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UPPER MIOCENE LEAF FLORA FROM MIROSTOWICE DOLNE (WESTERN POLAND)

Górnomioceńska flora liściowa z Mirostowic Dolnych

ABSTRACT. The results of the studies of leaf impressions have been presented, from the bottom of the Poznań series, and from the level of grey clays, dated as Upper Tortonian. The flora from Mirostowice, just as other Upper Miocene floras described from Poznań clays, depicts swamp coniferous forests. The deciduous trees and shrubs are represented by eight taxa, and in addition, climbing plants and monocotyledonous plants have been found. The majority of the genera distinguished are today connected with a temperate, moderately warm climate. The following have been described as new species for the Tertiary: *Clerodendrum silesiacum*, *Photinia szaferi* and *Prunus microserrata*.

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INTRODUCTION

In 1969 Dr. S. Dyjor discovered sediments with a fossil flora occurring in an disused brickyard at Mirostowice Dolne. A detailed description of the sediments in the outcrop is to be found in Dyjor's paper (1978) while the results of palynological studies and a preliminary estimation of the leaf flora have been published by Sadowska & Zastawniak (1978).

The material examined comprises 404 specimens, collected by the author in the years 1971—1973 and stored in the Paleobotanical Museum of the Institute of Botany of the Polish Academy of Sciences, Cracow, and 122 specimens from the collections of the Museum of the Institute of Geological Sciences of the University of Wrocław.

The plants, preserved exclusively in the form of impressions, occur in a horizon of grey clays at a depth of 0—90 cm, above a brown coal seam. The accumulation

is so abundant that the clays give the impression of being interspersed with shoots of conifers, and the leaves lie densely on each other. No distinct regularity was observed in their arrangement in the sediment.

DESCRIPTION OF FOSSIL FLORA

The impressions of leafy twigs of *Glyptostrobus europaeus* (Brongn.) Ung. and isolated seed cones of this species predominate (Pl. II). *Taxodium dubium* (Sternb.) Heer, with the needles arranged on one plane (Pl. I, II), comes second numerous as regards plant remains and is accompany by abundant concentrations of *Glyptostrobus*. Male inflorescences of *Taxodium* were also found.

The remains of angiosperms are much less numerous than those of conifers. These are small, often impossible to determine, fragments of leaves, and from among the more complete specimens eleven taxa were differentiated (Table 1).

The abundant occurrence of plant remains, and the limited taxonomic variety, point to the autochthonous origin of the flora.

DESCRIPTION OF VEGETATION

The dominant plant community was a coniferous forest growing on the marshy bank of a body of water in which clays accumulated. Both dominant tree genera, i.e. *Taxodium* and *Glyptostrobus*, today grow on marshes or periodically submerged areas. The conifers were accompanied by a few deciduous trees and shrubs of the genera *Populus*, *Salix* and *Vaccinium*. Damp habitats were also occupied by trees of *Acer*, *Fraxinus* and *Phellodendron* and twining shrubs of *Periploca* and *Vitis* which today occur in the shady, humid forests of river valleys. The genera *Clerodendrum*, *Photinia* and *Prunus* were probably connected with the same type of habitat. Herbaceous plants also grew there, chiefly, *Phragmites*, growing on the waterside.

Most genera determined in the flora from Mirostowice are now deciduous plants connected with temperate and warm temperate climates. Besides *Taxodium*, the genera *Photinia*, ranging presently over South-East Asia, and *Clerodendrum*, with its centre of occurrence in the same area, represent a more thermophilous element. Today *Glyptostrobus* and *Phellodendron* only occur in Asia, and *Prunus* and *Periploca* also seems to be related to East-Asiatic representatives of these genera. *Taxodium dubium* (Sternb.) Heer, *Fraxinus praedicta* Heer and *Vitis strictum* (Goepp.) Knobl. belong to the North-American element.

COMPARISON OF LEAF FLORAS FROM POZNAŃ CLAYS

The results of studies on the flora from Mirostowice complement the knowledge of the fossil vegetation known from the area of occurrence of Poznań clays.

Table 1

The list of identified fossil plants remains from Mirostowice Dolne

Names of plants	Number of specimens
Taxodiaceae	
1. *Taxodium dubium* (Sternb.) Heer	∞
2. *Glyptostrobus europaeus* (Brongn.) Ung.	∞
Salicaceae	
3. *Salix* sp. div.	5
4. *Populus mutabilis* Heer	1
Rosaceae	
5. *Prunus microserrata* n. sp.	8
6. *Photinia szaferi* n. sp.	139
Rutaceae	
7. *Phellodendron* cf. *amurense* Rupr.	2
Aceraceae	
8. *Acer* sp.	2
Vitaceae	
9. *Vitis strictum* (Goepp.) Knobl.	5
Ericaceae	
10. *Vaccinium pseudouliginosum* Krysht.	1
Verbenaceae	
11. *Clerodendrum silesiacum* n. sp.	9
Asclepiadaceae	
12. *Periploca* sp.	1
Oleaceae	
13. *Fraxinus praedicta* Heer	5
Gramineae	
14. *Phragmites oehningensis* A. Br.	79
Monocotyledones indet.	88

They merit attention since the locality of Mirostowice is situated in the westernmost part of the sedimentational basin of the Poznań series. Three leaf floras are known from its central part: Koronowo (Menzel 1910), Chodzież (Zabłocki 1924) and Konin (Raniecka-Bobrowska 1954). The fourth locality at Zielona Góra, examined by Engelhardt (1892), lies closest to Mirostowice (Fig. 1).

In all these localities, plant remains occur in clays lying directly above a brown coal seam. They are considered to be the initial phase of sedimentation of the Poznań series in the vast, midland water reservoir, dated as Upper Miocene (Quitzow 1953). The Upper Tortonian is accepted for the horizon of grey clays with the flora from Mirostowice (Dyjor & Sadowska 1977; Sadowska 1977).

