them are more numerous (3—4). *Cyperites zollikoferi* Heer has an approximate number of distinct nerves (8), but there are no tiny nerves between them. Leaves of *Cyperacites zollikoferi* (Heer) Schimper from the Pliocene of the trans-Carpathians (Iliinskaja 1968) have 1·0—1·7 cm in breadth and more numerous nerves (11—16), between which there occur 9 tiny nerves.

Gramineae

type *Gramineae*

(Fig. 4g; Pl. XXVIII, 3)

Material. Level under the wayside shrine, specimen No 342; 1 fragment of leaf.

Description. The breadth of the strap-shaped leaf is about 5 mm. Through the middle of the blade runs a more strongly marked rib and on both sides of it, at even intervals, 10 distinct nerves.

Comparison. Fragments of narrow leaves of similar nervation are assigned to *Gramineae* (Straus 1954; Kownas 1956). The numerous genera of this family distinguished by Heer (1855) differ from the described fragment in the number of distinct nerves and occurrence of tiny ones between them.

Occurrence in fossil floras of Poland. Fragment of *Gramineae* leaves were described by Kownas (1956) from the Miocene of Dobrzyń, while Łańcucka-Środoniowa (1966) reported several not fully determined fruits of grasses from the Miocene flora of the Gdów Bay.

Typhaceae

Typha latissima A. Br.

(Fig. 4h; Pl. XXVIII, 2)

Material. Level of magnolia flora, specimens Nos 326–336; 11 fragments of leaves.

Description. On account of the poor state of preservation of the specimens, the exact dimensions of the leaves and the number of nerves could not be determined. The breadth of the blades could have been approximatedly 1·5—2·0 mm. Distinctly marked nerves run parallel at more or less even intervals (1 mm). The intervals between these nerves are parted by 3 slightly less marked nerves, between which several more delicate nerves can be observed. Anastomoses, being visible only in places, join the most distinctly marked nerves at a right angle and at intervals of about 0·6 mm.

Comparison. Leaves of such nervation described as *Typha latissima* A. Br., are known from many stands of Tertiary floras of Europe and Asia. They are compared with the contemporary *Typha latifolia* L. (Heer 1855; Iliinskaja 1968).

Occurrence in fossil floras of Poland. Impressions of *Typha latisima.* A. Br. leaves have so far been found only in the flora of Dobrzyń (Kownas 1956), while seeds of various species of *Typha* have been reported from several stands of Neogene floras of Poland (cf. Łańcucka-Środoniowa 1966).

Monocotyledones gen. et sp. indet.

(Fig. 4b, c; Pl. XXVII, 5; Pl. XXIX, 3)

Material. Level of magnolia flora, specimens Nos 345–357, 360–364; 416; 18 samples of clay with numerous impressions of fragments of stems and leaves.

Description. It would be impossible to determine even approximately the systematic appurtenance of the numerous impressions of monocotyledonous plants, on account of the poorly marked and little characteristic nervation. Some of them could be fragments of stems with slightly protruding and non-uniformly distributed nerves. In Pl. XXVII, 5 a node of a stem is visible. The other remains are fragments of leaves, this being evidenced by the presence of striae or keel.

Specimen No 360 (Fig. 4c) differs from the other remains in the presence of anastomoses. The breadth of the impression is 1·3 cm, but only part of the leaf is visible in it. The nerves run at intervals of 1·5 mm and

Table 3
Tabela 3

List of the plants described from Domanski Wierch and number of determined remains
Lista roślin opisanych z Domańskiego Wierchu z podaniem ilości oznaczonych szczątków

Fossil form Forma kopalna	Related contemporary species Pokrewny gatunek współczesny	Level under the wayside shrine Poziom pod kapliczką	Level of magnolia flora Poziom flory magnoliowej	Boring Wiercenia badawcze	Total Razem
Equisetaceae					
1. *Equisetum parlatorii* (Heer) Schimper	—		3		3
Betulaceae					
2. *Alnus cecropiaefolia* (Ett.) Berger	—		21		21
3. *Alnus feroniae* (Ung.) Czecz.	—	1	3		4
4. *Alnus* cf. *glutinosa* Gaertn.	*Alnus glutinosa* Gaertn.		6		6
5. *Alnus* sp. — strobiles			3		3
6. *Carpinus grandis* Ung.	*Carpinus betulus* L. p. p.	3	40	2	45
7. *Betulaceae* gen. et sp. indet.			10		10
Fagaceae					
8. *Castanea atavia* Ung.	*Castanea sativa* Mill.	31	3		34
9. *Fagus haidingeri* Kov. sensu Knobl.		24	4	4	32
10. *Quercus pseudocastanea* Goepp.		24			24
11. *Quercus kubinyi* (Kov. ex Ett.) Berger	*Quercus libani* Oliv.	3			3
12. *Quercus pontica miocenica* Kubát	*Quercus pontica* K. Koch	4			4
13. *Quercus* sp.		1			1
Juglandaceae					
14. *Juglans* sp.			2		2
15. *Pterocarya paradisiaca* (Ung.) Iliinsk.	*Pterocarya pterocarpa* Kunth.		6		6
Salicaceae					
16. *Salix varians* Goepp.	*Salix fragilis* L.		1		1
17. *Salix angusta* A. Br.	*Salix viminalis* L.		6		6
18. *Populus balsamoides* Goepp.	*Populus lasiocarpa* Oliv.	13			13
19. *Populus tremula* L. foss.	*Populus tremula* L.	1		1	2
20. *Populus* cf. *nigra* L.	*Populus nigra* L.	1		1	2
Ulmaceae					
21. *Ulmus* sp. div.		33			33
22. *Zelkova zelkovaefolia* (Ung.) Bůžek et Kotlaba	*Zelkova carpinifolia* K. Koch	3	1	1	5
Hamamelidaceae					
23. *Liquidambar europaea* A. Br.	*Liquidambar styraciflua* L.		2		2

Fossil form Forma kopalna	Related contemporary species Pokrewny gatunek współczesny	Level under the wayside shrine Poziom pod kapliczką	Level of magnolia flora Poziom flory magnoliowej	Boring Wiercenia badawcze	Total Razem
24. *Parrotia pristina* (Ett.) Stur	*Parrotia persica* C. A. Mey.	24	57	1	82
Platanaceae					
25. *Platanus platanifolia* (Ett.) Knobl.	*Platanus occidentalis* L.	1		1	2
Aceraceae					
26. *Acer vindobonense* (Ett.) Berger	*Acer palmatum* Thunb.		3		3
27. *Acer firmianoides* Andreanszky			1		1
28. *Acer platanoides* L. foss.	*Acer platanoides* L.	1			1
29. *Acer subcampestre* Goepp.	*Acer campestre* L.	1	3		4
Vitaceae					
30. *Vitis* sp.		2	1		3
Cornaceae					
31. *Cornus* cf. *mas* L.	*Cornus mas* L.		1		1
32. *Cornus* sp.		1			1
Cyperaceae					
33. *Scirpus* cf. *silvaticus* L.	*Scirpus silvaticus* L.		1		1
34. *Carex* sp.		2			2
35. *Cyperacites rechsteineri* (Heer) Schimper			3		3
36. *Cyperacites* sp. div.			11		11
Gramineae					
37. type *Gramineae*		1			1
Typhaceae					
38. *Typha latissima* A. Br.	*Typha latifolia* L.		11		11
		175	203 numerous liczne	11	389
Monocotyledones gen. et sp. indet.					

between them traces of tiny nerves are visible. Numerous, horizontally running anastomoses, are 0·5 mm apart.

Another specimen (Fig. 4b), on which only part of the leaf was preserved, has parallel nerves, disposed closer at the margin of the leaf than to its centre. No more delicate nerves appear between them, while the anastomoses are slightly diagonal. The fragment of a fossil leaf of *Sparganium simplex* Huds., represented by M a s t r o r i l l i (1965, Pag. 39, Fig. 10), has a similar nervation.

CLASSIFICATION OF THE FORMS DESCRIBED

In the flora of Domański Wierch there occur impressions of leaves of trees and shrubs, as well as of monocotyledon shoots. 389 specimens were determined (87 per cent of the whole collected material), three of which were assigned to the class *Equisetales* and all the other ones to the classes *Dicotyledones* and *Monocotyledones* (Table 3). The majority of specimens of monocotyledonous plants was not included in the sum total of the determined remains.

The class of dicotyledons is represented by 24 species belonging to 9 families: *Betulaceae, Fagaceae, Juglandaceae, Salicaceae, Ulmaceae, Hamamelidaceae, Platanaceae, Aceraceae,* and *Cornaceae.* The family *Vitaceae* is also represented here. Some poorly preserved or fragmentary remains were determined only as to family or genus. There are leaves of the family *Betulaceae* and of the genera *Juglans, Ulmus, Vitis,* and *Cornus,* as well as *Alnus* strobiles and a cup of *Quercus.*

Within the class of monocotyledons there occur representatives of three families: *Cyperaceae, Gramineae,* and *Typhaceae.* Among the numerous fragments of leaves and shoots which were difficult to determine three species and two genera were discriminated, and one specimen was assigned only as to family.

The taxons *Equisetum parlatorii* (Heer) Schimper, *Alnus cecropiaefolia* (Ett.) Berger, *Alnus feroniae* (Ung.) Czecz., *Fagus haidingeri* Kov. sensu Knobloch, *Quercus kubinyi* (Kov. ex Ett.) Berger, *Quercus pontica miocenica* Kubát, *Populus tremula* L. foss., *Populus* cf. *nigra* L., *Acer vindobonense* (Ett.) Berger, *Acer firmianoides* Andreánszky, and *Cyperacites rechsteineri* (Heer) Schimper were described for the first time from the Tertiary of Poland. Moreover, a description was given for the first time of leaves of species hitherto known from the Tertiary floras of Poland only thanks to the fruits found. There are *Acer platanoides* L., *Cornus* cf. *mas* L., and *Scirpus* cf. *silvaticus* L.

PICTURE OF THE VEGETATION AND ITS GEOGRAPHICAL CONNECTIONS

The preserved fragments of leaves permit an only very general characterization of plant communities surrounding the place of sedimentation. The floristic analysis of the fossil material shows the presence of a mesophilous deciduous forest, which occupied a terrain of a fairly diversified relief.

The damp habitats were overgrown with an alder forest with a considerable proportion of *Populus, Salix* and *Pterocarya,* and admixture of *Liquidambar* and *Platanus.* The presence of wet places in these forests is evi-

denced by shoots of monocotyledons occurring in masses, as well as by horsetail tubers and rhizomes.

The drier habitats were occupied by a forest in which *Parrotia* predominated with a considerable proportion of *Fagus, Carpinus, Ulmus, Castanea,* and *Quercus. Zelkova* and *Acer* also grew there, as well as species of the genera *Cornus, Juglans,* and *Vitis.* The two communities formed part of the same floristic altitudinal belt, this being evidenced by the lack of conifer remains.

Components of the two forest associations are slightly different in the principal flora-bearing levels. In the level under the wayside shrine leaves of trees of drier habitats of the genera *Castanea, Fagus, Quercus, Ulmus, Zelkova, Acer platanoides, Acer subcampestre,* and *Cornus* prevail. In the level of magnolia flora trees connected with damp habitats (*Alnus, Pterocarya, Salix, Liquidambar*) play a more important role. The relatively large proportion of the genus *Parrotia* in both levels is worthy of note.

Attention should be drawn to the fact that in the level of magnolia flora, from which numerous magnolia seeds proceed (S z a f e r 1950), no indisputable leaves of this genus were found. It is true that in part of the material from this level, which has not as yet been determined, there do occur fragments of ill-preserved leaves with an entire blade and brochidodrome nervation, but they may belong to the various genera.

The species reported from Domański Wierch were assigned to the geographical elements distinguished by P a w ł o w s k a (1966) for the flora of Poland. Remains determined only as to genus, species of ambiguous systematic position, and the majority of monocotyledons were disregarded. In the specification presented in Table 4 those species prevail, whose related forms living at the present-day are connected with the contemporaneous flora of Europe and Asia Minor. The Mediterranean element is represented by two genera of trees shedding their leaves in the autumn.

The leaf flora from Domański Wierch is clearly related in its composition to forests growing on the coasts of the Caspian Sea and in the Talish and Elbrus Mts. The particularly large proportion of *Parrotia* leaves relates the flora from Domański Wierch with the Talish forests, in which this monotypical element is one of the chief components of the lowland and submontane zone (G r o s s g e i m 1948, S t a n k ó w n a 1963).

The climatic requirements of the trees and shrubs, which built the forest associations on Domański Wierch, indicate the temperate or warm-temperate character of the climate and its considerable humidity; presumably, it was similar to the climate of the terrains on which relict forests of the Talish and Elbrus Mts grow to-day. The climate of the northern slopes of the Elbrus is characterized by a mean annual temperature of 13°—15°C, and abundant rainfall with a maximum in the autumn months (mean annual about 1500 mm), and mild winters with frosty periods (B o b e k 1951).

Table 4
Tablica 4

Geographical elements of the leaf flora from Domański Wierch
Elementy geograficzne flory liściowej z Domańskiego Wierchu

Geographical element Element geograficzny	Contemporary species Gatunek współczesny	Fossil species Gatunek kopalny
I. Holarctic element Element holarktyczny		
a) Central-European sub-element Podelement środkowoeuropejski	*Carpinus betulus* L. *Acer platanoides* L.	*Carpinus grandis* Ung. *Acer platanoides* L. foss.
b) Euro-Siberian sub-element Podelement eurosyberyjski	*Salix viminalis* L. *Scirpus silvaticus* L.	*Salix angusta* A. Br. *Scirpus* cf. *silvaticus* L.
c) Ponto-Hyrcanian sub-element Podelement pontohirkański	*Quercus pontica* K. Koch	*Quercus pontica* miocenica Kubát
II. Mediterranean element Element śródziemnomorski	*Castanea sativa* Mill. *Quercus libani* Oliv.	*Castanea atavia* Ung. *Quercus kubinyi* (Kov. ex Ett.) Berger
III. Irano-Turanian element Element irano-turański	*Pterocarya pterocarpa* Kunth. *Zelkova carpinifolia* K. Koch *Parrotia persica* C.A. Mey.	*Pterocarya paradisiaca* (Ung.) Iliinsk. *Zelkova zelkovaefolia* (Ung.) Bůžek et Kotlaba *Parrotia pristina* (Ett.) Stur
IV. Holarctic-Mediterranean connective element Element łącznikowy holarktyczno-śródziemnomorski	*Acer campestre* L. *Populus nigra* L. *Populus tremula* L. *Alnus glutinosa* Gaertn. *Cornus mas* L.	*Acer subcampestre* Goepp. *Populus* cf. *nigra* L. *Populus tremula* L. foss. *Alnus* cf. *glutinosa* Gaertn. *Cornus* cf. *mas*. L
V. Holarctic-Mediterraneo-Irano-Turanian connective element Element łącznikowy holarktyczno-śródziemnomorsko-irano-turański	*Salix fragilis* L.	*Salix varians* Goepp.
VI. East-Asiatic element Element wschodnioazjatycki	*Populus lasiocarpa* Oliv. *Acer vindobonense* (Ett.) Berger	*Populus balsamoides* Goepp. *Acer palmatum* Thunb.
VII. North-American element Element północnoamerykański	*Liquidambar styraciflua* L. *Platanus occidentalis* L.	*Liquidambar europaea* A.Br. *Platanus platanifolia* (Ett.) Knobl.
VIII. Cosmopolitan connective element Element łącznikowy kosmopolityczny	*Typha latifolia* L.	*Typha latissima* A.Br.

THE AGE OF THE FLORA OF DOMAŃSKI WIERCH

The approximate specific composition of plants proceeding from the two principal flora-bearing levels suggests that they are of the same age, i. e. proceed from the same Tertiary period, and that in spite of their being separated by sediments of considerable thickness.

The majority of species determined in the fossil flora belong to those commonly encountered in the Neogene, and particularly Sarmatian-Pannonian floras of Europe. Of the 24 distinguished species 17 are also known from the Pliocene, and some still from the Plio-Pleistocene floras of the western part of Central Europe (*Zelkova ungeri, Parrotia* aff, *parsica, Castanea* (?) — Geissert 1967; Geissert et al. 1969), as well as from the Early Pleistocene of southern Europe (*Liquidambar europaeum, Platanus aceroides* — Kitanov and Nikolova 1956; *Parrotia* aff. *persica, Zelkova ungeri* — Bout 1960; Bourdier 1961, quoted after Geissert 1967). Others are similar to the present-day southern European species (*Castanea sativa*), or to those known from Pleistocene and contemporary forest associations of Central Europe (*Alnus glutinosa, Acer platanoides, Acer campestre,* and others). Two species: *Acer platanoides* and *Populus nigra,* are not known earlier than from Pliocene floras. The genus *Pterocarya* subsisted in Europe till the Middle Pleistocene in areas lying north of the Alps and Carpathians. One species: *Acer firmianoides* Andreánszky, has hitherto been reported only from the Sarmatian.

In the leaf flora of Domański Wierch no forms were found representing a characteristic component of Miocene forest associations, many of which subsisted also up to the Lower Pliocene, as, among others *Taxodiaceae, Cupressaceae, Lauraceae, Myricaceae.* Nor were any species found of the genera *Carya* or *Byttneriophyllum tiliaefolium* (Al. Braun) Knobl. et Kvač. A mass occurrence of the latter species is, among others factors, characteristic of the Upper Tortonian up to the Sarmatian inclusively floras of Slovakia (Němejc 1967).

The Pliocene sediments containing fossil fruits and seeds were closely investigated from the stands of Mizerna and Huba, lying in the eastern part of the Nowy Targ-Orava Basin, and from Krościenko on the Dunajec (Szafer 1946, 1947, 1954). The flora from Krościenko contained plants proceeding from two stages: a lower one with a predominance of deciduous trees, and an upper stage in which conifers prevailed. In the lower stage the dominant tree was the hornbeam and *Pterocarya fraxinifolia.* The forms common with the flora of Domański Wierch were *Alnus glutinosa, Fagus, Carpinus, Pterocarya, Juglans, Acer palmatum, Acer campestre, Acer platanoides,* and *Cornus.* As was stressed by Szafer (1946), the scarcity of evergreen trees and leafy shrubs, as well as the large proportion of relicts from the older Tertiary periods, give this flora a peculiar character.

A fossil flora was found on close proximity to Domański Wierch, in the Slovak part of the Orava Basin, in the localities of Vavrečka and Ustie (Fig. 1). In lignite clays of Vavrečka P a c l t (1965) determined the following forms: *Osmunda parschlugiana* (Ung.) Andr., *Glyptostrobus europaeus* (Brongn.) Ung., *Alnus crebrinervis* E. Kovács, Carya sp.? *„Ficus" tiliaefolia* auct., and *Phoenicites* sp. [1].

In the flora of Ustie (K n o b l o c h 1968b) which contained, besides fruits and seeds, also remains of leaves, the author distinguished the following taxons: *Sequoia* sp., *Glyptostrobus europaeus* (Brongn.) Ung., *Alnus* sp., *Fagus grandifolia* Ehrh. foss., *Quercus* vel *Castanea* sp., *Myrica ceriferiformoides* Bůž. et Holý, *Pterocarya* sp., *?Salix* sp., *Alangium hungaricum* Andreánszky, *Byttneriophyllum tiliaefolium* (Al. Braun) Knobl. et Kvač., *Ulmus bükkense* Andreánszky, *?Ulmus pyramidalis* Goepp., cf. *Zelkova juglandina* Andreánszky, *Banisteriaecarpum giganteum* (Goepp.) Kräusel, *?Platanus platanifolia* (Ett.) Knobl., *Acer* cf. *borsodense* Andreánszky, *Acer* div. sp., *Sparganium* cf. *ramosum* Huds. foss., *„Typha"* cf. *latissima* Al. Braun, and *Monocotyledonidae* gen. et sp. indet.

K n o b l o c h (l. c.), considers that the remains found represent two types of plant communities. One of them (encountered in the majority of outcrops) consisted of waterside and swamp communities, composed chiefly of *Glyptostrobus, Byttneriophyllum, Alnus, Myrica, Typha,* and *?Sparganium.* The other type of community was made up of mesophilous deciduous forest with a predominance of beech and large proportion of plane-tree.

In all probability, this flora represents the Sarmatian, though the author does not exclude either the Upper Tortonian or Pannonian age. In K n o b l o c h's opinion, the presence of *Alangium hungaricum, Banisteriaecarpum giganteum, Byttneriophyllum tiliaefolium* and *Fagus* cf. *grandifolia* has a stratigraphic significance. The element of laurel type (*Daphnogene bilinica* (Ung.) Kvač. et Knobl.) is lacking.