A characteristic feature of the above-mentioned fossil floras, and this also includes the flora from Mirostowice, is the scantiness of specific composition in conjunction with mass occurrence of the plant remains of particular taxons. This is connected with the autochthonous origin of these floras the remains of

which found their way into the sediment from plants growing *in situ* or in direct proximity to the place of sedimentation. Thus the composition of floras reflects local plant communities though the amount of preserved fossil remains does not always define the part played in them by particular taxons. In the main, the

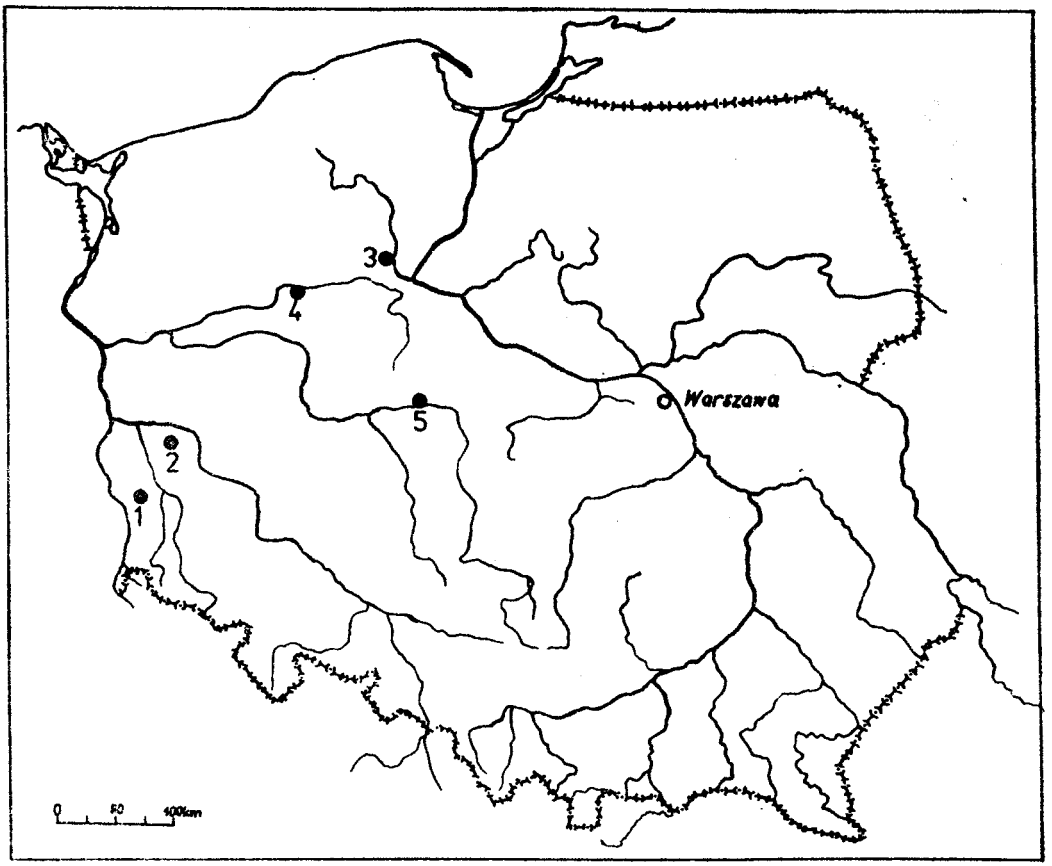

Fig. 1. Map of distribution of localities of leaf floras from Poznań clays: 1 — Mirostowice Dolne, 2 — Zielona Góra, 3 — Koronowo, 4 — Chodzież, 5 — Konin

domination of only two genera of trees: *Glyptostrobus* and *Alnus* in the floras under comparison, seems to be beyond doubt (Table 2). In these fairly homogenous forest communities of very humid habitats, it was only trees and shrubs of the *Salicaceae* and *Betula* that appeared more frequently. In forests of the western part of the sedimentational basin of Poznań clays, *Glyptostrobus* also dominates, *Salicaceae* are present, whereas no representative of the family *Betulaceae* was found and this also includes *Alnus* which is replaced by *Taxodium*. The picture of vegetation is enriched by the taxons unknown from other localities of this age (*Fraxinus praedicta* Heer, *Periploca* sp., *Phellodendron* cf. *amurense* Rupr., *Vitis strictum* (Goepp.) Knobl.) or those hitherto unknown in Poland's fossil floras (*Clerodendrum silesiacum* n. sp., *Photinia szaferi* n. sp., *Prunus microserrata* n. sp., *Vaccinium pseudouliginosum* Krisht.).

Table 2

The most numerous plants and those appearing repeatedly in most localities of fossil floras of Poznań clays (excluding *Monocotyledones*)

Locality / Names of taxons	Mirostowice	Zielona Góra	Koronowo	Chodzież	Konin
Glyptostrobus	+++	+++	—	+++	+++
Taxodium	+++	—	—	—	—
Alnus	—	+	+++	+++	+++
Betula	—	+	+	+	+
Salix	+	+	—	+	—
Populus	+	—	+	+	+++
"Ficus" tiliaefolia A. Br.	—	+++	+++	—	—
Photinia	+++	—	—	—	—

TAXONOMICAL DESCRIPTION OF SOME PLANT REMAINS *

Family *Rosaceae*

Prunus microserrata n.sp.

Pl. III, 2, 3; Fig. 2, *1—3*

Holotypus: specimen No 132/65, Pl. III, 3; Museum of the Institute of Botany of the Polish Academy of Sciences, Cracow
Locus typicus: Mirostowice Dolne, Lower Silesia
Stratum typicum: Poznań clays, lewel of grey clays, Upper Tortonian
Derivatio nominis: from very finely serrate margins of leaves

Diagnosis. Leaves of narrow elliptic shape, apex acute or attenuate, base cuneate, entire, petiole 1 cm long. Leaf margins serrate, teeth very small, with glands. Nervation brochidodromous. Secondary veins numerous, arranged irregularly, intersecondary veins present. Tertiary veins oblique in relation to the primary vein.

Material. Eight specimens, including four with twin impressions.

* Descriptions of leaves in accordance with the terminology suggested by Hickey (1973).