The Pliocene flora (younger than the Pannonian) of Dřeveník hill (610 m above sea level) in northern Slovakia seems to be closer in age to that of Domański Wierch (N ě m e j c 1967). In the composition of forest associations *Fagus* (*F.* aff. *orientalis* Lipsky), *Quercus* (among others, *Q. pseudocastanea* Goepp.) and *Parrotia* (*P.* aff. *persica* C. A. Mey.) prevailed; the other forms occurring there were *Carpinus grandis* Ung. (aff. C. betulus L.), *Zelkova ungeri* (Ett.) Kov. (aff. *Z. carpinifolia* K. Koch), *Ulmus,* and *Acer* (*A.* cf. *campestre* L. and *A.* cf. *platanoides* L.). The forests of damp habitats were composed of *Alnus* (*A.* cf. *glutinosa* Gaertn.), *Liquidambar europaea* A. Br., Populus (P. cf. *nigra* L., *P.* cf. *tremula* L.), and *Pterocarya* (*P.* aff. *pterocarpa* Kunth.). Moreover, *Cercidiphyllum crenatum* (Ung.) Brown, *Carrya serraefolia* (Goepp.) Kräus., *Celtis primigenia* Sap.,

[1] K n o b l o c h (1968b) questions the appurtenance of this fragment to palms.

Acer laetum C. A. Mey. *pliocenicum* Sap., *Buxus* cf. *sempervirens* L., *Fraxinus, Phillyrea, Rhododendron, Styrax* and *Diospyros* grew there, and conifers were represented by *Torreya, Picea, Juniperus* and *Cupressus.*

Němejc (1967), giving the characteristics of the vegetation of the Pliocene of Slovakia, observed that compared with older floras, it is distinguished by a close relation with the contemporary vegetation of the eastern part of the Mediterranean area, and presence of macroscopic remains of *Picea* and *Fagus* of a different type from *F. attenuata* Goepp. considered to be an older species.

The other flora, in which there occurs a diversity of deciduous trees similar to that of Domański Wierch, is the flora from Willershausen at the foot of the Harz Mountains, regarded as Upper Pliocene (Straus 1930, 1935, 1954, 1955/56, 1956). According to Straus, the remains of *Coniferae* in the flora from Willershausen (*Glyptostrobus, Sequoia, Picea,* and others) constituted only an insignificant admixture. In beech forests *Quercus* (among others, *Q. libani* Oliv.), *Parrotia persica* C. A. Mey., *Zelkova ungeri* (Ett.) Kov., *Carpinus betulus* L., *Castanea* cf. *sativa* Mill., *Acer* (among others, *A. platanoides* L.), and *Ulmus,* as well as *Tilia* and *Carya,* formed a large proportion. Forests of damp habitats were composed of *Alnus* cf. *glutinosa* Gaertn., *Populus* cf. *tremula* L., *Salix, Pterocarya fraxinifolia* Spach, *Liquidambar,* and *Fraxinus.* In the flora from Willershausen, apart from the forestine vegetation, a marshy and aquatic vegetation occurred (the families *Potamogetonaceae, Najadaceae, Gramineae, Cyperaceae,* and others).

The Tertiary character of the vegetation of Willershausen is marked by the presence of such fossil species as *Glyptostrobus europaeus* (Brongn.) Ung., *Sequoia langsdorfi* (Brongn.) Heer, *Acer decipiens* Al. Br., the relatively large proportion of the North American element, and the considerable number of species related with the Near and Far East.

The similarity of the flora from Domański Wierch to that from Dřeveník and Willershausen indicates that this flora belongs to the Pliocene. Its Pliocene character appears distinctly especially against the background of the older floras from Ustie and Vavrečka situated close by. The interpretation of the lack or presence of individual species is particularly difficult in this case, since the considerable elevation of Domański Wierch and its situation in the interior part of the Carpathians, at the foot of the High Tatra Mts, had indubitably a strong influence on the composition of this flora.

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Institute of Botany of the Polish Academy of Sciences in Kraków
Department of Palaeobotany

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STRESZCZENIE

PLIOCEŃSKA FLORA LIŚCIOWA Z DOMAŃSKIEGO WIERCHU KOŁO CZARNEGO DUNAJCA (KARPATY ZACHODNIE)

Opisana w rozprawie flora liściowa pochodzi z osadów Domańskiego Wierchu, wzniesienia położonego w Kotlinie Nowotarsko-Orawskiej na południe od Czarnego Dunajca (ryc. 1). Badania geologiczne, oparte na obserwacji naturalnych i sztucznych odkrywek oraz na szczegółowej analizie materiału uzyskanego z wiercenia geologicznego do głębokości 228 m, doprowadziły do wniosku, że Domański Wierch jest stożkiem napływowym neogeńskiego wieku (Birkenmajer 1954, 1958; Urbaniak 1960). W części stropowej jest on zbudowany z utworów gliniastych, poniżej występują osady ilasto-łupkowe i żwirowo-zlepieńcowate. W warstwach tych wielokrotnie występują makroskopowe szczątki roślin (owoce, nasiona, liście, lignity), które były przedmiotem wstępnych badań paleobotanicznych (Szafer 1950; Łańcucka-Środoniowa 1963, 1965) oraz sporomorfy, opracowane i przedstawione w postaci diagramu pyłkowego przez Oszast (1970).

Rozprawa zawiera opracowanie szczątków roślin, głównie liści, występujących w formie odcisków w dwóch poziomach dostępnych w naturalnych odkrywkach. W poziomie górnym, zwanym „poziomem pod kapliczką", odciski liści zachowane są w utworze piaszczysto-iłołupkowo-żwirowym na głębokości 3·3—18·2 m. Drugi poziom, zwany „poziomem flory magnoliowej", zawiera odciski liści w warstwie ilasto-piaszczystej na głębokości 76·8—80·6 m. Cały materiał oznaczano wyłącznie na podstawie cech morfologicznych odcisków liści. Brak tkanki roślinnej uniemożliwił sprawdzenie oznaczeń metodą analizy kutikularnej, a próby zastosowania metody błonki kolodionowej były także negatywne.

Po zbadaniu 389 okazów wyróżniono przedstawicieli czternastu następujących rodzin: *Equisetaceae, Betulaceae, Fagaceae, Juglandaceae, Salicaceae, Ulmaceae, Hamamelidaceae, Platanaceae, Aceraceae, Vitaceae, Cornaceae, Cyperaceae, Gramineae* i *Typhaceae*. Nowymi dla trzeciorzędu Polski są gatunki: *Equisetum parlatorii* (Heer) Schimper, *Alnus cecropiaefolia* (Ett.) Berger, *Alnus feroniae* (Ung.) Czecz., *Fagus haidingeri* Kov. sensu

Knobloch, *Quercus kubinyi* (Kov. ex Ett.) Berger, *Q. pontica miocenica* Kubát, *Populus tremula* L. foss., *Populus* cf. *nigra* L., *Acer vindobonense* (Ett.) Berger i *A. firmianoides* Andreánszky. Po raz pierwszy opisano odciski liści *Acer platanoides* L., *Cornus* cf. *mas* L., *Scirpus* cf. *silvaticus* L., których owoce były już dawniej znane z flor kopalnych Polski.

Oznaczone szczątki roślin pochodzą ze zbiorowiska mezofilnego lasu liściastego, ograniczonego prawdopodobnie do jednego piętra roślinnego, o dość zróżnicowanym, mimo braku drzew szpilkowych, składzie. Obok rodzajów drzew takich jak *Alnus, Populus, Salix, Pterocarya, Liquidambar* i *Platanus,* o dużych wymaganiach pod względem wilgotności siedliska, występowały także składniki zbiorowisk leśnych zajmujących suchsze stanowiska (*Parrotia, Fagus, Carpinus, Ulmus, Castanea, Quercus* i in.). Liczne szczątki roślin jednoliściennych wskazują na obecność śródleśnych mokradeł.

Pod względem klimatycznym flora ta ma charakter umiarkowany, względnie ciepłoumiarkowany; roczna suma opadów była prawdopodobnie dość wysoka.

Gatunki współczesne najbliższe formom kopalnym występują dzisiaj głównie we florze Europy i Małej Azji (Tab. 4). Szczególnie wyraźnie zaznacza się podobieństwo flory kopalnej z Domańskiego Wierchu do współczesnych zbiorowisk leśnych niższego i podgórskiego piętra gór Tałyszu i Elbrusu.

Florę liściową z Domańskiego Wierchu uznano za plioceńską z uwagi na niewielki udział form starszych (mioceńskich), opisanych ze stanowisk położonych na Orawie słowackiej, sąsiadującej z Domańskim Wierchem (P a c l t 1965; K n o b l o c h 1968b). Składem florystycznym zbliża się ona najbardziej do flor plioceńskich z Dřeveník (N ě m e j c 1967) i Willershausen (S t r a u s 1930, 1935, 1956).

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Zakład Paleobotaniki

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TABLICE

Plate I

Alnus cecropiaefolia (Ett.) Berger

1. Specimen No 45
2. Specimen No 46
3. Specimen No 34
4. Specimen No 323
5. Specimen No 36
6. Specimen No 44

Tablica I

Alnus cecropiaefolia (Ett.) Berger

1. Okaz nr 45
2. Okaz nr 46
3. Okaz nr 34
4. Okaz nr 323
5. Okaz nr 36
6. Okaz nr 44

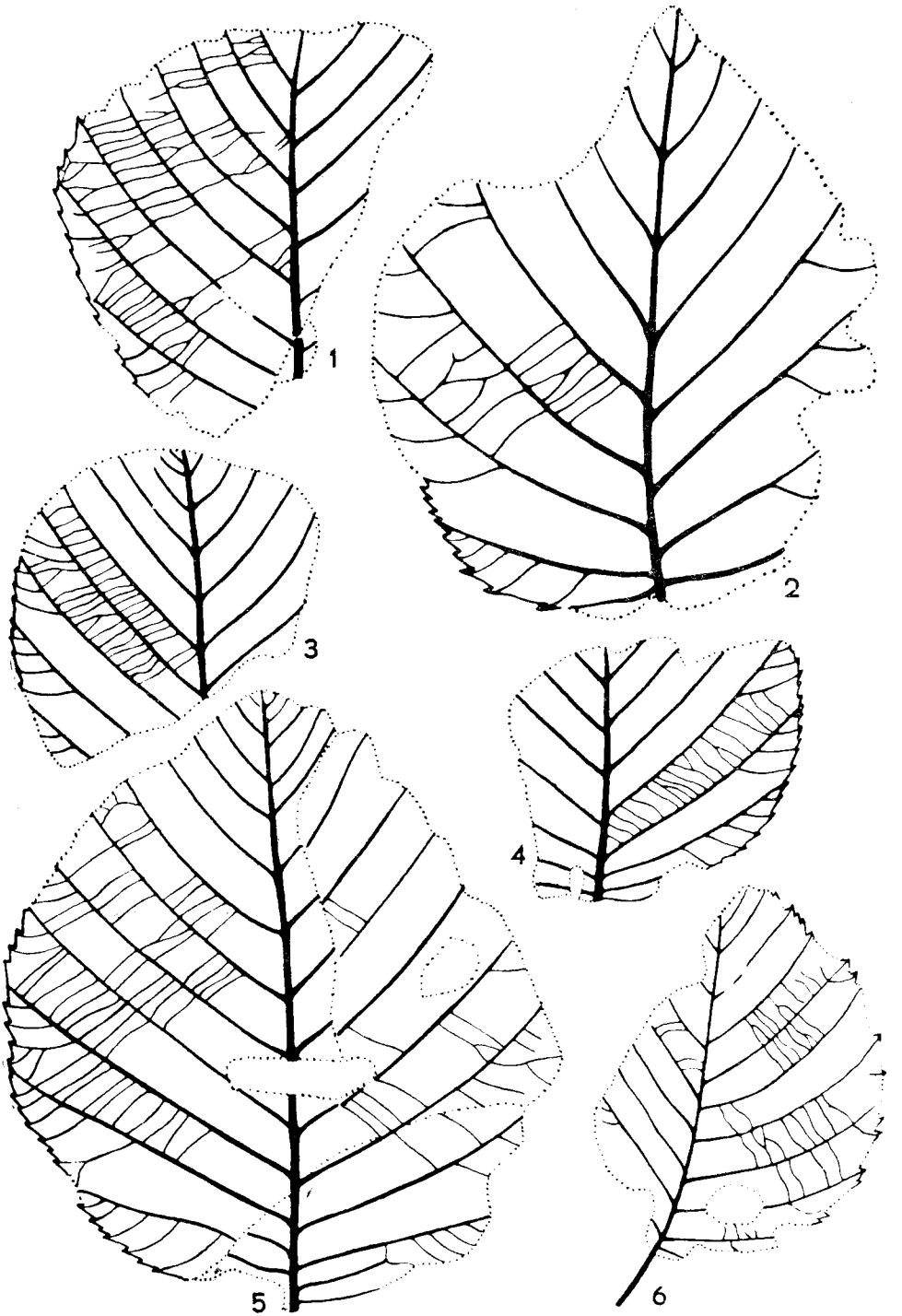
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Plate II

Alnus cecropiaefolia (Ett.) Berger

1. Specimen No 35

Alnus cf. *glutinosa* Gaertn.

2. Specimen No 30 (a + b)

Alnus feroniae (Ung.) Czecz.

3. Specimen No 388
4. Specimen No 85
5. Specimen No 28 (a + b); a — enlargement of the leaf margin, × 4·5

Betulaceae gen. et sp. indet.

6. Specimen No 25
7. Specimen No 381
8. Specimen No 387
9. Specimen No 64 (a + b)
10. Specimen No 27
11. Specimen No 383
12. Specimen No 24

Carpinus grandis Ung.

13. Specimen No 432
14. Specimen No 81

Tablica II

Alnus cecropiaefolia (Ett.) Berger

1. Okaz nr 35

Alnus cf. *glutinosa* Gaertn.

2. Okaz nr 30 (a + b)

Alnus feroniae (Ung.) Czecz.

3. Okaz nr 388
4. Okaz nr 85
5. Okaz nr 28 (a + b); a — powiększenie brzegu liścia, × 4.5

Betulaceae gen. et. sp. indet.

6. Okaz nr 25
7. Okaz nr 381
8. Okaz nr 387
9. Okaz nr 64 (a + b)
10. Okaz nr 27
11. Okaz nr 383
12. Okaz nr 24

Carpinus grandis Ung.

13. Okaz nr 432
14. Okaz nr 81

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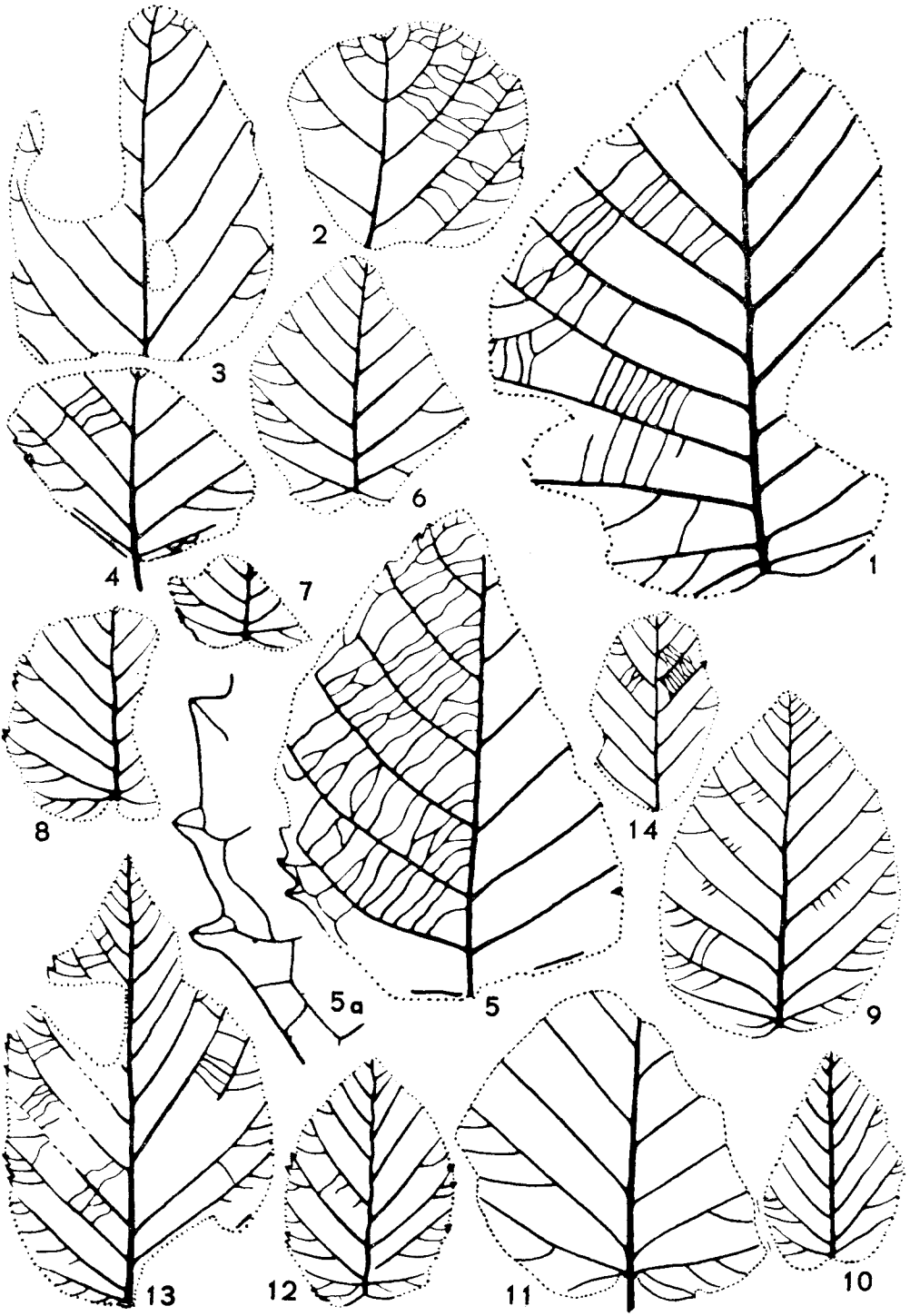
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Plate III

Carpinus grandis Ung.

1. Specimen No 426
2. Specimen No 390
3. Specimen No 83
4. Specimen No 57; a — enlargement of the leaf margin, × ca. 4
5. Specimen No 391
6. Specimen No 382
7. Specimen No 88
8. Specimen No 389
9. Specimen No 62
10. Specimen No 446
11. Specimen No 61
12. Specimen No 67
13. Specimen No 60

Tablica III

Carpinus grandis Ung.

1. Okaz nr 426
2. Okaz nr 390
3. Okaz nr 83
4. Okaz nr 57; a — powiększenie brzegu liścia, × ok. 4
5. Okaz nr 391
6. Okaz nr 382
7. Okaz nr 88
8. Okaz nr 389
9. Okaz nr 62
10. Okaz nr 446
11. Okaz nr 61
12. Okaz nr 67
13. Okaz nr 60

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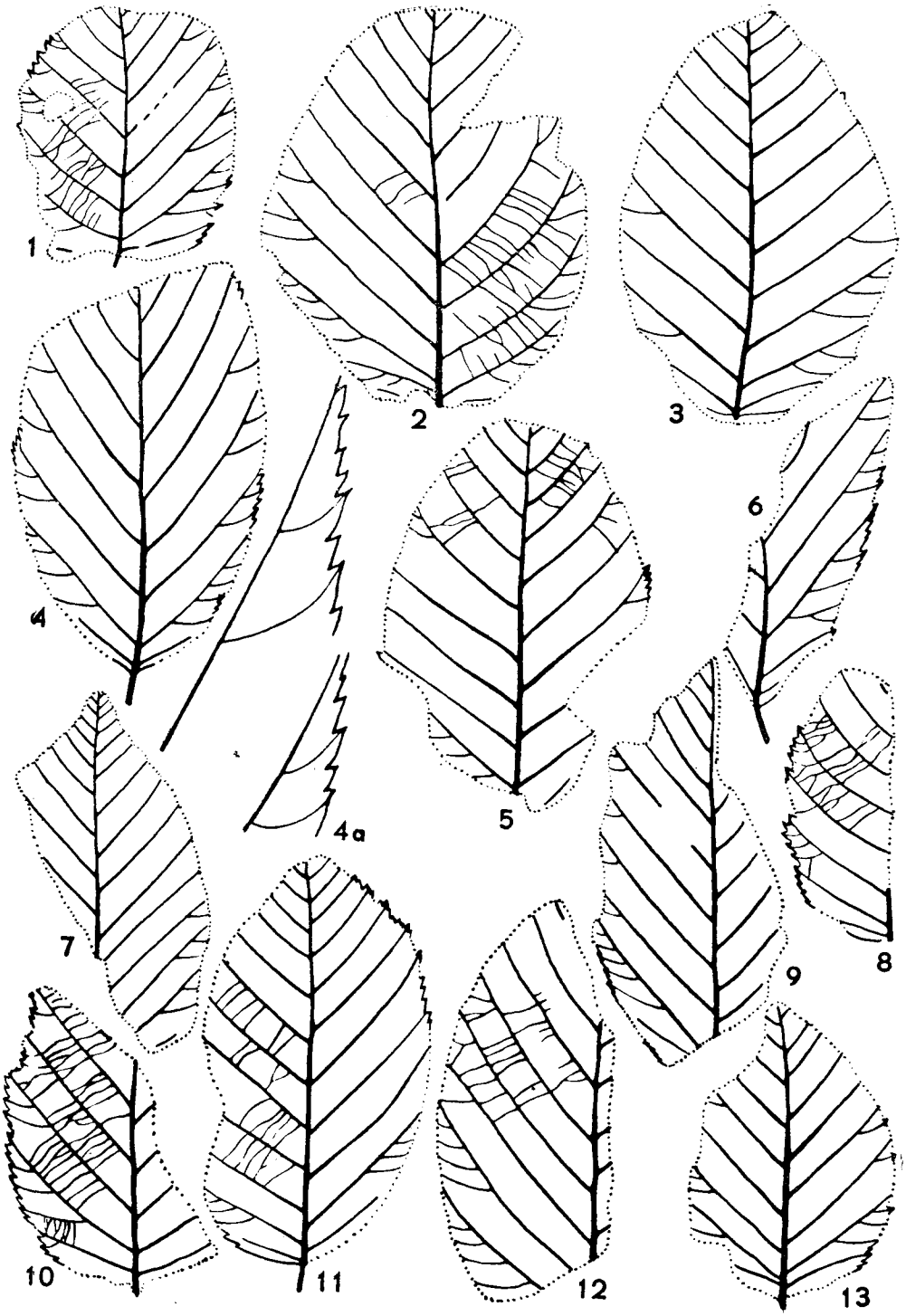
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Plate IV

Carpinus grandis Ung.

1. Specimen No 87
2. Specimen No 443

Fagus haidingeri Kov. sensu Knobloch

3. Specimen No 117 (a + b)
4. Specimen No 96
5. Specimen No 116
6. Specimen No 97
7. Specimen No 95

Castanea atavia Ung.

8. Specimen No 136
9. Specimen No 124
10. Specimen No 118
11. Specimen No 127. Reconstruction of the whole blade.
12. Specimen No 121
13. Specimen No 176
14. Specimen No 134

Quercus kubinyi (Kov. ex Ett.) Berger

15. Specimen No 171

Tablica IV

Carpinus grandis Ung.

1. Okaz nr 87
2. Okaz nr 443

Fagus haidingeri Kov. sensu Knobloch

3. Okaz nr 117 (a + b)
4. Okaz nr 96
5. Okaz nr 116
6. Okaz nr 97
7. Okaz nr 95

Castanea atavia Ung.

8. Okaz nr 136
9. Okaz nr 124
10. Okaz nr 118
11. Okaz nr 127. Rekonstrukcja całej blaszki liściowej
12. Okaz nr 121
13. Okaz nr 176
14. Okaz nr 134

Quercus kubinyi (Kov. ex Ett.) Berger

15. Okaz nr 171

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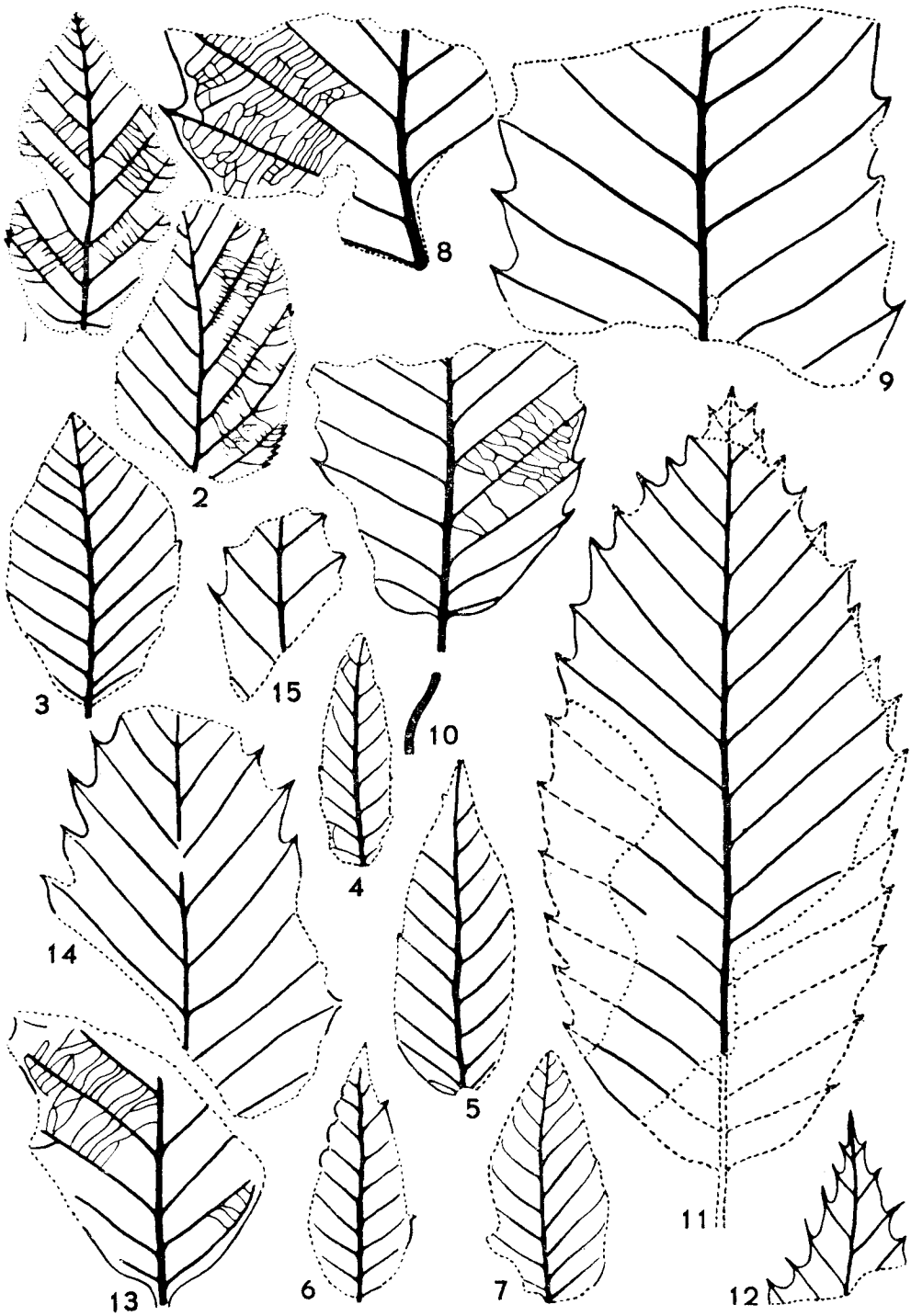
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Plate V

Fagus haidingeri Kov. sensu Knobloch

1. Specimen No 109; a — enlargement of the leaf margin, × 4
2. Specimen No 107; a — enlargement of the leaf margin, × 3
3. Specimen No 108
4. Specimen No 113; a — enlargement of the leaf margin, × 4
5. Specimen No 99
6. Specimen No 106

Quercus kubinyi (Kov. ex Ett.) Berger

7. Specimen No 168
8. Specimen No 169; a — enlargement of the leaf margin, × 4

Tablica V

Fagus haidingeri Kov. sensu Knobloch

1. Okaz nr 109; a — powiększenie brzegu liścia, × 4
2. Okaz nr 107; a — powiększenie brzegu liścia, × 3
3. Okaz nr 108
4. Okaz nr 113; a — powiększenie brzegu liścia, × 4
5. Okaz nr 99
6. Okaz nr 106

Quercus kubinyi (Kov. ex Ett.) Berger

7. Okaz nr 168
8. Okaz nr 169; a — powiększenie brzegu liścia, × 4

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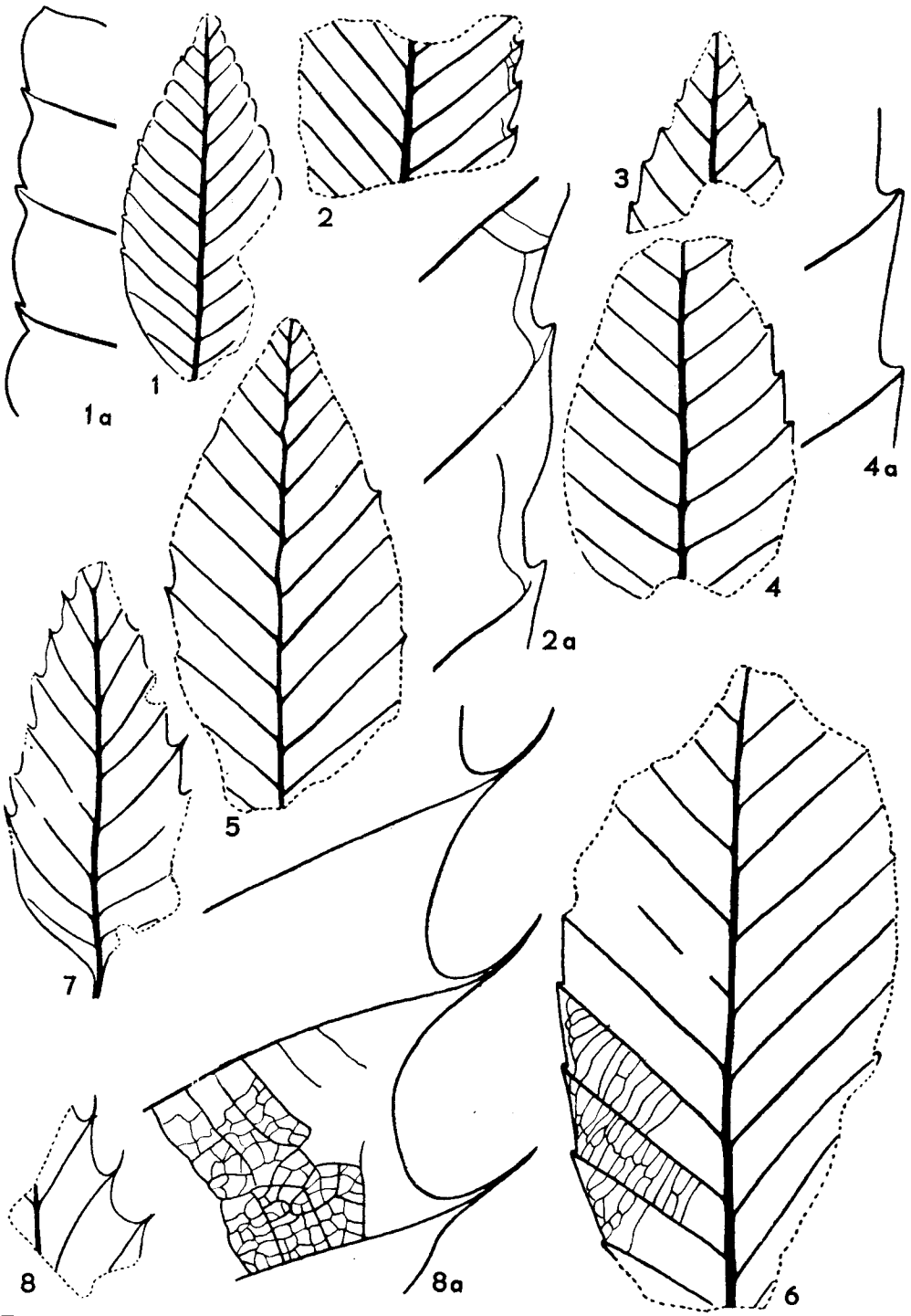
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Plate VI

Quercus pseudocastanea Goepp.

1. Specimen No 153
2. Specimen No 159

Quercus pontica miocenica Kubát

3. Specimen No 175
4. Specimen No 174 (a + b)
5. Specimen No 178
6. Specimen No 173

Quercus sp.

7. Specimen No 405. Impression of an acorn cup.

Pterocarya paradisiaca (Ung.) Iliinsk.

8. Specimen No 21

Tablica VI

Quercus pseudocastanea Goepp.

1. Okaz nr 153
2. Okaz nr 159

Quercus pontica miocenica Kubát

3. Okaz nr 175
4. Okaz nr 174 (a + b)
5. Okaz nr 178
6. Okaz nr 173

Quercus sp.

7. Okaz nr 405. Odcisk miseczki żołędzia.

Pterocarya paradisiaca (Ung.) Iliinsk.

8. Okaz nr 21

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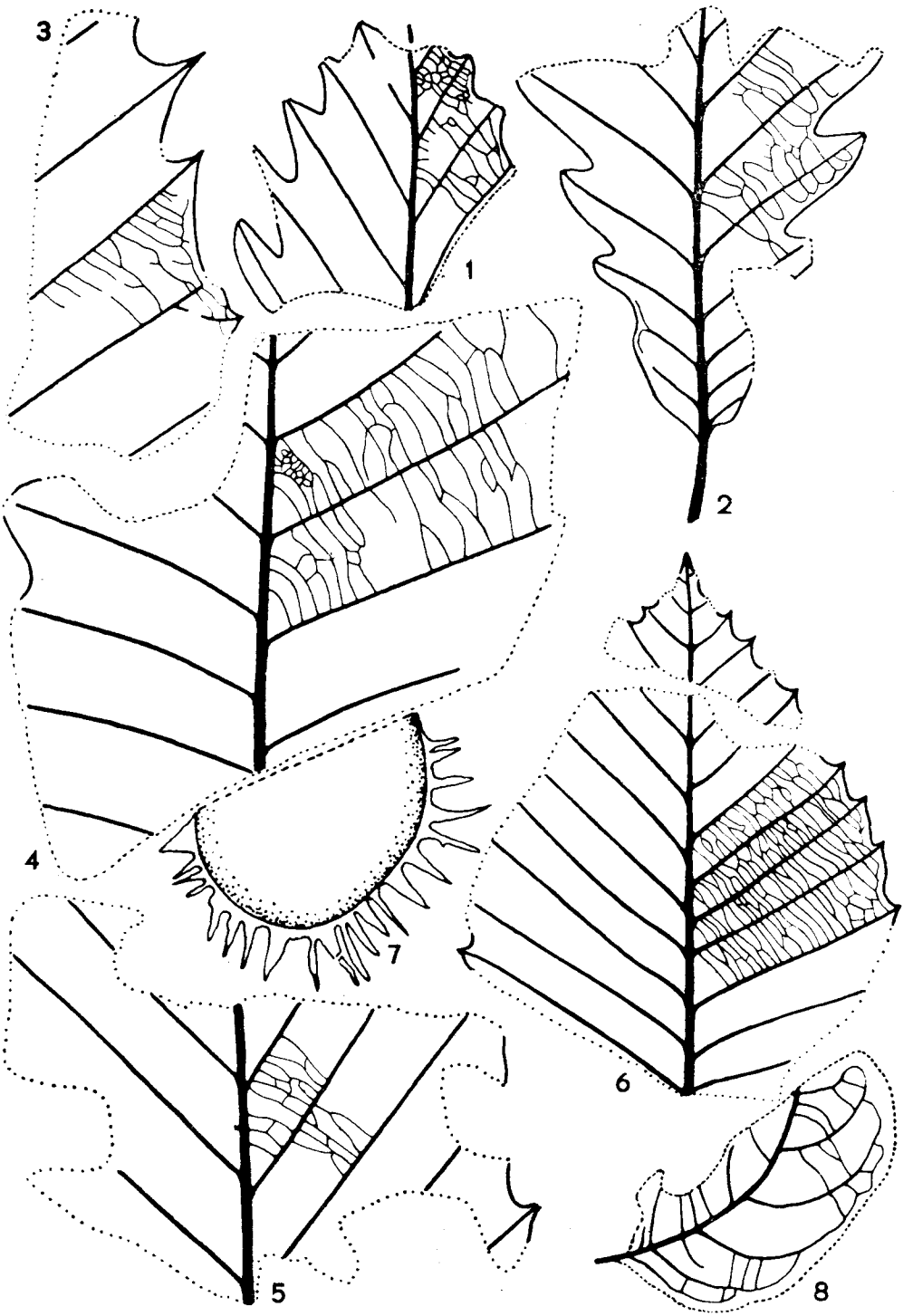
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Plate VII

Quercus pseudocastanea Goepp.

1. Specimen No 152
2. Specimen No 149
3. Specimen No 156
4. Specimen No 148
5. a — specimen No 150; b — specimen No 151
6. Specimen No 157

Juglans sp.

7. Specimen No 428
8. Specimen No 22; a — enlargement of the leaf margin, × 6

Pterocarya paradisiaca (Ung.) Iliinsk.

9. Specimen No 18

Tablica VII

Quercus pseudocastanea Goepp.

1. Okaz nr 152
2. Okaz nr 149
3. Okaz nr 156
4. Okaz nr 148
5. a — okaz nr 150; b — okaz nr 151
6. Okaz nr 157

Juglans sp.

7. Okaz nr 428
8. Okaz nr 22; a — powiększenie brzegu liścia, × 6

Pterocarya paradisiaca (Ung.) Iliinsk.

9. Okaz nr 18

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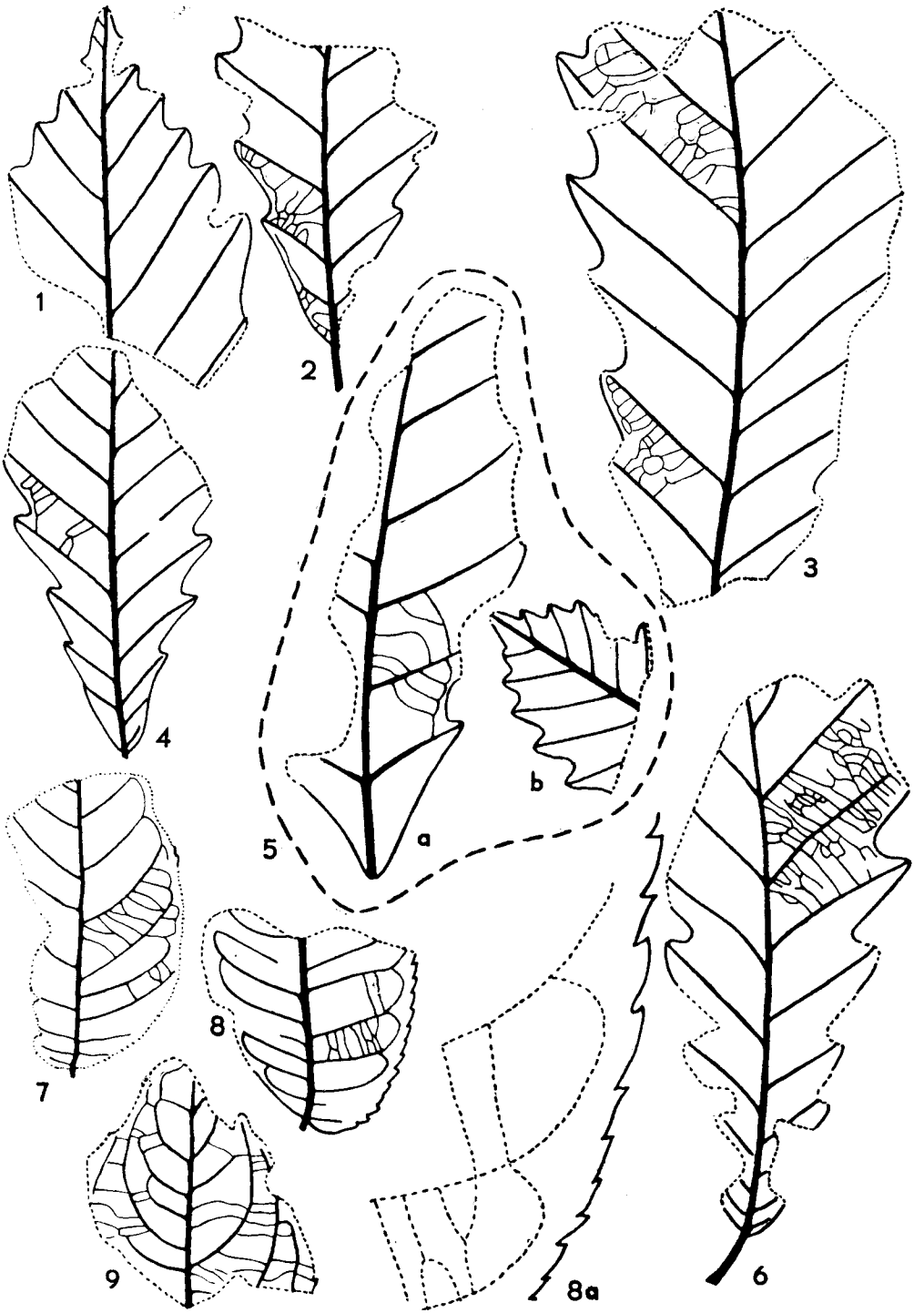
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Plate VIII

Pterocarya paradisiaca (Ung.) Iliinsk.