Description. Leaves of narrow elliptic shape, with cuneate base, narrowing upwards into an acute or attenuate apex. The size of the whole leaf: 7·3 cm in length and 2·9 cm in width, the length of petiole 1 cm, the width — 1 mm. The length of the leaves preserved on the remaining specimens is unknown, their width amounts to 2·2—2·8 cm. The margins of the leaves within the base entire, higher up — serrate. Teeth relatively widely distributed, very small, with traces of glands at the ends of branches of veins running into the teeth. Nervation brochidodromous. Primary vein straight, stout in the lower and middle parts of the leaves. The number of pairs of secondary veins amounts to 15, their arrangement is irregular, especially within the base. Secondary veins diverge from the primary vein at different intervals and angles (33—65°), the smallest angles being those of the lowest and the highest pairs of secondary veins. The course of secondary veins curved, especially in the apical part of the leaves. They are connected with each other by arches, distant from the margins of the leaves, besides, distinct tertiary arches are visible, from which diverge small, curved branches of veins towards teeth and small loops, at the very margin of the leaves. There are composite intersecondary veins. Tertiary veins percurrent, are simple or branched, generally sinuous and run obliquely in relation to the primary vein. Quaternary veins in the form of an irregular network, in the meshes of which there are quinternary veins visible here and there.

Remarks. From the Miocene of Poland leaves of three fossil species of *Prunus* are known: *P. hartungi* Heer (Menzel 1910), *P. zeuschneri* Ung. (Unger 1849; Ilinskaya 1964) and *P. sambucifolia* Menzel (Kownas 1956), all of which differ from the specimens of flora studied, and have no glands on the ends of the teeth. Besides, the leaves of *Prunus hartungi* Heer are much smaller, of ovate shape and have less numerous secondary veins, but larger teeth on the margins. The second species — *Prunus zeuschneri* Ung. — has leaves of similar shape but secondary veins are less numerous (8 pairs) and the margins are crenate — dentate and not serrate. The arrangement of tertiary veins is also different. These veins run vertically to the primary vein, as in *Prunus sambucifolia* Menzel, the third of the taxons comparied. The leaves assigned to this fossil species are elliptic, and the teeth on the margins are more closely placed, larger and curved upwards.

The majority of remains of *Prunus* leaves have been found in the Tertiary floras of Northern America (Brown 1962; Axelrod 1966; Becker 1960, 1966, and others) and the Neogene of Asia (Tanai 1961, 1976; Tanai & Suzuki 1963, and others). However, as a rule, they have larger and more distinct teeth on the margins. This is true also of the species known from fossil floras of Europe, i.e. *Prunus acuminata* A. Br. (Heer 1859, Pl. 132, fig. 7 [1]), *P. marchica* Menzel

[1] The second specimen of the leaf of the same flora (Pl. 130, Fig. 23) has very finely serrate margins and smaller teeth than in recent species of *Prunus* (Heer l.c., p. 95).

(Menzel 1906), *P. nanodes* Ung. (Berger 1957), *P. laeta* Pim. (Pimenova 1954), *P.* cf. *cerasus* L. (Andreánszky 1959), *P. palaeocerasus* Ett. (Krishtofovich & Baykovskaya 1965). Moreover, the nervation of their leaves is different in character and they are unlike specimens from Mirostowice in the shape and number of veins.

The only species, similar to *Prunus microserrata* n. sp. is *P. pereger* (Ung.) Laurent from the Pliocene of France (Laurent 1904—1905). The leaves are of the same shape and size, have intersecondary veins, a similar course of tertiary veins and entire base. Still higher up, the teeth are, however, big, curved upwards and without glands [2].

From among other fossil species only one — *Prunus microdonta* Boulay (Boulay 1887; Grangeon 1958) — has finely serrate leaves, with marginal glands. However, it differs from *P. microserrata* n. sp. in the presence of acropetiolar glands, serrate base of the leaves, somewhat different shape and nervation of leaves (comp. Grangeon 1958, Text-fig. 40, fig. 2).

The presence of very small teeth on the margins of the leaves is characteristic of *Prunus serrulata* [3], described by Heer (1878) from the Miocene of Sakhalin and also found later in the Miocene of Kazakhstan (Schmalhausen 1887). Leaves of this species, with entire base and oblique arrangement of tertiary veins in relation to the primary vein, have much less numerous secondary veins. Data on the glands is lacking.

Since the leaf remains from Mirostowice differ from the hitherto described fossil taxa of this genus, they have been recognized as a new fossil species, which, in consideration of the character of the formation of the leaf margins links to section *Mahaleb* L. in the subgenus *Cerasus* Pers. However the fossil species differ in shape and size from contemporary representatives of this section (*P. mahaleb* L., *P. pensylvanica* L., *P. emarginata* (Hook.) Walp.). Only one species, North-American *Prunus prunifolia* (Greene) Shafer (= *Cerasus pattoniana* Hort., *Prunus mollis* Walp.) — judging by description — has leaves of similar shape and size (up to 8 cm in length) (Rehder 1949).

Occurrence in fossil floras of Poland. Endocarps of *Prunus*, compared to *P. mahaleb* L., were reported from the Sarmatian flora of Stare Gliwice (Szafer 1961).

Photinia szaferi n. sp.

Pl. IV, 1—4, fig. 2, *5*

Holotypus: specimen No 132/160, Pl. IV, 2; Museum of the Institute of Botany of the Polish Academy of Sciences, Cracow

[2] *Prunus pereger* (Ung.) Laurent is, according to Laurent (1904—1905), synonymous for *Amygdalus pereger* Ung. This species, described by Unger (1850) from the fossil flora of Sotzka and also reported from other fossil floras (e.g. Oehningen, Heer 1859) has leaves of a different morphological character from those of the genus *Prunus*. Hence, it may be regarded as incorrect to change its generic name.

[3] The use of the name "*serrulata*" is incorrect, since it belongs to the recent species *Prunus serrulata* Lindl.

Locus typicus: Mirostowice Dolne, Lower Silesia
Stratum typicum: Poznań clays, level of grey clays, Upper Tortonian
Derivatio nominis: In honour of the distinguished Polish paleobotanist Prof. Dr. Władysław Szafer

Diagnosis. Leaves of very narrow elliptic shape, oblanceolate or narrow oblanceolate, apex attenuate, base cuneate, entire. Margins of the leaves finely serrate, with marginal glands. Nervation brochidodromous. Primary vein stout. Secondary veins numerous, on the outside of secondary arches numerous tertiary arches in the form of irregular rectangles, the longer sides of which are vertical to the leaf axis. Small branches of veins run into the teeth or sinuses between them. There are composite intersecondary veins. Tertiary nervation orthogonal reticulate.