1. a — specimen No 19, b — specimen No 20. Fragments of two leaflets belonging to a pinnate leaf.
2. Specimen No 16 (a + b)
3. Specimen No 17

Salix angusta A. Br.

4. Specimen No 11
5. Specimen No 12
6. Specimen No 10
7. Specimen No 13
8. Specimen No 14
9. Specimen No 15

Salix varians Goepp.

10. Specimen No 9

Populus balsamoides Goepp.

11. Specimen No 1
12. Specimen No 315
13. Specimen No 410
14. Specimen No 4
15. Specimen No 2
16. Specimen No 317
17. Specimen No 7

Tablica VIII

Pterocarya paradisiaca (Ung.) Iliinsk.

1. a — okaz nr 19, b — okaz nr 20. Fragmenty dwóch listków należących do liścia złożonego
2. Okaz nr 16 (a + b)
3. Okaz nr 17

Salix angusta A. Br.

4. Okaz nr 11
5. Okaz nr 12
6. Okaz nr 10
7. Okaz nr 13
8. Okaz nr 14
9. Okaz nr 15

Salix varians Goepp.

10. Okaz nr 9

Populus balsamoides Goepp.

11. Okaz nr 1
12. Okaz nr 315
13. Okaz nr 410
14. Okaz nr 4
15. Okaz nr 2
16. Okaz nr 317
17. Okaz nr 7

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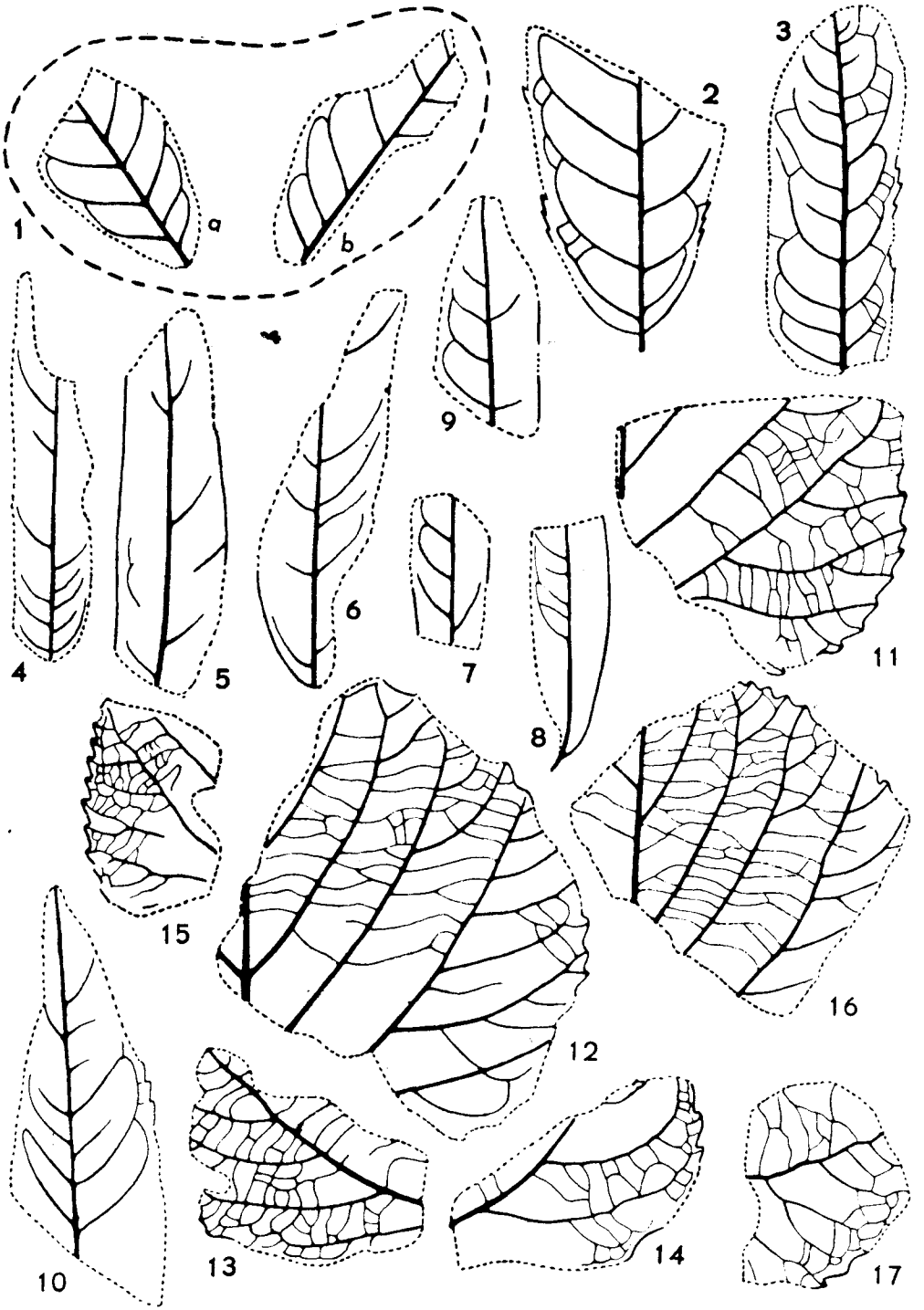
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Plate IX

Populus balsamoides Goepp.

1. Specimen No 3; a — enlargement of the leaf margin, × 3. Traces of glands at the ends of small teeth.
2. Specimen No 295. Traces of two glands at the base of a leaf.

Populus tremula L. foss.

3. Specimen No 5
4. Specimen No 445

Populus cf. *nigra* L.

5. Specimen No 51
6. Specimen No 442

Ulmus sp. div.

7. Specimen No 201
8. Specimen No 210
9. Specimen No 199
10. Specimen No 191
11. Specimen No 182
12. Specimen No 193
13. Specimen No 217, enlargement of the leaf margin, × 5
14. Specimen No 197
15. Specimen No 205

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

16. Specimen No 184

Tablica IX

Populus balsamoides Goepp.

1. Okaz nr 3; a — powiększenie brzegu liścia, × 3. Ślady gruczołków na końcach ząbków
2. Okaz nr 295. Ślady dwóch gruczołków u nasady liścia

Populus tremula L. foss.

3. Okaz nr 5
4. Okaz nr 445

Populus cf. *nigra* L.

5. Okaz nr 51
6. Okaz nr 442

Ulmus sp. div.

7. Okaz nr 201
8. Okaz nr 210
9. Okaz nr 199
10. Okaz nr 191
11. Okaz nr 182
12. Okaz nr 193
13. Okaz nr 217, powiększenie brzegu liścia, × 5
14. Okaz nr 197
15. Okaz nr 205

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

16. Okaz nr 184

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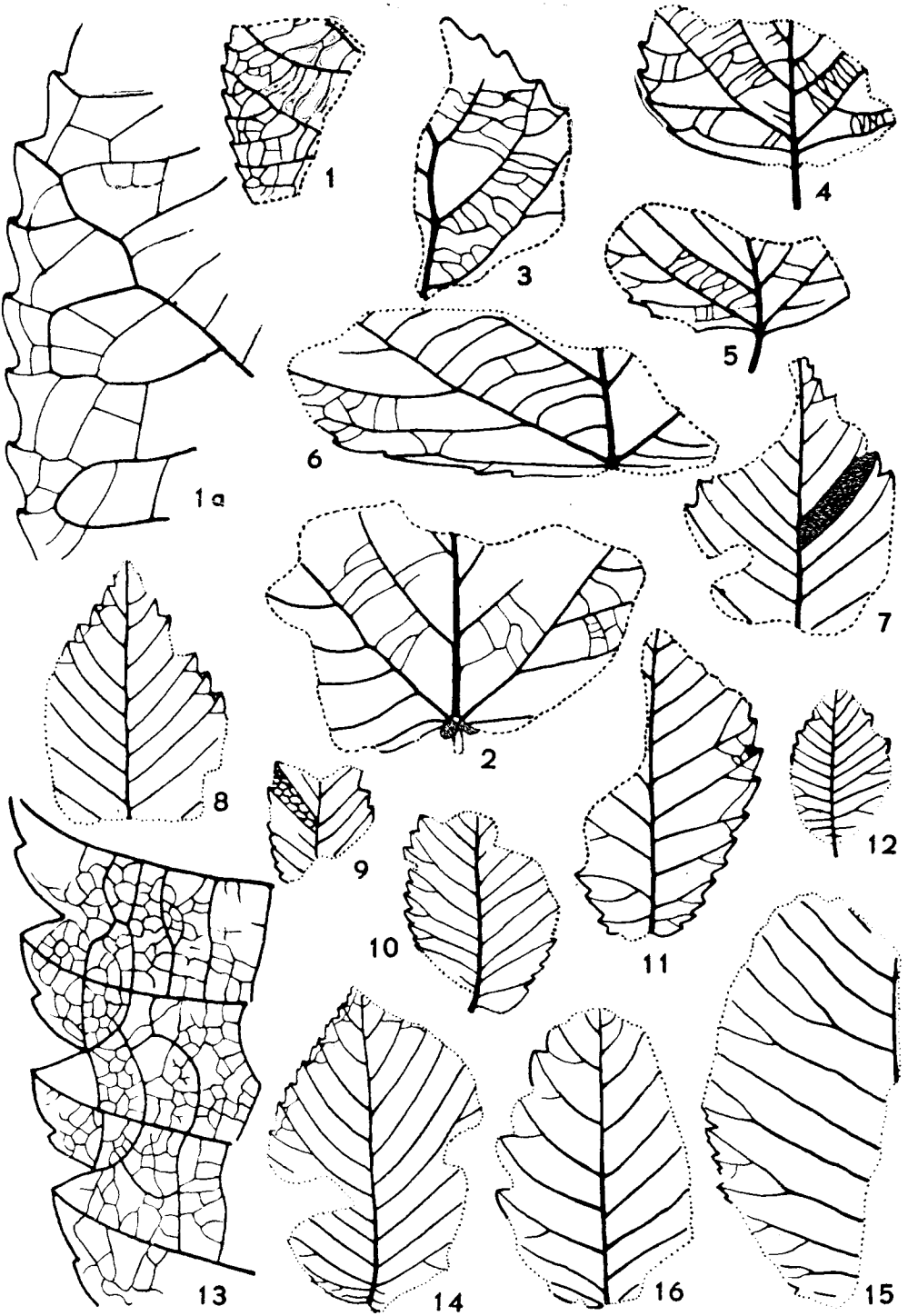
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Plate X

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

1. Specimen No 186
2. Specimen No 188
3. Specimen Nr 187

Parrotia pristina (Ett.) Stur

4. Specimen No 265
5. Specimen No 286
6. Specimen No 256
7. Specimen No 251
8. Specimen No 273
9. Specimen No 272

Liquidambar europaea A. Br.

10. Specimen No 218
11. Specimen No 23

Tablica X

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

1. Okaz nr 186
2. Okaz nr 188
3. Okaz nr 187

Parrotia pristina (Ett.) Stur

4. Okaz nr 265
5. Okaz nr 286
6. Okaz nr 256
7. Okaz nr 251
8. Okaz nr 273
9. Okaz nr 272

Liquidambar europaea A. Br.

10. Okaz nr 218
11. Okaz nr 23

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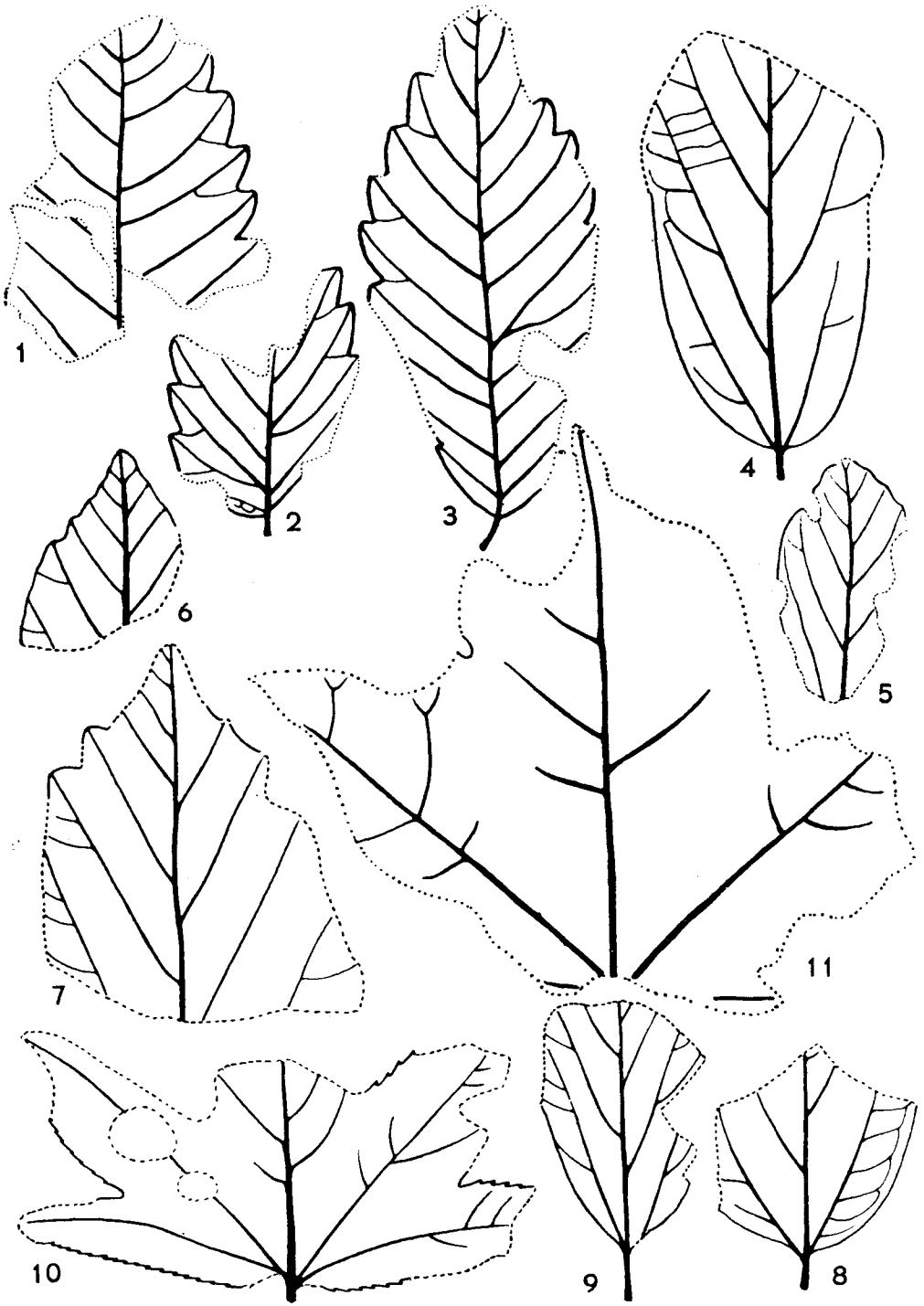
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Plate XI

Acer subcampestre Goepp.

1. Specimen No 299 (a + b)
2. Specimen No 298
3. Specimen No 300
4. Specimen No 301

Acer vindobonense (Ett.) Berger

5. Specimen No 302
6. Specimen No 413
7. Specimen No 412 (a + b)

Acer platanoides L. foss.

8. Specimen No 293

Parrotia pristina (Ett.) Stur

9. Specimen No 291
10. Specimen No 290
11. Specimen No 271

Tablica XI

Acer subcampestre Goepp.

1. Okaz nr 299 (a + b)
2. Okaz nr 298
3. Okaz nr 300
4. Okaz nr 301

Acer vindobonense (Ett.) Berger

5. Okaz nr 302
6. Okaz nr 413
7. Okaz nr 412 (a + b)

Acer platanoides L. foss.

8. Okaz nr 293

Parrotia pristina (Ett.) Stur

9. Okaz nr 291
10. Okaz nr 290
11. Okaz nr 271

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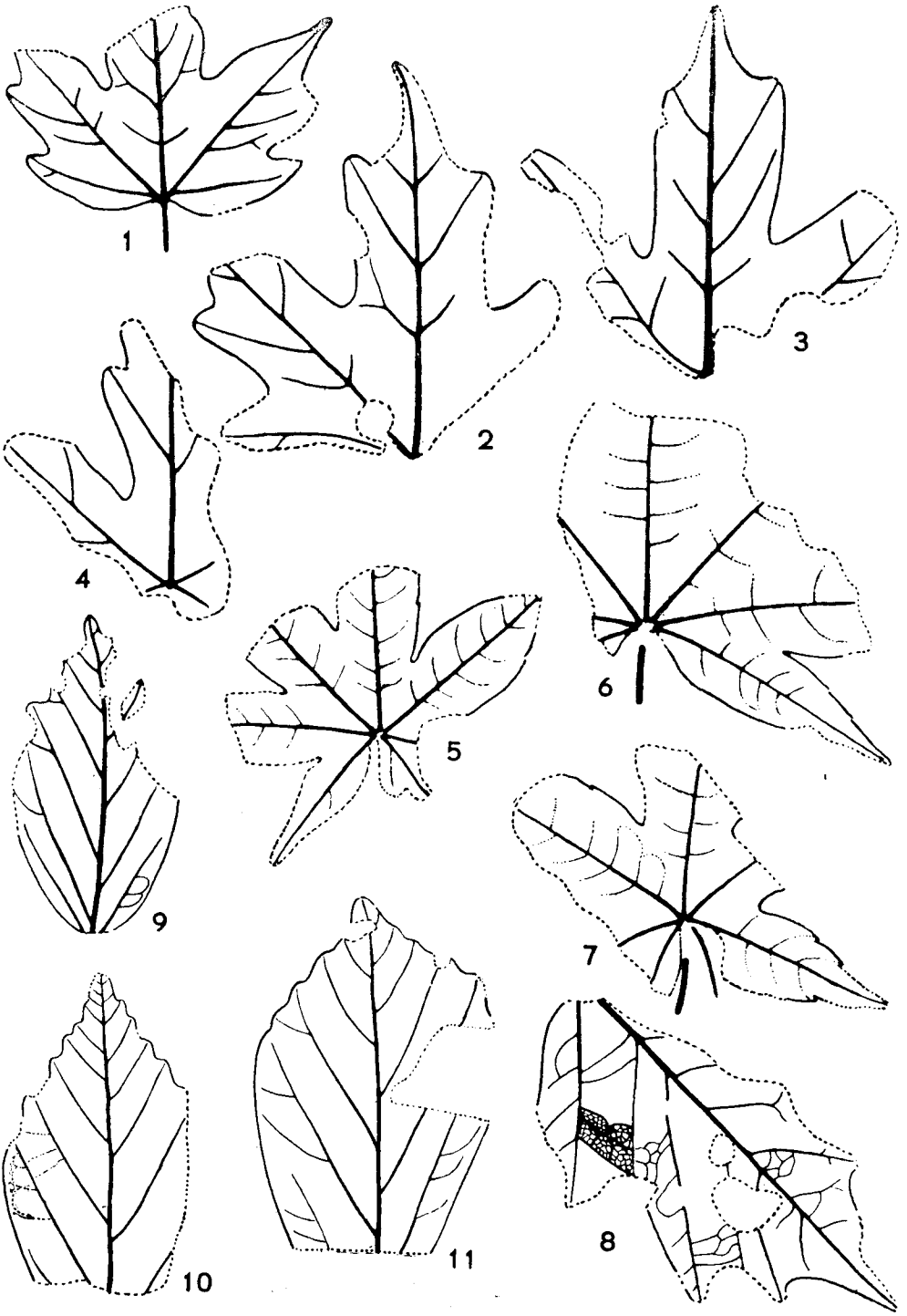
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Plate XII

Vitis sp.

1. Specimen No 185
2. Specimen No 447
3. Specimen No 296

Platanus platanifolia (Ett.) Knobl.

4. Specimen No 294
5. Specimen No 441

Cornus cf. *mas* L.

6. Specimen No 303

Cornus sp.

7. Specimen No 313

Acer firmianoides Andreánszky

8. Specimen No 297

Tablica XII

Vitis sp.

1. Okaz nr 185
2. Okaz nr 447
3. Okaz nr 296

Platanus platanifolia (Ett.) Knobl.

4. Okaz nr 294
5. Okaz nr 441

Cornus cf. *mas* L.

6. Okaz nr 303

Cornus sp.

7. Okaz nr 313

Acer firmianoides Andreánszky

8. Okaz nr 297

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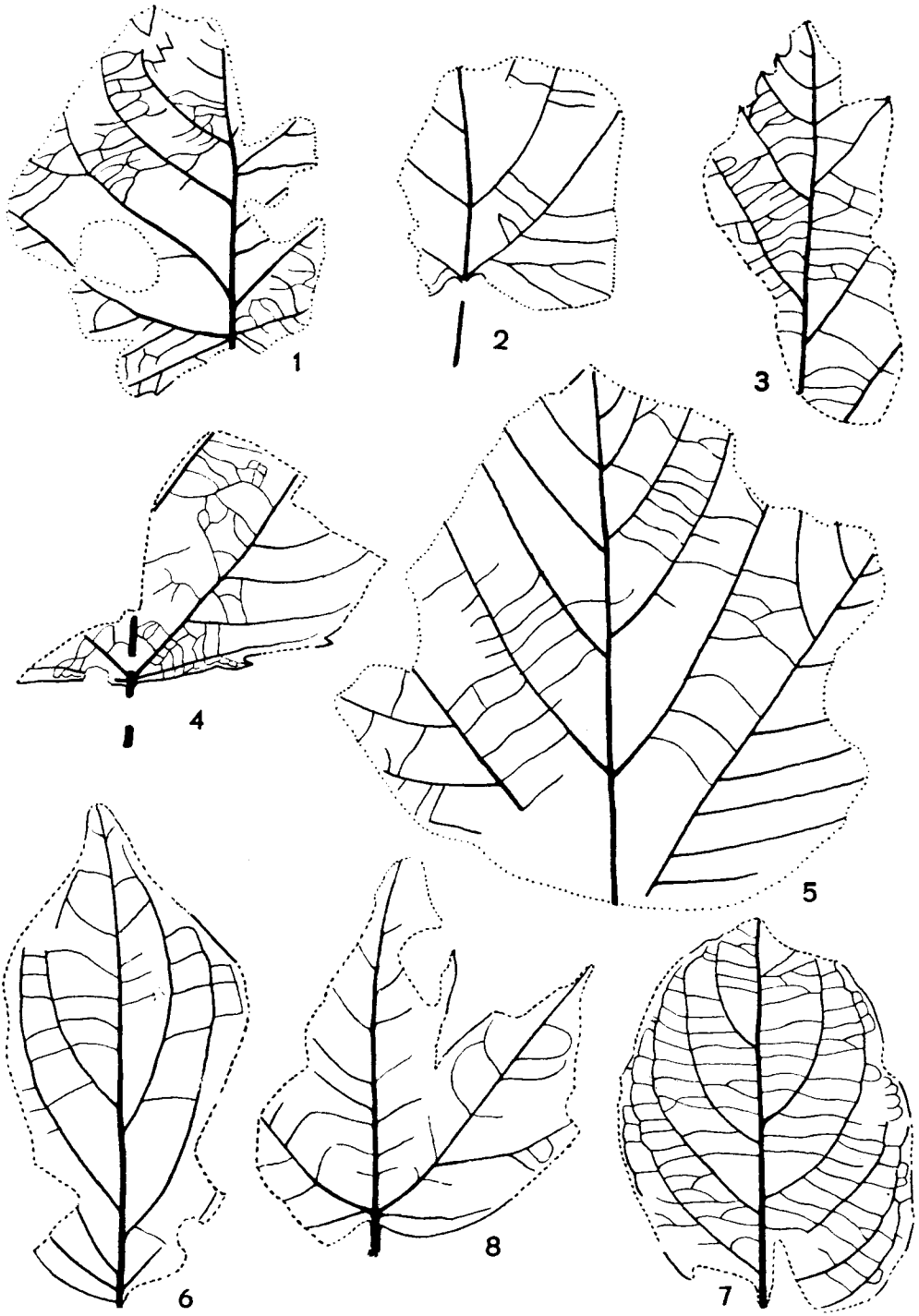
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Plate XIII

Alnus cecropiaefolia (Ett.) Berger

1. Specimen No 323; a — enlargement of the leaf margin, ×5
2. Specimen No 46
3. Specimen No 308a
4. Specimen No 34

Alnus sp. — strobiles

5. Specimen No 433, ×2

Tablica XIII

Alnus cecropiaefolia (Ett.) Berger

1. Okaz nr 323; a — powiększenie brzegu liścia, ×5
2. Okaz nr 46
3. Okaz nr 308a
4. Okaz nr 34

Alnus sp. — owocostany

5. Okaz nr 433, ×2

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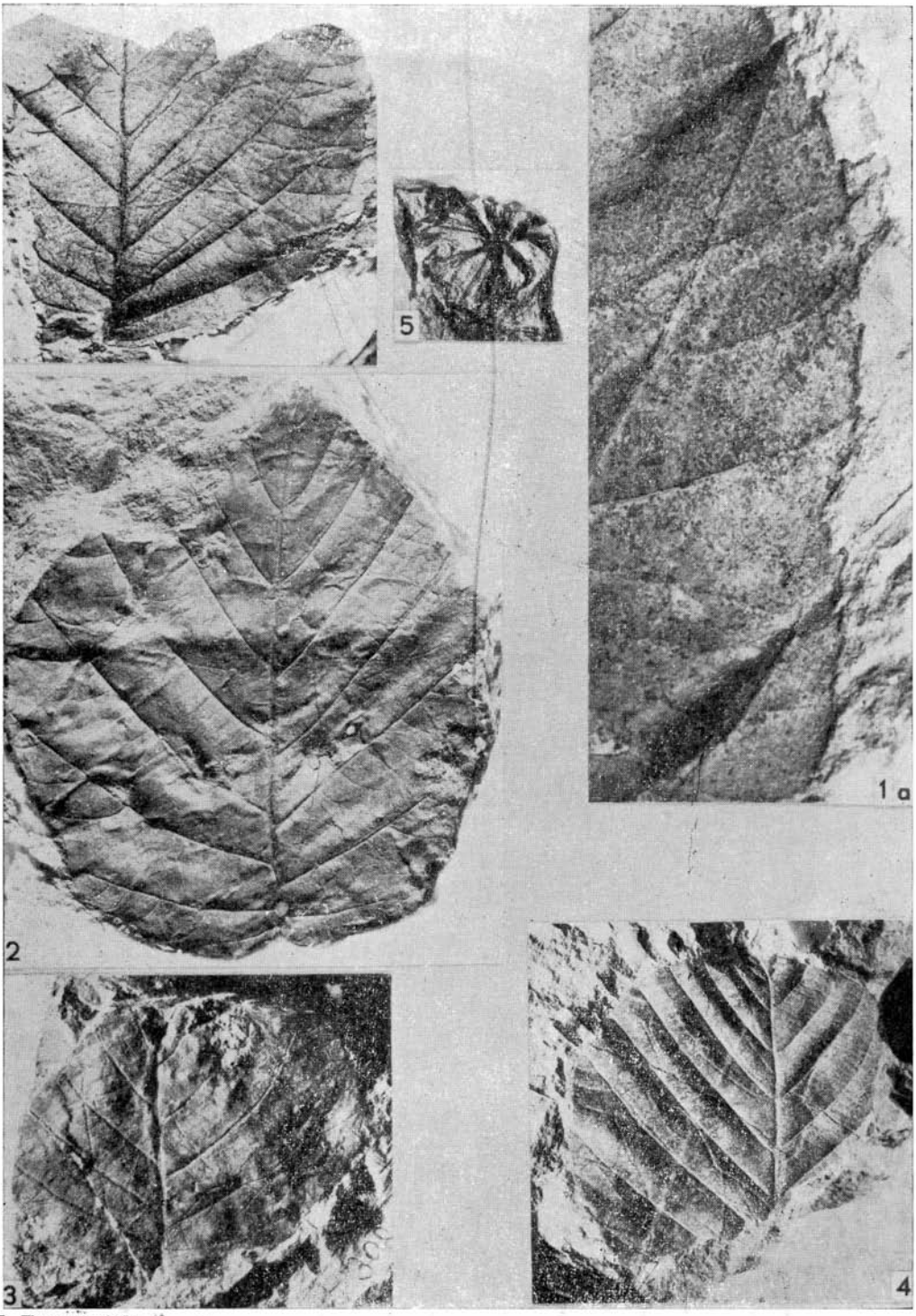

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Plate XIV

Alnus cecropiaefolia (Ett.) Berger

1. Specimen No 36; a — enlargement of the leaf margin, ×2,5
2. Specimen No 35

Alnus sp. — strobiles

3. Specimen No 435, ×2

Alnus cf. *glutinosa* Gaertn.

4. Specimen No 30
5. Specimen No 436, ×2

Tablica XIV

Alnus cecropiaefolia (Ett.) Berger

1. Okaz nr 36; a — powiększenie brzegu liścia, ×2,5
2. Okaz nr 35

Alnus sp. — owocostany

3. Okaz nr 435, ×2

Alnus cf. *glutinosa* Gaertn.

4. Okaz nr 30
5. Okaz nr 436, ×2

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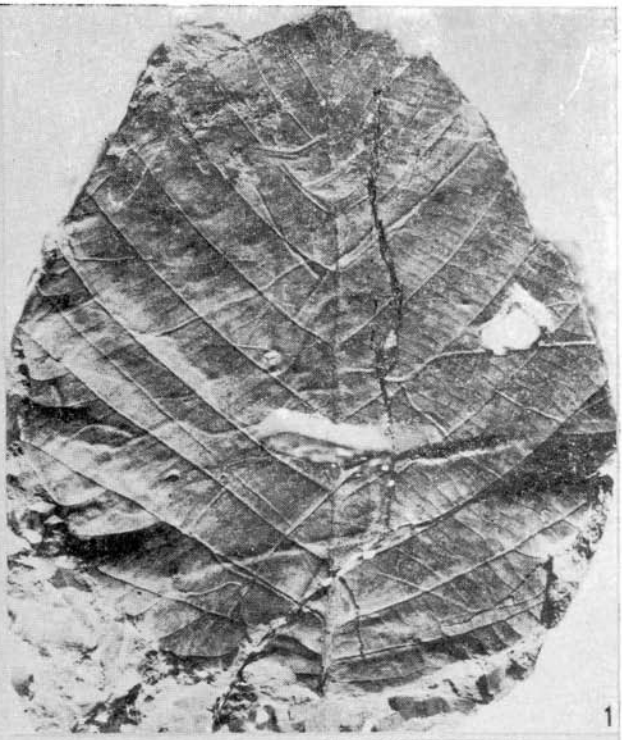

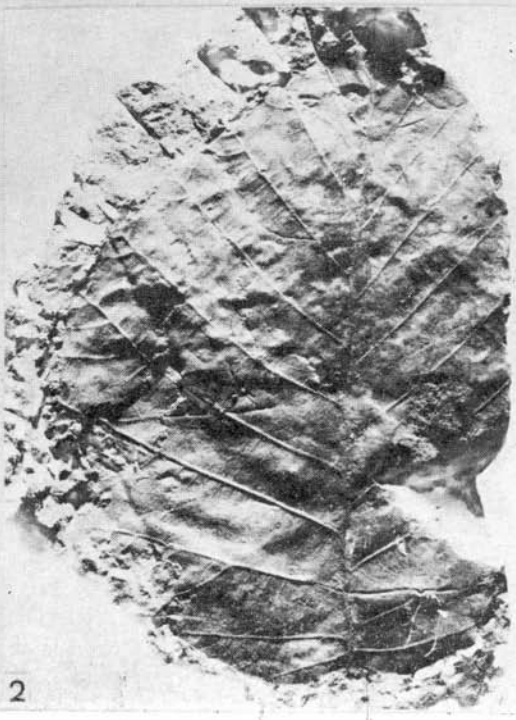

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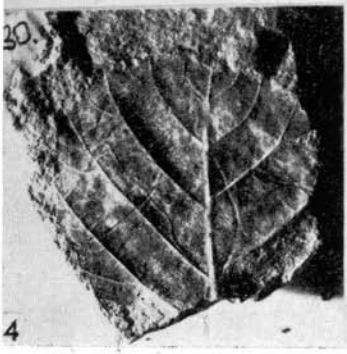

Plate XV

Carpinus grandis Ung.

1. Specimen No 57; a — enlargement of the leaf margin, ×4,5

Betulaceae gen. et sp. indet.

2. Specimen No 25

Equisetum parlatorii (Heer) Schimper

3. Specimen No 402; a — × ca. 2
4. Specimen No 401; a — ×2

Alnus feroniae (Ung.) Czecz.

5. Specimen No 28; a — enlargement of the leaf margin, ×3

Tablica XV

Carpinus grandis Ung.

1. Okaz nr 57; — powiększenie brzegu liścia, ×4,5

Betulaceae gen. et sp. indet.

2. Okaz nr 25

Equisetum parlatorii (Heer) Schimper

3. Okaz nr 402; a — × ca. 2
4. Okaz nr 401; a — ×2

Alnus feroniae (Ung.) Czecz.

5. Okaz nr 28; a — enlargement of the leaf margin, ×3

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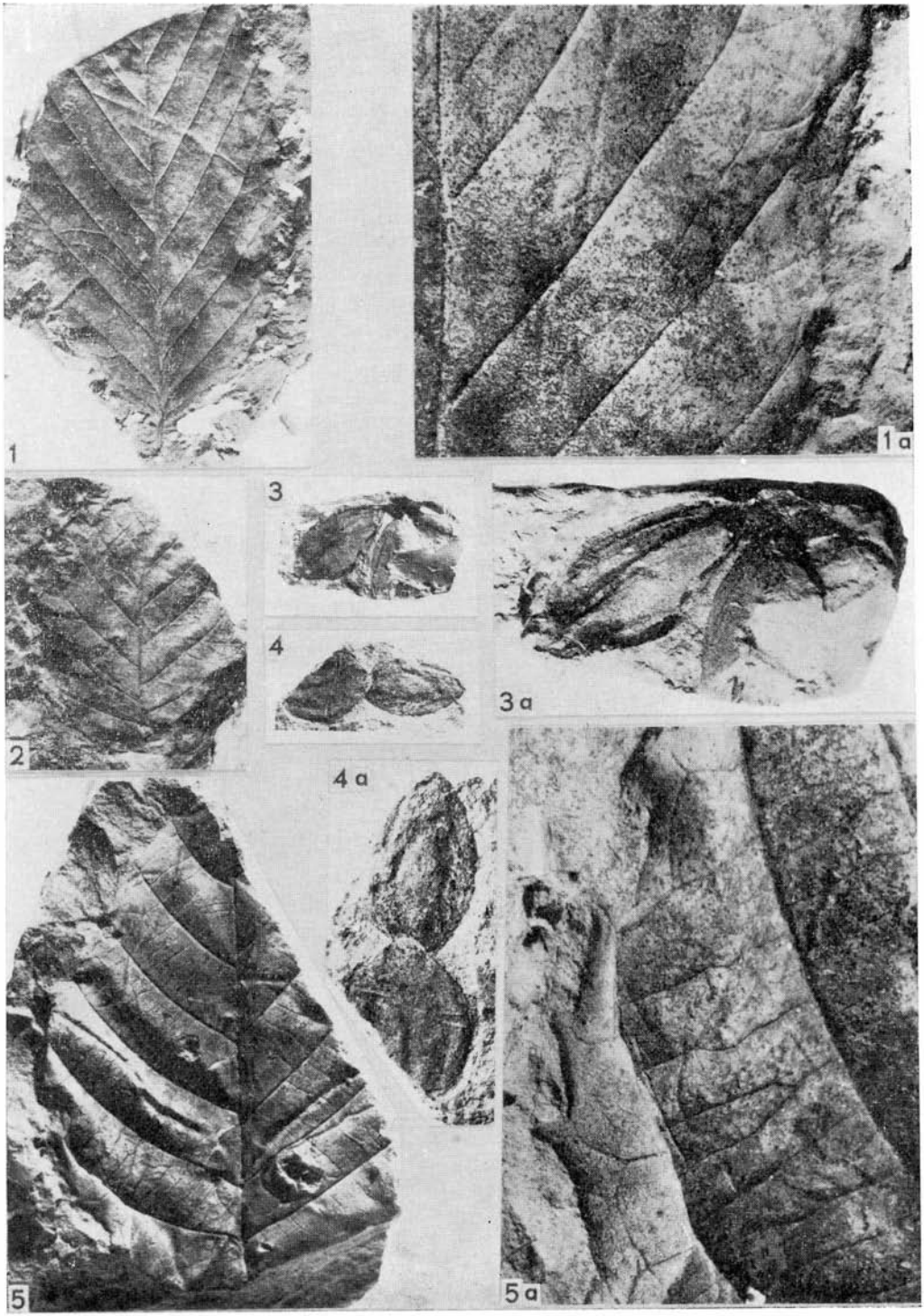

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Plate XVI

Carpinus grandis Ung.

1. Specimen No 390
2. Specimen No 87
3. Specimen No 61
4. Specimen No 83
5. Specimen No 389, enlargement of the leaf margin, ×3

Betulaceae gen. et sp. indet.

6. Specimen No 64a
7. Specimen No 24; a — enlargement of the leaf margin, ×3
8. Specimen No 383

Tablica XVI

Carpinus grandis Ung.

1. Okaz nr 390
2. Okaz nr 87
3. Okaz nr 61
4. Okaz nr 83
5. Okaz nr 389, powiększenie brzegu liścia, ×3

Betulaceae gen. et sp. indet.

6. Okaz nr 64a
7. Okaz nr 24; a — powiększenie brzegu liścia, ×3
8. Okaz nr 383

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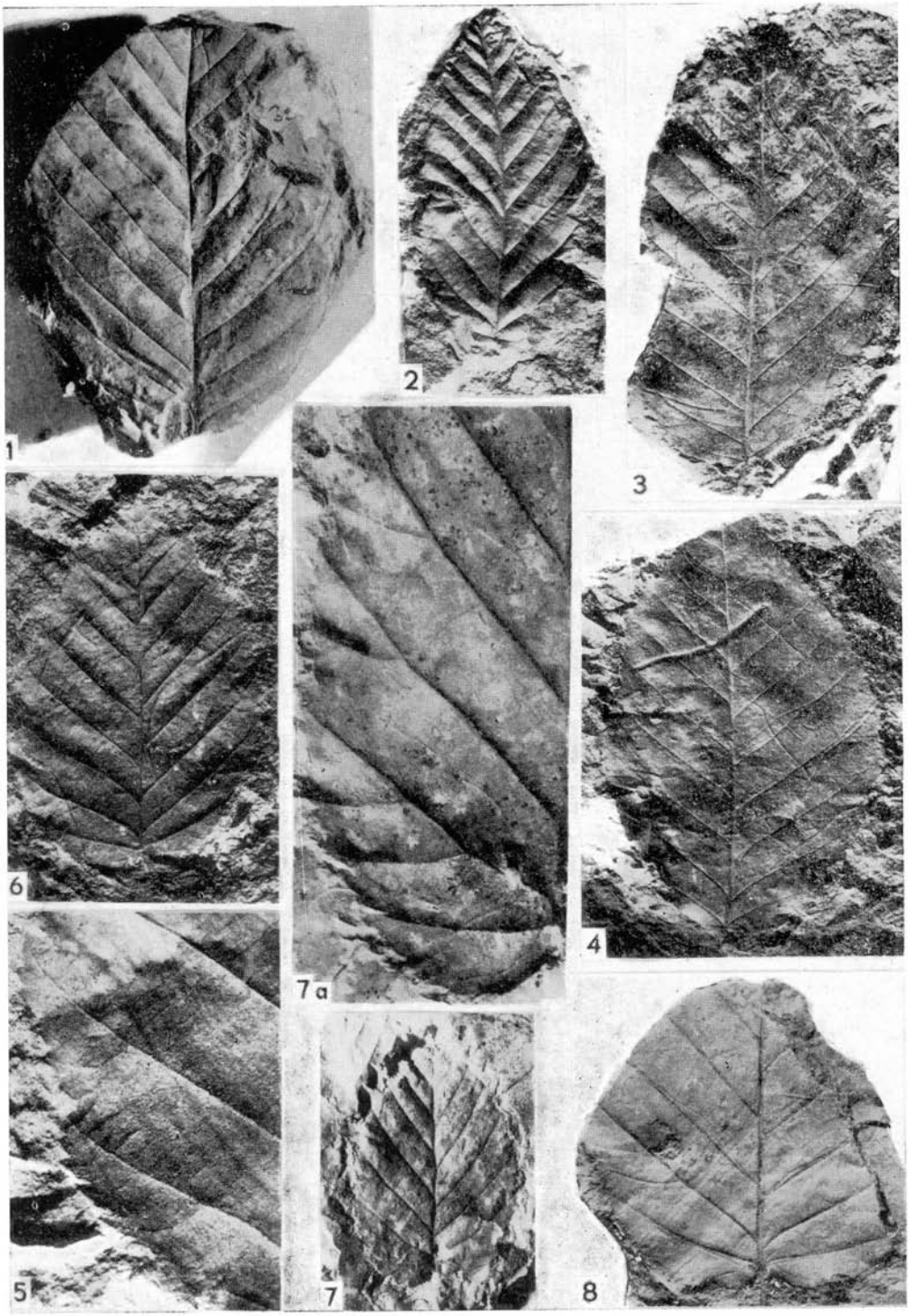
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Plate XVII

Castanea atavia Ung.