Material. 139 specimens of leaf fragments, 34 of which with twin impressions.

Description. The shape of the leaves is from very narrow elliptic to oblanceolate or narrow oblanceolate. Apex of the leaves attenuate, base cuneate, slightly decurrens. The dimensions of the leaves range from (2·7) 5 to 9·7 cm in length and (0·7) 1 to 2·5 cm in width. Margins within the base entire, finely serrate higher up, large glands are visible at the end of the teeth (fig. 2, 5'). Nervation brochidodromous. Primary vein straight, stout. Secondary veins, much thinner than the primary, diverge from it at rather irregular intervals at an angle of 50—55°, with the exception of the lowest pairs, for which the angle is smaller and amounts to 40—45°. At first, they are almost straight, nearing the margins of the leaves curve strongly upwards and are connected with each other by arches. On the outside of the arches, formed by secondary veins, there are tertiary arches, usually in the form of slightly irregular rectangles, the longer sides of which are vertical to the primary vein. There are also frequently quaternary arches (Pl. IV, 1, 3a). From the arches, small branches of veins diverge into sinuses between the teeth or into the teeth, ending there in glands. There occur composite intersecondary veins. Tertiary nervation orthogonal, reticulate, quaternary nervation is distinctly visible and, in places, quineternary nervation.
Remarks. The general type of the nervation of the specimens found is peculiar to leaves of *Rosaceae*, the arrangement of secondary and tertiary veins and the formation of the margins of the leaves are characteristic of the genus *Photinia*. Leaves of recent species of this genus are in the main elongate, and, on the margins, if there are teeth, they have distinct, large glands at the ends. The formation of primary veins which distinctly project above the lower surface of the leaves and are visible only from the below, is characteristic. This is also visible in specimens from Mirostowice, which are impressions of the lower side of the leaves. A trace of the primary vein appears as a deep hollow circular in section (Pl. IV, 3a).

Of the contemporary species comparised [4] the leaves of Japanese *Photinia*

[4] *Photinia arbutifolia* Lindl., *Ph. laevis* DC., *Ph. laevis* DC. var. *villosa* Koidz., Ph. *serrulata* Lindl. and *Ph. glabra* (Thunb.) Maxim.

glabra (Thunb.) Maxim. (Pl. IV, 5) are similar to the fossil specimens, though they have wider angles between the primary and secondary veins and a distinctly different character of arches at the margins. Perhaps, Chinese *Ph. beauverdiana* Schneid. [5] is a related species, its leaves are 5—13 cm long, narrow obovate to narrow elliptic, have attenuate apices, 8—14 pairs of secondary veins and very fine, adpressed, serrate margins, with glands at the ends of the teeth (Krüssmann 1977). However, the leaves of an other Chinese species *Ph. davidsoniae* Rehd. & Wils., have the most similar nervation. Moreover, they always have, as *Ph. szaferi* n. sp., a cuneate base, the shape of leaves is oblanceolate to narrow elliptic, but they are somewhat longer (8—14 cm) and have acute apices (Krüssmann l.c.).

The genus *Photinia* in fossil state is known from a few localities of Tertiary floras, exclusively in the form of leaf impressions. From the Lower Miocene of Radoboj Ettingshausen (1870) described *Photinia europaea*, an other species comes from the Middle Miocene flora of Leoben (Ettingshausen 1888). Two species: *Ph.* cf. *integrifolia* Lindl. and *Ph. kodorica* Kol. (Kolakovski 1957, 1959) are known from the Pliocene of the Caucasus. The first of them has entire leaves, the second, in comparison with the specimens from the Mirostowice, has much longer leaves (12—13 cm), margins finely serrate, without glands, and a similar angle of divergence of secondary veins from the primary vein (40°). According to Kolakovski (1959) *Ph. kodorica* Kol. is similar to a contemporary, Chinese species *Ph. serrulata* Lindl. Chelidze (1967, 1970) connects the specimens of leaves from the Sarmatian of southern Georgia with the same recent species. The specimens of leaves from Mirostowice differ also in shape and size from *Ph. acuminata* Baik., described from the Sarmatian flora of Krynka (Krishtofovich & Baykovskaya 1965), reported later from the Pliocene of Roumania (Givulescu & Olos 1973). In the specimens of this species no glands are visible on the margins of the leaves.

Occurrence in fossil floras of Poland. A genus hitherto not reported.

Family *Rutaceae*

Phellodendron cf. *amurense* Rupr.

Fig. 2, *4*

1955. cf. *Phellodendron amurense* Rupr., W. Berger, Die altpliozäne Flora des Laaerberges in Wien, p. 103, figs. 150, 151

1959. *Phellodendron* cf. *amurense* Rupr., G. Andreánszky, Die Flora der sarmatischen Stufe in Ungarn, p. 150, figs. 172, 173: Pl. 44, fig. 9; Pl. 45, fig. 2

Material. Fragments of two leaflets preserved in twin impressions.

Description. A greater specimen is a part of a slightly asymmetrical leaflet of narrow obovate shape, probably entire, with damaged base and apex, 5·5 cm

[5] *Photinia beauverdiana* Schneid. grows at the present time in China, in Mixed Mesophytic Forest together with *Fagus longipetiolata, Acer cinnamomifolium, Alniphyllum fortunei, Carpinus turczaninovii, Carya cathayensis, Castanopsis tibetana, Liquidambar formosana, Nyssa chinensis, Quercus, Schefflera, Cupressus, Cephalotaxus,* and others (Wang 1961).

in length and 2·8 cm in width. Nervation brochidodromous, irregular. Primary vein straight, stout. Secondary veins much thinner than the primary, depart from it at irregular intervals at the angles of 55° in the lower and 75° in middle parts of the leaflets; they are slightly arcuately bent, sinuous, and sometimes branched, connected by arches or bent veins of another order. There are intersecondary, simple and composite veins of different length. Tertiary veins, clearly visible on the second specimen form an irregular network.

Remarks. The most characteristic feature of leaflets of *Phellodendron*, present in the specimens found, is an irregular nervation of the secondary and tertiary orders and the ratio of the width of the secondary to the primary vein. The shape of the leaflets, with a slightly marked asymmetry, their size, the number of secondary veins and the angle of divergence correspond to the characteristics of specimens of cf. *Phellodendron amurense* Rupr. from the Pliocene flora of Laaerberges (Berger 1955). Remains of the same type also occur in the Hungarian Sarmatian (Andreánszky 1959).

So far, two fossil species of leaflets have been described: *Phellodendron grandifolium* Ilinsk. from the Oligocene of Kazakhstan (Ilinskaya, in Krishtofovich 1956) and *Ph. mioamurense* Tanai & Suzuki from the Miocene of Japan (Tanai & Suzuki 1963, 1965; Tanai 1971). The former generally has larger leaflets, with a wide scale of shape variability and differently shaped margins (entire, crenate or serrate). *Ph. mioamurense* Tanai & Suzuki resembles more the remains of the Miocene of Europe.

Numerous seeds of this genus are known from fossil floras of Europe and Asia (Japan). They also occur in the Pliocene of Poland from which two species, *Ph. amurense* Rupr. *fossilis* and *Ph. japonica* Max. have been described (Szafer 1947).

The occurrence area of *Ph. amurense* Rupr. covers Korea, Manchuria, northern China, the region of the Ussuri and the Amur rivers and Japan. This deciduous tree grows in river valleys and on the slopes of small elevations up to an altitude of 300—400 m a.s.l. as an admixture in deciduous and mixed forests. Species with limited requirements as regards temperature (Nechaev 1967).

Occurrence in fossil floras of Poland. Hitherto unknown leaf remains. Seeds of *Ph. amurense* Rupr. *fossilis* occur in the Pliocene floras of Krościenko and Mizerna (Szafer 1947, 1954), *Phellodendron* sp. in the Pliocene of Domański Wierch and the Miocene of Wieliczka (Łańcucka-Środoniowa 1963). The pollen grains of *Phellodendron* was determined in the Sarmatian deposits of Stare Gliwice (Oszast 1960).

Family *Vitaceae*

Vitis strictum (Goepp.) Knobl.

Pl. V, 1; fig. 2, *6*

1855. *Acer strictum* Goepp., H. Goeppert, Die tertiäre Flora von Schossnitz in Schlesien, p. 35, Pl. 23, figs. 1—5

1969. *Vitis strictum* (Goepp.) n. comb., E. Knobloch, Tertiäre Floren von Mähren, p. 125, fig. 269; Pl. 64, fig. 9

Material. Five fragments of leaves, three leaves with twin impressions.

Description. The specimens are parts of several-lobed leaves, with preserved fragments of the middle and narrow lateral lobes, attenuate at the ends. Leaves