1. Specimen No 126; a — enlargement of the leaf margin, ×3·5
2. Specimen No 121; a — enlargement of the leaf fragment, ×2
3. Specimen No 118
4. Specimen No 134

Fagus haidingeri Kov. sensu Knobloch

5. Specimen No 116
6. Specimen No 109

Tablica XVII

Castanea atavia Ung.

1. Okaz nr 126; a — powiększenie brzegu liścia, ×3,5
2. Okaz nr 121; a — powiększenie fragmentu liścia, ×2
3. Okaz nr 118
4. Okaz nr 134

Fagus haidingeri Kov. sensu Knobloch

5. Okaz nr 116
6. Okaz nr 109

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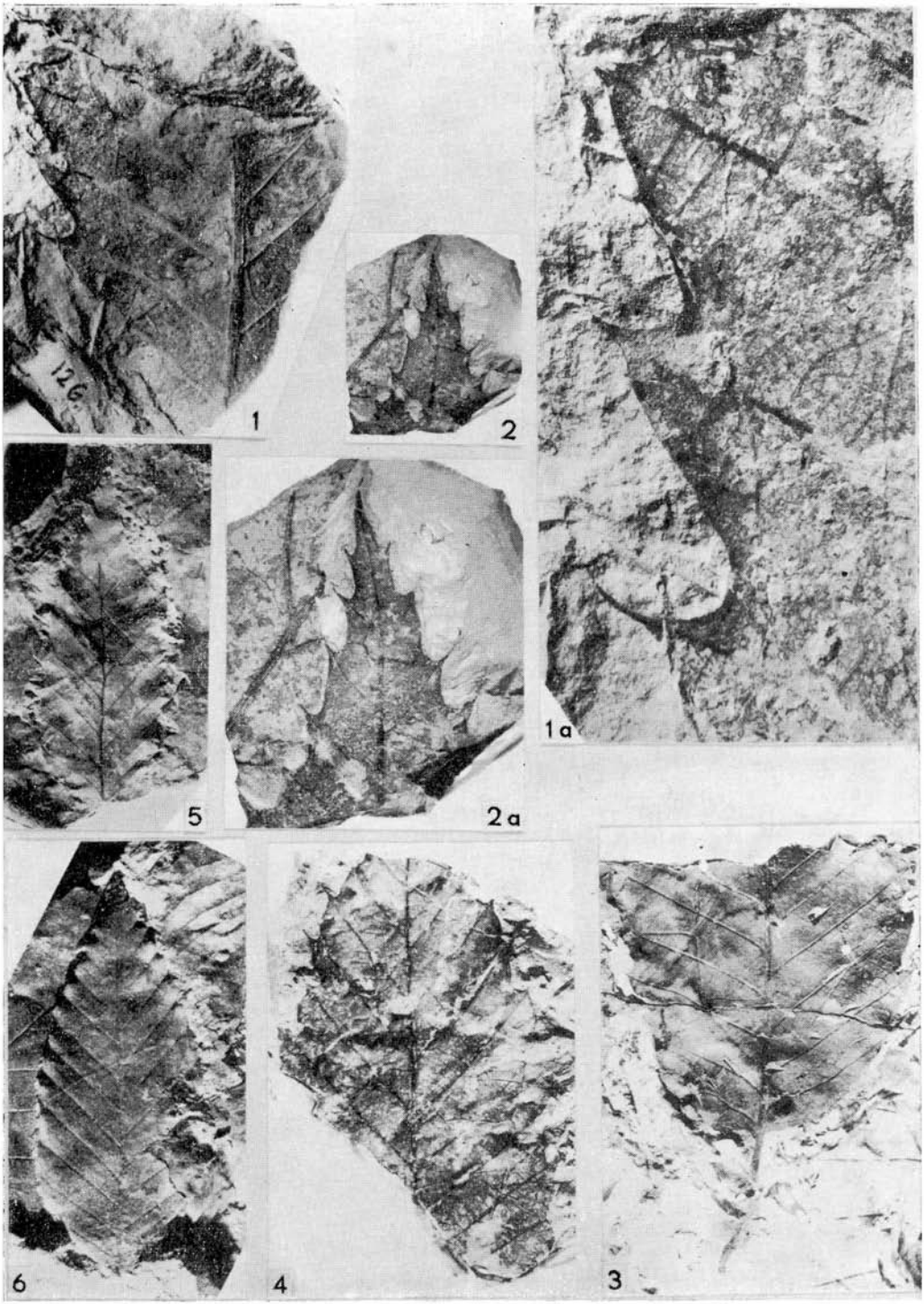
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Plate XVIII

Fagus haidingeri Kov. sensu Knobloch

1. Specimen No 99
2. Specimen No 106; a — enlargement of the leaf margin, ×7
3. Specimen No 113; a — enlargement of the leaf margin, ×4
4. Specimen No 107
5. Specimen No 110

Tablica XVIII

Fagus haidingeri Kov. sensu Knobloch

1. Okaz nr 99
2. Okaz nr 106; a — powiększenie brzegu liścia, ×7
3. Okaz nr 113; a — powiększenie brzegu liścia, ×4
4. Okaz nr 107
5. Okaz nr 110

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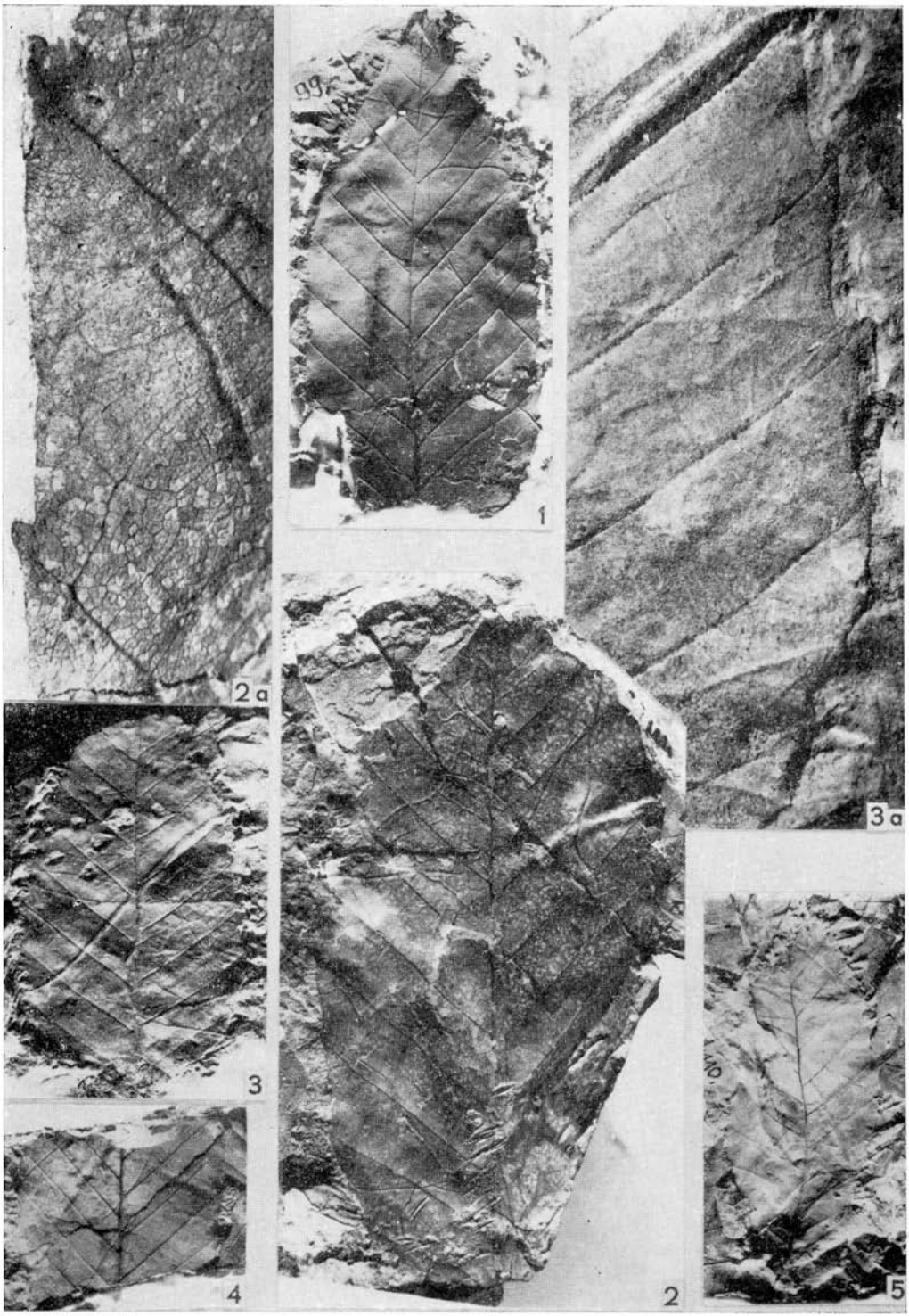

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Plate XIX

Quercus pseudocastanea Goepp.

1. Specimen No 159; a — enlargement of the leaf margin, ×3
2. Specimen No 148
3. Specimen No 165
4. a — specimen No 150, b — specimen No 151

Equisetum parlatorii (Heer) Schimper

5. Specimen No 358; a — enlargement of rhizome, ×2

Tablica XIX

Quercus pseudocastanea Goepp.

1. Okaz nr 159; a — powiększenie brzegu liścia, ×3
2. Okaz nr 148
3. Okaz nr 165
4. a — okaz nr 150, b — okaz nr 151

Equisetum parlatorii (Heer) Schimper

5. Okaz nr 358; a — powiększenie fragmentu pędu podziemnego, ×2

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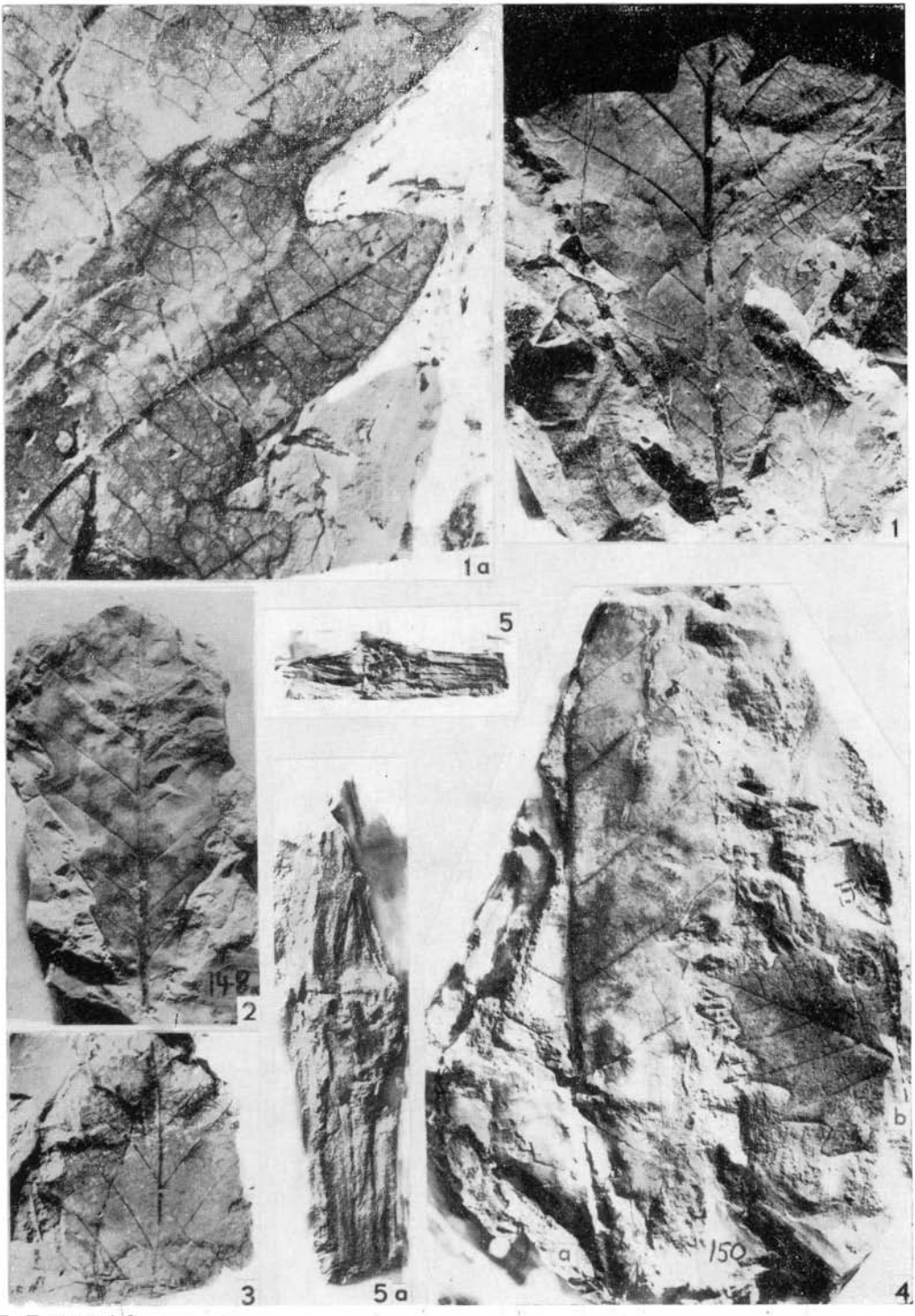
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Plate XX

Quercus pontica miocenica Kubát

1. Specimen No 173; a — enlargement of the leaf margin, ×4
2. Specimen No 175, ×2
3. Specimen No 174b

Quercus sp.

4. Specimen No 405, impression of an acorn cup.

Tablica XX

Quercus pontica miocenica Kubát

1 Okaz nr 173; a — powiększenie brzegu liścia, ×4
2 Okaz nr 175, ×2
3 Okaz nr 174b

Quercus sp.

4 Okaz nr 405, odcisk miseczki żołędzia

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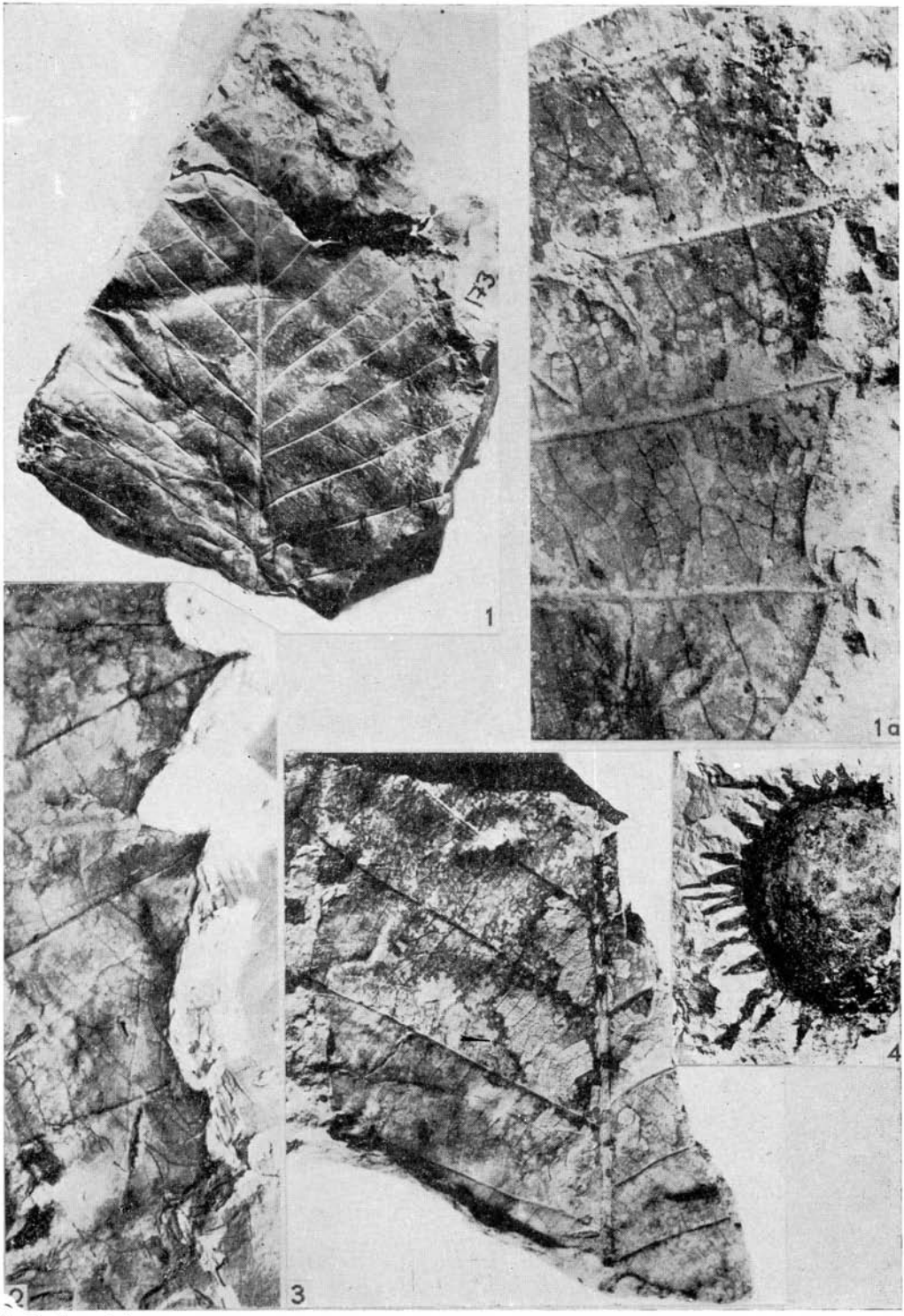
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Plate XXI

Quercus kubinyi (Kov. et Ett.) Berger

1. Specimen No 168; a, b — enlargements of the leaf margin, ×4
2. Specimen No 169; a — enlargement of the leaf margin, ×4
3. Specimen No 171

Juglans sp.

4. Specimen No 22; a — enlargement of the leaf margin, ×6

Tablica XXI

Quercus kubinyi (Kov. et Ett.) Berger

1. Okaz nr 168; a, b — powiększenie brzegów liścia, ×4
2. Okaz nr 169; a — powiększenie brzegu liścia, ×4
3. Okaz nr 171

Juglans sp.