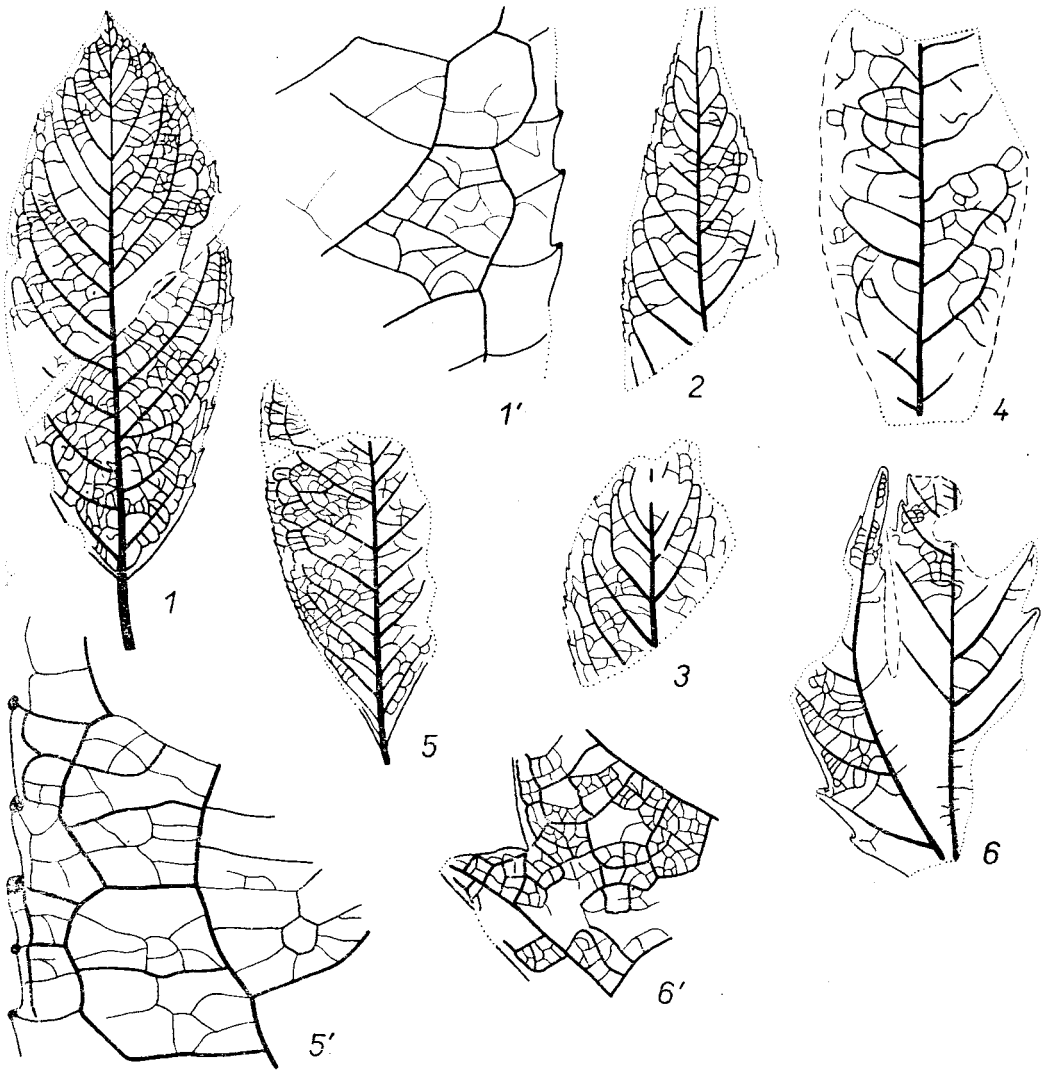

Fig. 2. *Prunus microserrata* n. sp.: *1* — specimen No 132/65+66, picture of the leaf from both twin impressions, *1'* — fragment of nervation and leaf margin from the specimen No 132/66, × ca. 6, *2* — specimen No 132/26, *3* — specimen No 132/23; *Phellodendron* cf. *amurense* Rupr.: *4* — specimen No 132/43+44, picture of the leaflet from both twin impressions; *Photinia szaferi* n. sp.: *5* — specimen No 132/61, *5'* — fragment of nervation and leaf margin from the specimen No 132/61, × ca. 6; *Vitis strictum* (Goepp.) Knobl.: *6* — specimen No 132/57+58, picture of the leaf from both twin impressions, *6'* — fragment of leaf nervation in enlargement from the specimen No 132/58, × ca. 3

of medium size, about 6 cm in width, one specimen is a part of a large leaf, of ca. 10 cm in width. Margins of leaves irregularly dentate. Several preserved teeth of various size are fairly wide and obtuse. The apical angles of the teeth are acute, basal sides convex, apical sides straight or concave. Nervation actinodromous, veins of particular orders of distinctly differentiated width (Fig. 2, *6'*). Primary vein of the middle lobe straight, that of lateral lobes strongly curved. The angle between them equals 43°. Secondary veins depart from primary veins at an angle of 40—50°, ending in teeth. Tertiary veins at the margins of leaves arranged in regular loops, the remaining together with the quaternary and quinternary veins form a distinct, irregular network.

Remarks. The characteristically lobed and dentate leaves belong to a fossil taxon *Vitis strictum* (Goepp.) Knobl., a synonym for the name *Vitis teutonica* A. Br., according to Knobloch (1969), used incorrectly for leaf remains. Excellently preserved specimens of whole leaves of this species have been presented in Goeppert's paper (1855) on the fossil flora of Sośnica.

The species is known in the floras of the Upper Miocene and the Pliocene of Europe. The remains of leaves and of seeds, described as *Vitis teutonica* A. Br. occur, among other areas, in the Miocene of Lower Lusatia (Menzel 1906, 1933), the Upper Miocene of France (Grangeon 1958), the Sarmatian of Slovakia (Sitár 1969), Hungary (Andreánszky 1959), Roumania (Givulescu & Ghiurca 1969), Moldavia (Yakubovskaya 1955) and Ukraine (Pimenova 1954; Ilinskaya & Shvareva 1961) as well as the Pliocene of Moravia (Knobloch 1969) and Austria (Berger 1955). The oldest localities are situated in northern Czechoslovakia (Oligo/Miocene and Lower Miocene, Knobloch l.c.; Bůžek, Holý & Kvaček 1976).

Vitis vulpina L. from the Atlantic part of North America is a contemporary species related to *Vitis strictum* (Goepp.) Knobl. The high climbing vine grows in shady forests, and river valleys (Sokolov 1958).

Occurrence in fossil floras of Poland. The leaves, described as *Acer strictum* Goepp. are known from Sośnica (Goeppert 1855; Meyer in Kräusel 1919), by the name of *Vitis teutonica* A. Br. from Chłapowo (Heer 1869), Piersuszów and Ruprechtów (Kräusel 1920). The seeds of *Vitis teutonica* A. Br. were found in Nowogrodziec and Wilgancice (Kräusel 1920), Stare Gliwice (Szafer 1961), Rypin, Chyżne and Domański Wierch (Łańcucka-Środoniowa 1957, 1963).

Family *Ericaceae*

Vaccinium pseudouliginosum Krysht.

Fig. 3, *2*

1965. *Vaccinium pseudouliginosum* Krysht., A. N. Kryshtofovich & T. N. Baykovskaya, Sarmatskaya flora Krynki, p. 117, fig. 38; Pl. 35, fig. 8

Material. One impression of a leaf fragment.

Description. Leaf entire, probably of obovate shape, with rounded apex and cuneate base. The length of the fragment amounts to 1·6 cm, the greatest width — 1·3 cm. Nervation brochidodromous. Primary vein straight, relatively distinct, secondary veins thinner, irregularly arranged, diverge from it at an angle of