4. Okaz nr 22; a — powiększenie brzegu liścia, ×6

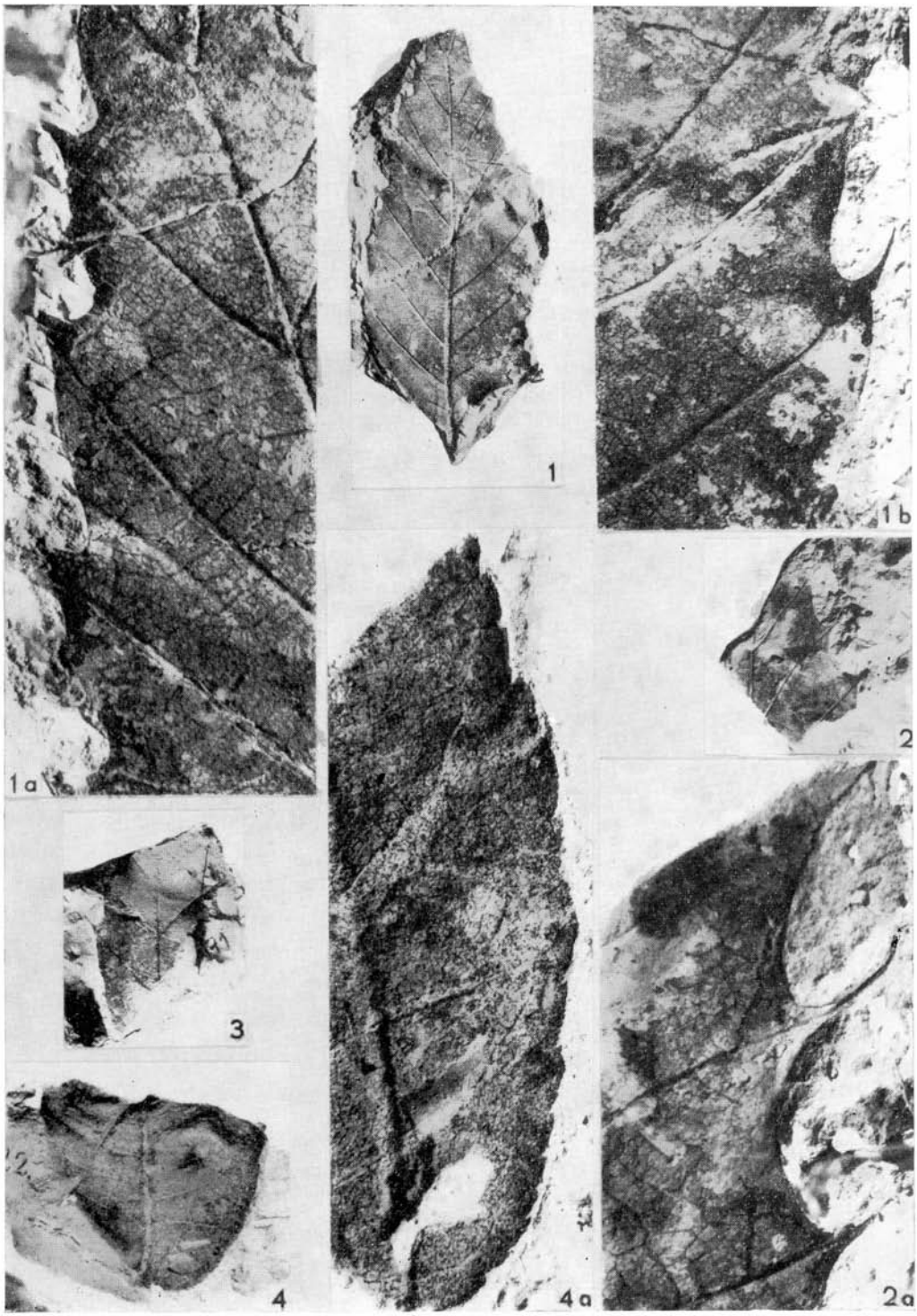
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Plate XXII

Pterocarya paradisiaca (Ung.) Iliinsk.

1. Specimen No 21
2. Specimen No 16a; a — enlargement of the leaf margin, ×4

Salix angusta A. Br.

3. Specimen No 15; a — enlargement of the leaf fragment, ×2

Salix varians Goepp.

4. Specimen No 9

Populus cf. *nigra* L.

5. Specimen No 51

Populus balsamoides Goepp.

6. Specimen No 2; a — enlargement of the leaf margin, ×4; traces of glands at the ends of teeth.

Tablica XXII

Pterocarya paradisiaca (Ung.) Iliinsk.

1. Okaz nr 21
2. Okaz nr 16a; a — powiększenie brzegu liścia, ×4

Salix angusta A. Br.

3. Okaz nr 15; a — powiększenie fragmentu liścia, ×2

Salix varians Goepp.

4. Okaz nr 9

Populus cf. *nigra* L.

5. Okaz nr 51

Populus balsamoides Goepp.

6. Okaz nr 2; a — powiększenie brzegu liścia, ×4; ślady gruczołków na końcach ząbków.

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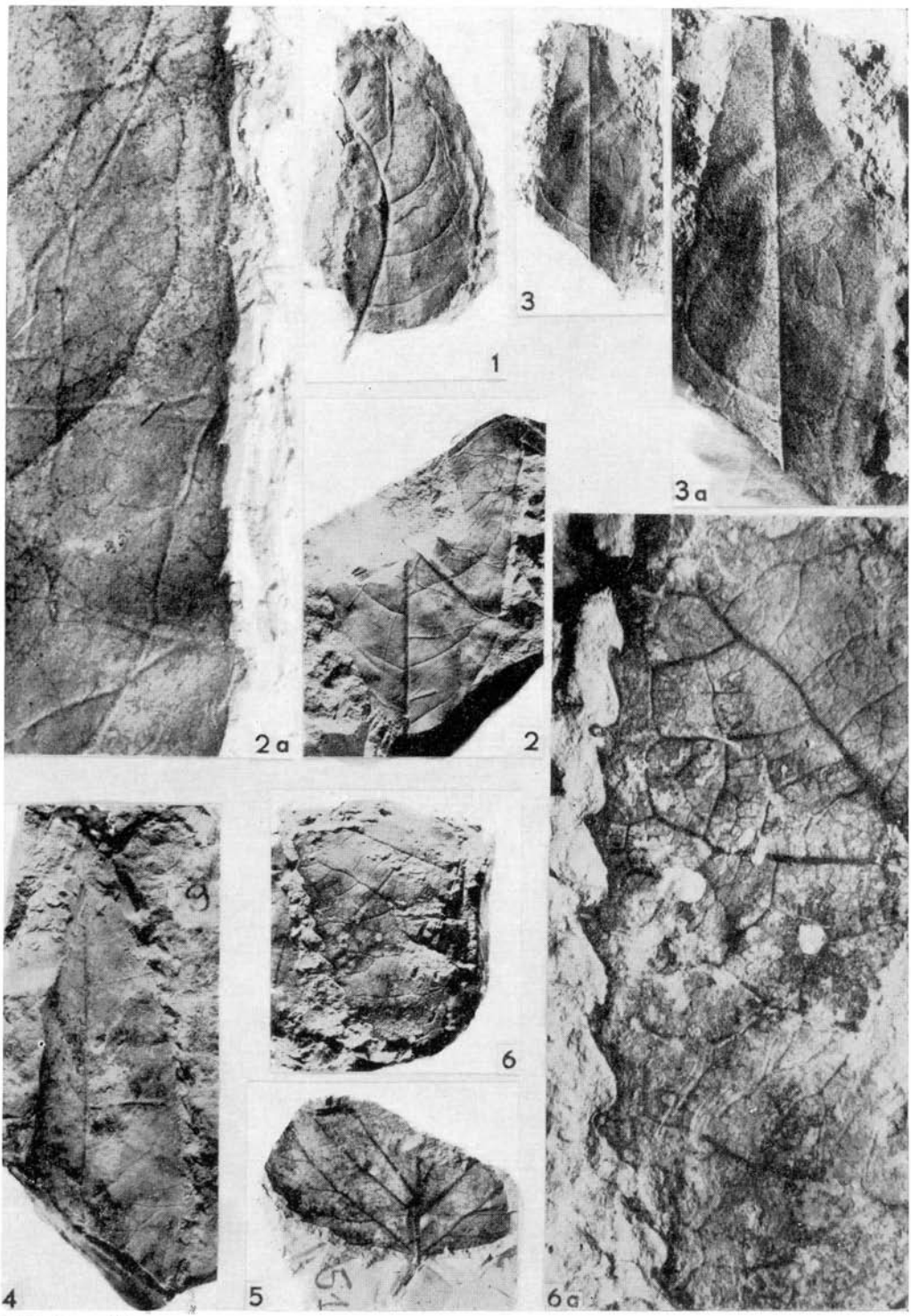

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Plate XXIII

Populus balsamoides Goepp.

1. Specimen No 4
2. Specimen No 3; a — enlargement of the leaf fragment, ×3
3. Specimen No 317; a — enlargement of the leaf margin, ×4
4. Specimen No 1
5. Specimen No 315; a — enlargement of the leaf margin, ×3

Ulmus sp. div.

6. Specimen No 193, ×2

Tablica XXIII

Populus balsamoides Goepp.

1. Okaz nr 4
2. Okaz nr 3; a — powiększenie fragmentu liścia, ×3
3. Okaz nr 317; a — powiększenie brzegu liścia, ×4
4. Okaz nr 1
5. Okaz nr 315; a — powiększenie brzegu liścia, ×3

Ulmus sp. div.

6. Okaz nr 193, ×2

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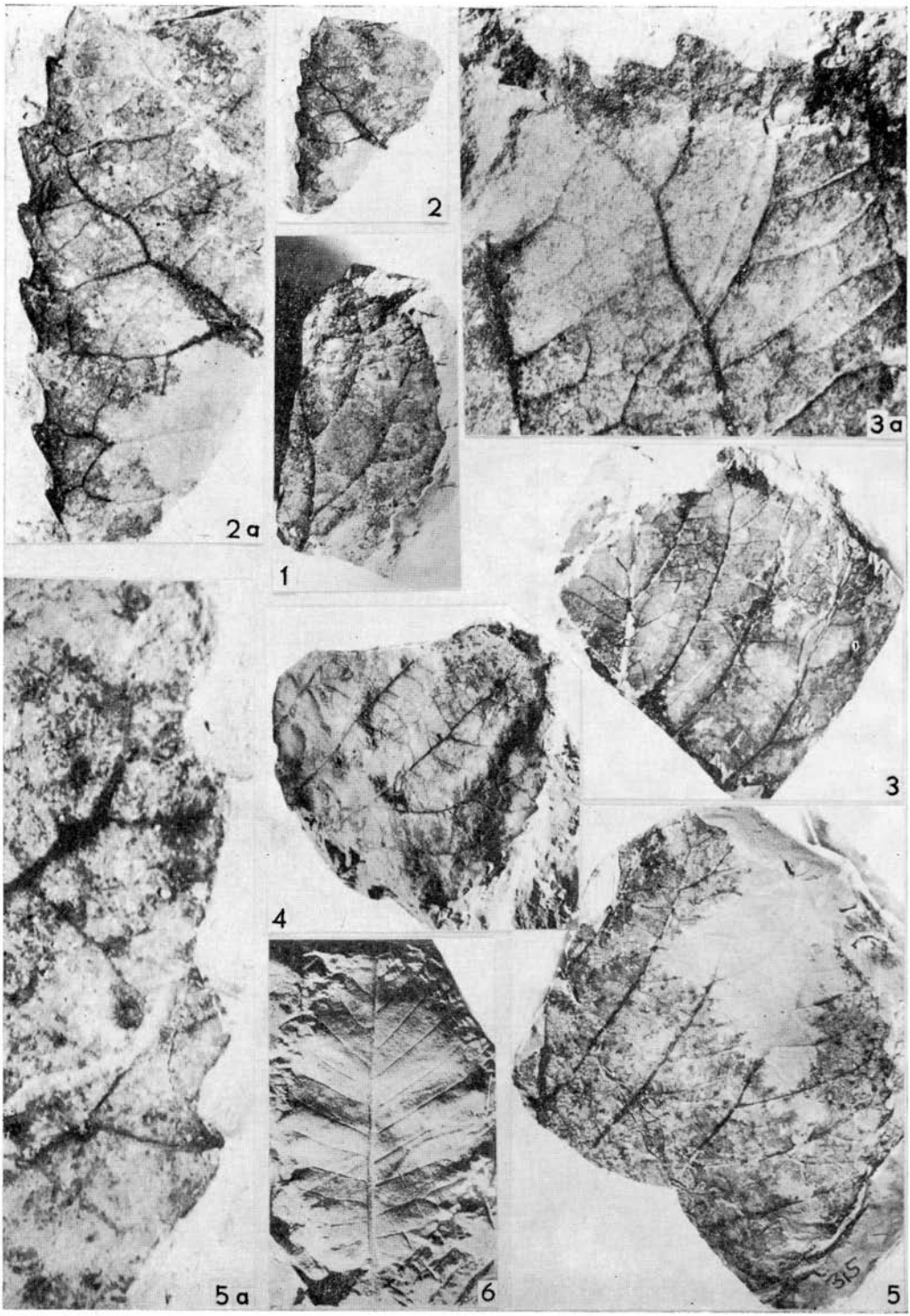

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Plate XXIV

Ulmus sp. div.

1. Specimen No 191; a — enlargement of the leaf, × ca. 3
2. Specimen No 182; a — enlargement of the leaf margin, ×5
3. Specimen No 205
4. Specimen No 195
5. Specimen No 199, ×2
6. Specimen No 217, ×6

Tablica XXIV

Ulmus sp. div.

1. Okaz nr 191; a — powiększenie liścia, × ca. 3
2. Okaz nr 182; a — powiększenie brzegu liścia, ×5
3. Okaz nr 205
4. Okaz nr 195
5. Okaz nr 199, ×2
6. Okaz nr 217, ×6

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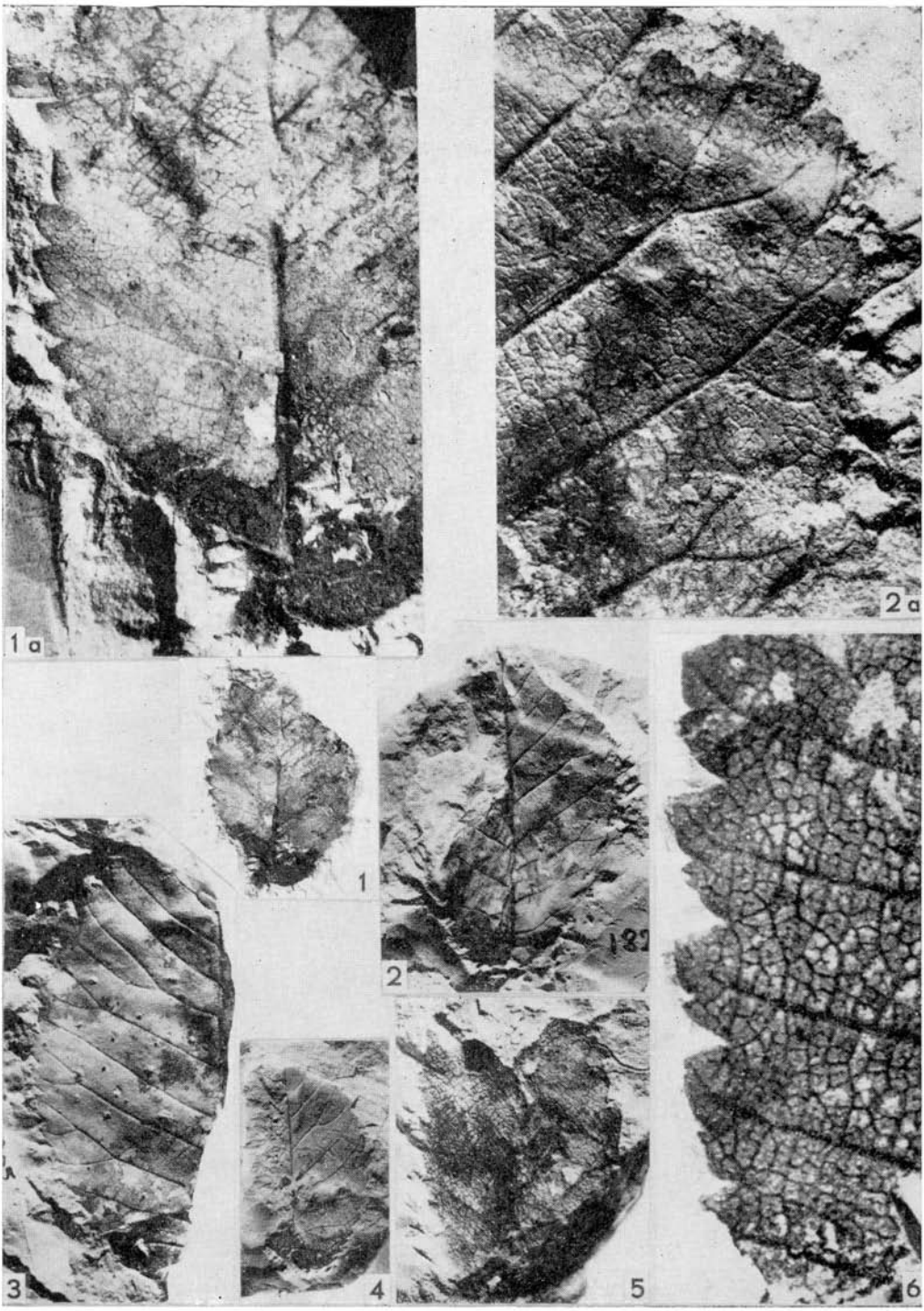
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6

Plate XXV

Ulmus sp. div.

1. Specimen No 197
2. Specimen No 210
3. Specimen No 216

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

4. Specimen No 184
5. Specimen No 187
6. Specimen No 188; a — enlargement of the leaf margin, ×3·5

Parrotia pristina (Ett.) Stur

7. Specimen No 273
8. Specimen No 291
9. Specimen No 256
10. Specimen No 290

Tablica XXV

Ulmus sp. div.

1. Okaz nr 197
2. Okaz nr 210
3. Okaz nr 216

Zelkova zelkovaefolia (Ung.) Bůžek et Kotlaba

4. Okaz nr 184
5. Okaz nr 187
6. Okaz nr 188; a — powiększenie brzegu liścia, ×3,5

Parrotia pristina (Ett.) Stur

7. Okaz nr 273
8. Okaz nr 291
9. Okaz nr 256
10. Okaz nr 290

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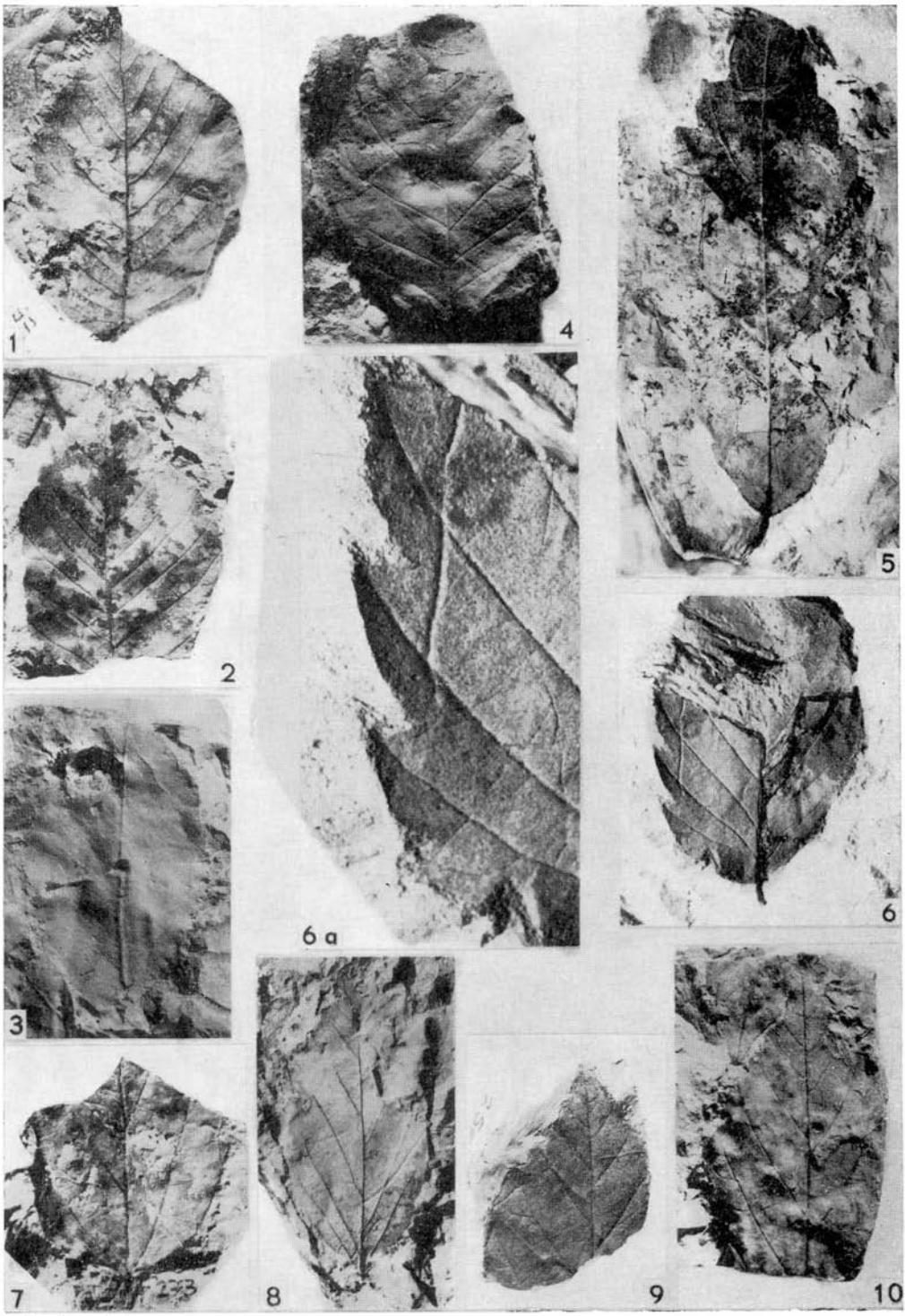
1
4
5
2
6a
6
3
7
8
9
10

Plate XXVI

Parrotia pristina (Ett.) Stur

1. Specimen No 265
2. Specimen No 260

Liquidambar europaea A. Br.