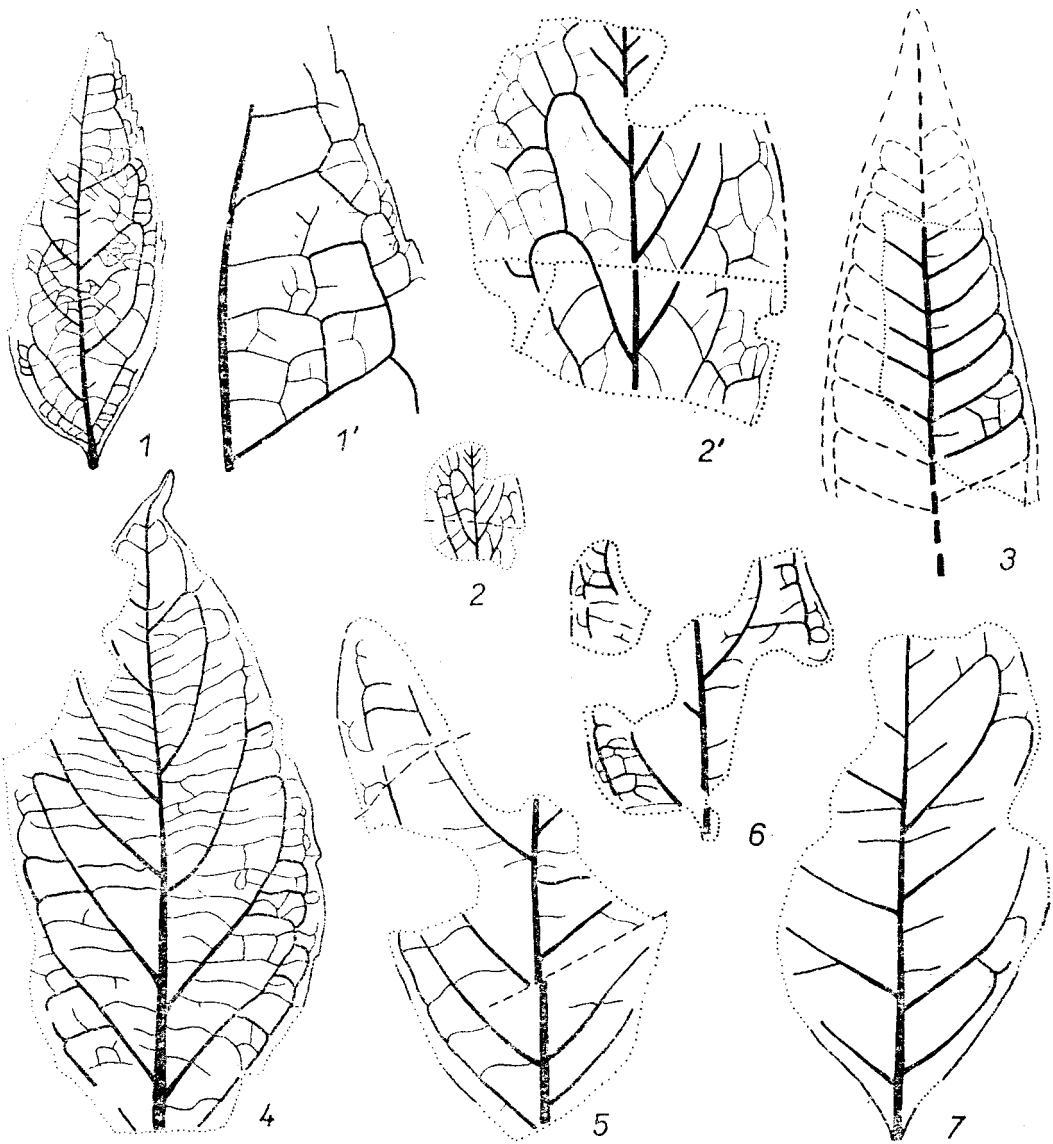

Fig. 3. *Fraxinus praedicta* Heer: *1* — specimen No 132/59+60, picture of the leaflet from both twin impressions, *1'* — fragment of nervation and leaflet margin from the specimen No 132/59, × ca. 3; *Vaccinium pseudouliginosum* Krysht.: *2* — specimen No 132/1, *2'* — picture of the leaf enlarged, × ca. 3; *Periploca* sp.: *3* — specimen No 116a, the reconstruction of a leaf fragment; *Clerodendrum silesiacum* n. sp.: *4* — specimen No 132/233+234, picture of the leaf from both twin impressions, *5* — specimen No 132/250, *6* — specimen No 132/87, *7* — specimen No 132/28+84, picture of the leaf from both twin impressions

28—40°. They are sinuous, connected with each other by arches, at a fairly long distance from the margin of the leaf. Tertiary veins, in the middle part of the leaf, directly connect secondary veins and are obliquely arranged in relation to the primary vein. The veins of the same order, diverging from the arches of secondary veins towards the margins of the leaves, form together quaternary veins an irregular network.

Remarks. Leaf nervation, clearly visible in the fossil specimen, permitted determination of *Vaccinium pseudouliginosum* Krysht., a taxon described from the Sarmatian flora of Krynka (Kryshtofovich & Baykovskaya 1965), close to the contemporary *Vaccinium uliginosum* L. (Pl. V, 4). The specimen from Mirostowice also resembles leaf remains from the Pliocene of Sofia, called *V. uliginosum* L. (Stoyanoff & Stefanoff 1929). Several localities of *V. uliginosum* L. *fossilis* are also known from the Pliocene of France (Saporta & Marion 1872; Laurent 1904—1905).

Low shrubs of *V. uliginosum* L. today grow on marshes, peat-bogs, and in damp forests, on lowland and in mountains of the whole northern hemisphere. Occurrence in fossil floras of Poland. The species hitherto not reported. Seed of *Vaccinium* was found in Upper Miocene sediments in Gozdnica, Lower Silesia (Stachurska *et al.* 1971).

Family *Verbenaceae*

Clerodendrum silesiacum n. sp.

Pl. V, 1, 2, fig. 3, *4—7*

Holotypus: specimen No 132/233, Pl. V, 1; Museum of the Institute of Botany of the Polish Academy of Sciences, Cracow
Locus typicus: Mirostowice Dolne, Lower Silesia
Stratum typicum: Poznań clays, level of grey clays, Upper Tortonian
Derivatio nominis: from the name of the Silesian region

Diagnosis. Leaves narrow obovate or elliptic, apex acuminate, base cuneate, decurrent, on the margins sparse teeth or margins entire. Nervation camptodromous. Secondary veins at first straight, their further course sinuous and directed abruptly upwards. Tertiary veins, in general very distinct, separate elongate, irregular rectangles, vertical to the leaf axis. They are connected at the margins of the leaf by arches decreasing in size.

1972. *Cornus* sp., E. Zastawniak, Pliocene leaf flora from Domański Wierch near Czarny Dunajec (Western Carpathians, Poland), p. 52, Pl. 12, *7*, Pl. 28, *1*, *1a*

Material. Nine specimens, including two with twin impressions.