3. Specimen No 218; a — enlargement of the leaf margin, ×8

Acer subcampestre Goepp.

4. Specimen No 299b
5. Specimen No 298

Acer platanoides L. foss.

6. Specimen No 293

Tablica XXVI

Parrotia pristina (Ett.) Stur

1. Okaz nr 265
2. Okaz nr 260

Liquidambar europaea A. Br.

3. Okaz nr 218; a — powiększenie brzegu liścia, ×8

Acer subcampestre Goepp.

4. Okaz nr 299b
5. Okaz nr 298

Acer platanoides L. foss.

6. Okaz nr 293

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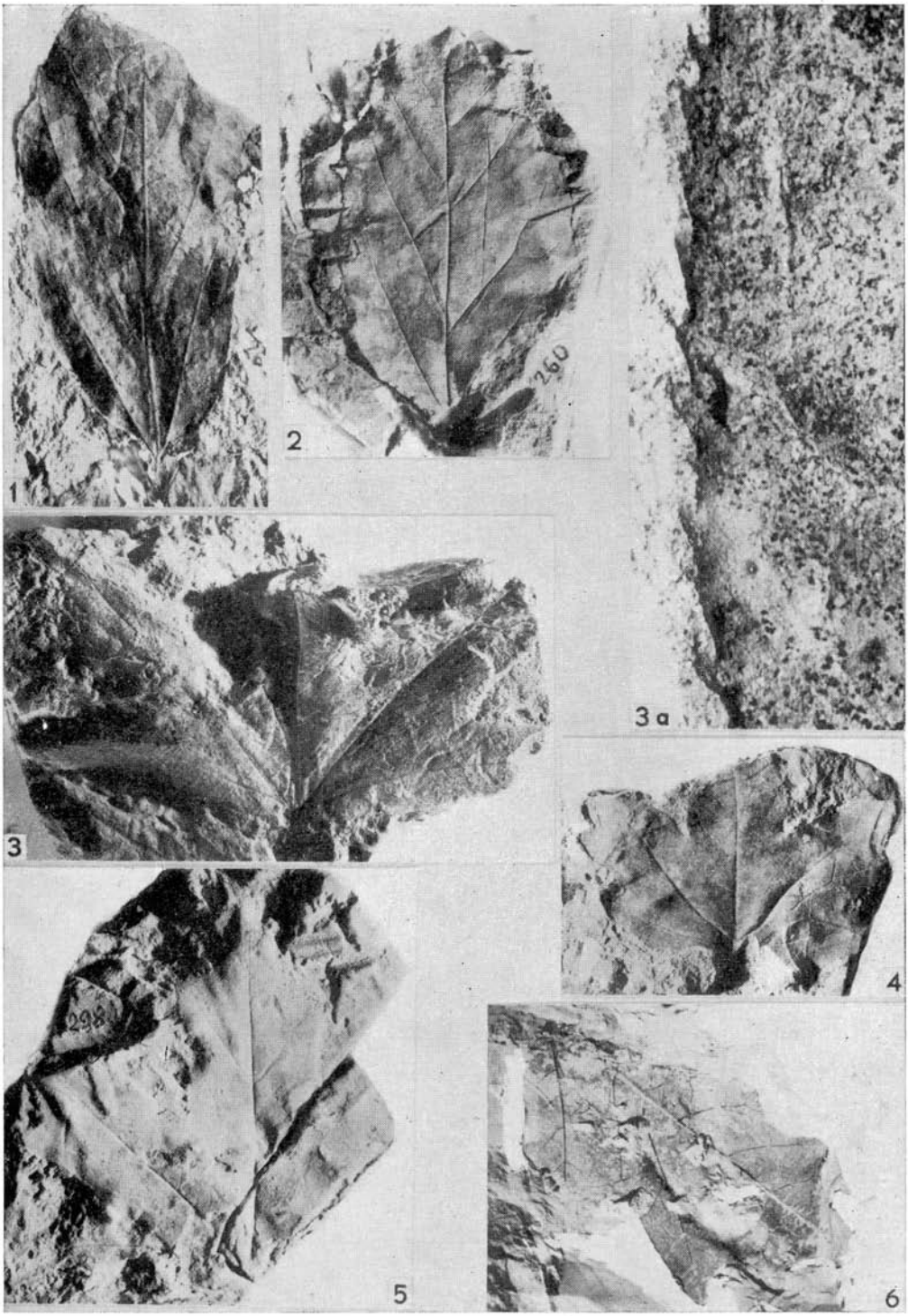
1
2
260
3
3a
4
298
5
6

Plate XXVII

Platanus platanifolia (Ett.) Knobloch

1. Specimen No 294; a — enlargement of the leaf margin, ×4·5

Acer vindobonense (Ett.) Berger

2. Specimen No 302

Cornus cf. *mas.* L.

3. Specimen No 303

Vitis sp.

4. Specimen No 296; a — enlargement of the leaf margin, ×3

Monocotyledones gen. div.

5. Specimen No 416, ×4

Tablica XXVII

Platanus platanifolia (Ett.) Knobloch

1. Okaz nr 294; a — powiększenie brzegu liścia, ×4,5

Acer vindobonense (Ett.) Berger

2. Okaz nr 302

Cornus cf. *mas.* L.

3. Okaz nr 303

Vitis sp.

4. Okaz nr 296; a — powiększenie brzegu liścia, ×3

Monocytyledones gen. div.

5. Okaz nr 416, ×4

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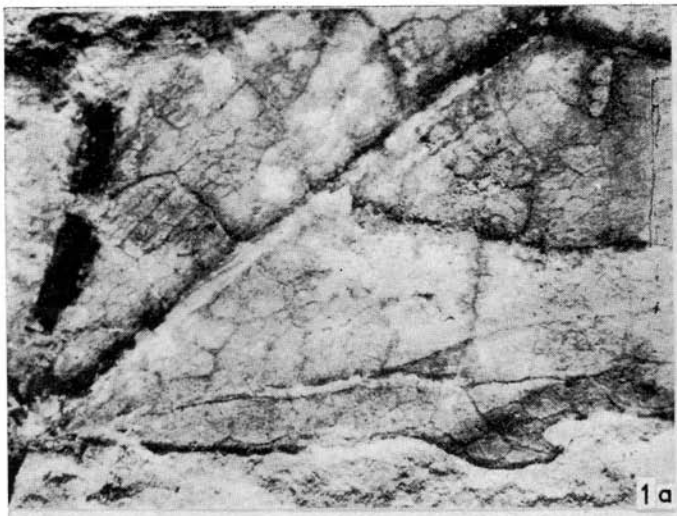

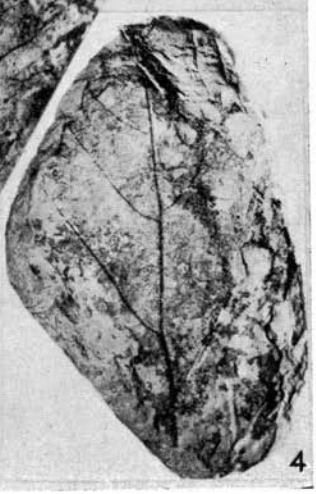

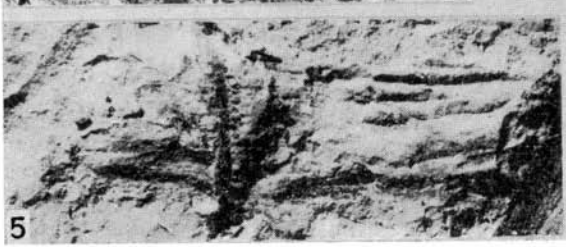

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Plate XXVIII

Cornus sp.

1. Specimen No 313; a — enlargement of the leaf fragment, ×2·5

Typha latissima A. Br.

2. Specimen No 334, ×4

Type *Gramineae*

3. Specimen No 342, ×4·5

Scirpus cf. *silvaticus* L.

4. Specimen No 337; a — enlargement of the leaf fragment, × ca. 6

Tablica XXVIII

Cornus sp.

1. Okaz nr 313; a — powiększenie fragmentu liścia, ×2,5

Typha latissima A. Br.

2. Okaz nr 334, ×4

Type *Gramineae*

3. Okaz nr 342, ×4,5

Scirpus cf. *silvaticus* L.

4. Okaz nr 337; a — powiększenie fragmentu liścia, × ca. 6

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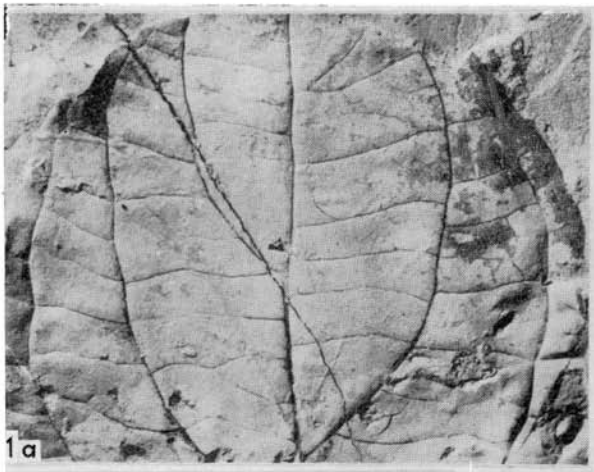

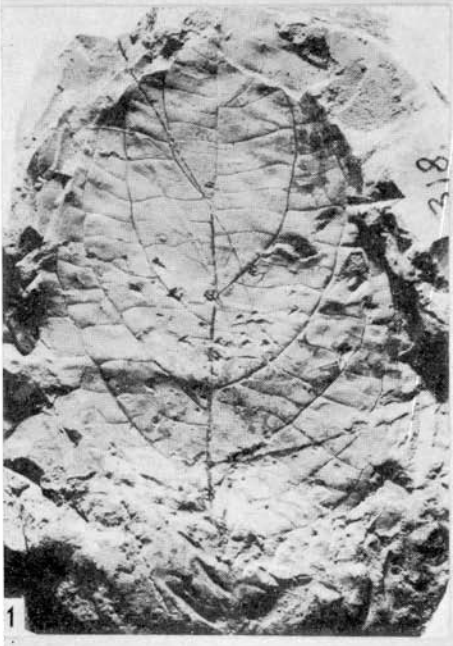

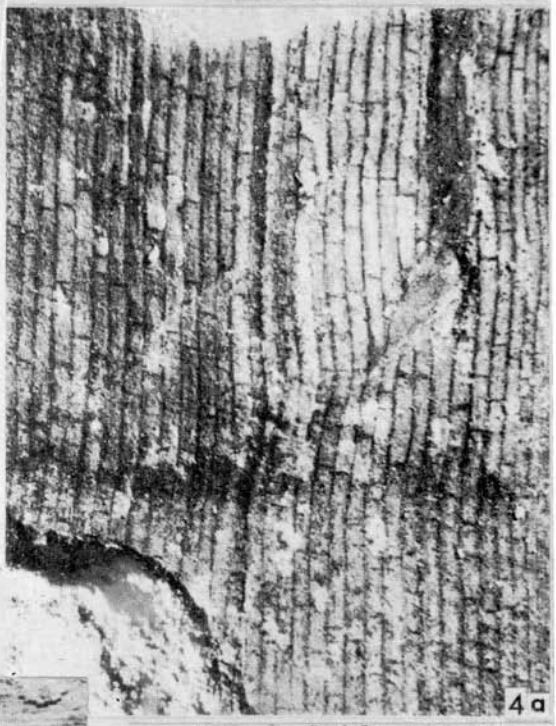

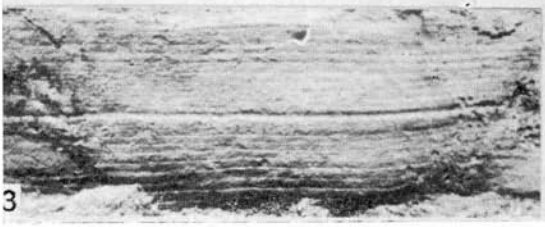

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Plate XXIX

Cyperacites sp. div.

1. Specimen No 365, ×4

Cyperacites rechsteineri (Heer) Schimper

2. Specimen No 344, ×8

Monocotyledones gen. div.

3. Specimen No 345, numerous fragments of monocotyledon shoots

Carex sp.

4. Specimen No 338, ×10; a — × ca. 20

Tablica XXIX

Cyperacites sp. div.

1. Okaz nr 365, ×4

Cyperacites rechsteineri (Heer) Schimper

2. Okaz nr 344, ×8

Monocotyledones gen. div.

3. Okaz nr 345, liczne fragmenty pędów roślin jednoliściennych

Carex sp.

4. Okaz nr 338, ×10; a — × ca. 20

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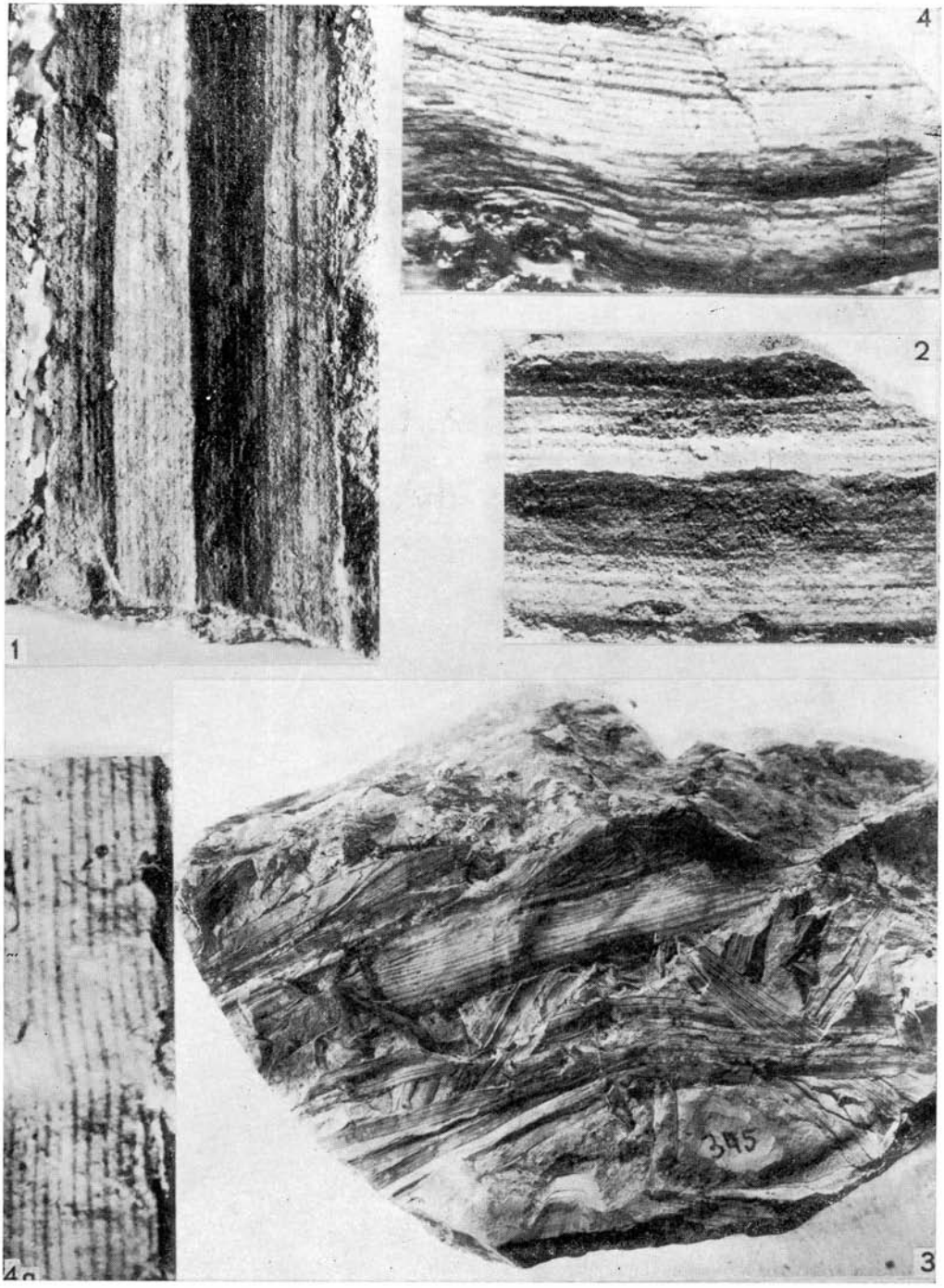
4
2
1
3
4a
345

Plate XXX

Sample of clay from the level under the wayside shrine with visible numerous impressions of leaves

a — *Ulmus* sp. div., specimen No 217
b — *Ulmus* sp. div., specimen No 216
c — *Parrotia pristina* (Ett.) Stur, specimen No 409
d — *Carpinus grandis* Ung., specimen No 415
e — Base of undetermined leaf

Tablica XXX

Próba iłu z poziomu pod kapliczką z widocznymi licznymi odciskami liści

a — *Ulmus* sp. div., okaz nr 217
b — *Ulmus* sp. div., okaz nr 216
c — *Parrotia pristina* (Ett.) Stur, okaz nr 409
d — *Carpinus grandis* Ung., okaz nr 415
e — Podstawa nie oznaczonego liścia

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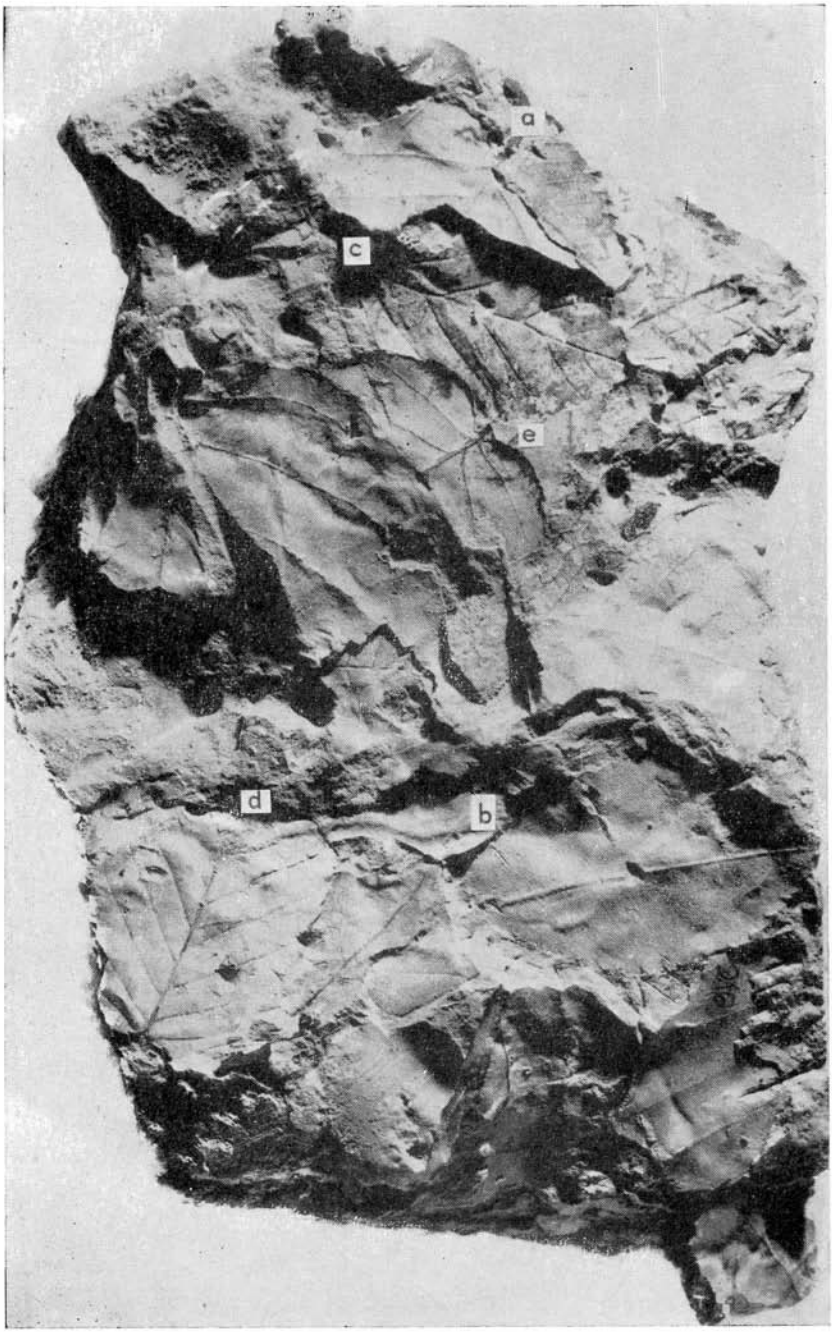
a
c
e
d
b