Description. The best preserved leaf is of narrow obovate shape, acuminate apex and the size of ca. 9·5 cm in length and 4·2 cm in width. Two specimens are probably fragments of elliptic leaves, ca. 4·5 cm wide, and one is a part of a wider leaf (ca. 6 cm). Base of the leaves cuneate, slightly decurrent. The

margins of the leaves, undamaged on short segments, are entire. On one specimen, approximately in the middle of the leaf, there remained a single tooth, fairly wide and obtuse, with a short vein. Primary vein almost straight, stout in the lower part of the leaf (ca. 1·5 mm wide), much thinner from the second half of its length upward. Secondary veins, six pairs, diverge alternately from the primary vein at fairly regular intervals at an angle of 45—50°. They are straight and fairly distinct only near the primary vein, in their further course become thinner and curved upwards at an acute angle. The points of connections with tertiary veins are indicated by a distinct bend in secondary veins. Secondary veins are shorter and thinner at the base of the leaf than the remaining ones. Loop-forming branches joining superadjacent secondary veins at an acute angle. There are also tertiary and quaternary arches. Numerous tertiary veins are no thinner than the terminal segments of secondary veins and are distinctly visible connecting secondary veins with the primary vein or secondary veins with each other forming elongate, irregular rectangles. Tertiary veins, arranged vertically in relation to the primary vein are mostly unbranched and generally sinuous. Here and there finer quaternary veins remained which divide the rectangles formed by tertiary veins into smaller areas. Tertiary and higher order nervation are distinct only in a few specimens which are probably the impressions of the upper side of leaves.

Remarks. Fossil remains of the genus *Clerodendrum* (= *Clerodendron*) have hitherto been known from few Tertiary localities of Europe. Endocarps of this genus have been found in the Lower Pliocene of France (Reid 1923), and two species of leaves have been described by Friedrich (1883) from the Lower Oligocene of Saxony (*Clerodendrum serratifolium* Friedr. and *C. latifolium* Friedr.) [6]. According to Schenk (1890) determination of *C. serratifolium* Friedr. is doubtful. Fossil leaves have craspedodromous nervation, whereas in *C. serratum* Spreng., considered by Friedrich (1883) to be their recent equivalent, just as in other recent species of this genus, it is exclusively captodromous (Pl. V, 3).

Leaves of the majority of the species *Clerodendrum* have palmate nervation, only in a few cases, pinnate, as in *C. silesiacum* n. sp. Secondary veins are always connected by arches, and stout tertiary veins form distinctly separate, rectangular areas, filled with a multi-lateral network of further order (Schenk 1890).

The nervation of leaves of *Clerodendrum* with pinnate-arranged secondary veins (e.g. *C. viscosum* Vent., see photograph of a leaf in "Blatt-Skelete der Dikotyledonen", Ettingshausen 1861, Pl. 31, fig. 6, *C. serratum* Spreng., Pl. V, 3) and that of *C. silesiacum* n. sp. show a considerable degree of similarity. Besides, the general scheme of nervation, the following features are similar: the sinuous course of secondary veins, shape of arches formed by them, arrangement of tertiary veins in the middle part of the leaf and at the margins, character of tertiary and quaternary arches, width ratio of veins of particular orders and

[6] Schenk (1890) mentions leaves of *Clerodendrum* determined by Ettingshausen from the Eocene of Alum Bay. Leaves of *Clerodendrum ovalifolium* Baik. have been described from the Sarmatian flora of Krynka (Kryshtofovich & Baykovskaya 1965).

presence of branches of veins, ending in the teeth on the margins of the leaves. On the other hand, the arrangement of secondary veins is different. In leaves of contemporary species they diverge at a greater angle from the primary vein, and the general outline of leaves and dentation of its margins is also different.

No leaves of identical shape and nervation have been found in the available herbarium materials of species almost exclusively tropical and sub-tropical. The most similar, judging by the pictures of leaves published in "Flora of Kwangchow" (How 1956, p. 633, fig. 338) and in "Iconographia Cormophytorum Sinicorum" (1974, fig. 5148), seems to be a contemporary, Chinese species, *Clerodendrum fortunatum* L. Its leaves are of similar shape, the same base and apex, the margins are also irregularly serrate, and the nervation seems to be identical.

Leaves of *Clerodendrum silesiacum* n. sp., at first glance, have the secondary nervation of leaves of *Cornus* (e.g. *C. walteri* Wanger, *C. alba* L., *C. stolonifera* Michx.). Secondary veins of leaves of *Cornus* are, however, longer, more stout throughout their length, rarely bend and then only in the terminal part, and trace very distinct, long arches. There is a more significant difference in the width of secondary and tertiary veins. In *Cornus* the leaves have much thinner tertiary than secondary veins, therefore, they were not so clearly visible in the impressions. In addition the veins of this order do not form distinct, dense rectangles which are clearly visible in some specimens of *C. silesiacum* n. sp. Besides, the formation of margins is different, always being entire in leaves of *Cornus*.

Thanks to the specimens of *C. silesiacum* n. sp. found in Mirostowice, a fragment of leaf from the Pliocene flora of Domański Wierch was determined, which had been described as *Cornus* sp. (Zastawniak 1972). Characteristics of tertiary nervation (Pl. V, 2) appeared to be identical with those of the leaves of *C. silesiacum* n. sp., and the presence of small branches of veins, directed towards the margin of the leaf, suggests the possibility of the occurrence of sporadic teeth. Since, in the flora of Domański Wierch one leaf fragment, damaged to a considerable degree (lack of the base and apex), was found, the type of species was determined on the basis of an almost complete specimen from Mirostowice.

Paleobotanic literature has not reported leaves of the type *C. silesiacum* n. sp. *C. latifolium* Friedr., it is true, has leaves of a similar arrangement and course of veins, but has big, numerous teeth on the margins. This genus might, however, be represented in the Tertiary of Europe by other species. There is a striking similarity in leaves of *Ficus titanum* Ett., described by Ettingshausen (1867, p. 153, Pl. 22, fig. 12) from Zábrušany, to those of the contemporary, East-Asiatic species *Clerodendrum trichotomum* Thunb. (Pl. III, 1). The leaves of "*Ficus*" *truncata* Heer sensu Bůžek (1971) also have a very similar nervation. It should be added that fossil seeds similar to *C. trichotomum* Thunb. are known from the Pliocene of Japan (Miki 1938).

Species of *Clerodendrum* are small trees or shrubs, frequently climbers, either evergreen or deciduous. About 150 species occur at the present time mainly

in the tropical and sub-tropical zone, with its centre in South-East Asia (Briquet in Engler & Prantl 1897). In Japan and China, some species e.g. *C. trichotomum* Thunb., extend into the temperate zone (Kurata 1968). In China, *C. fortunatum* L. and *C. mandarinorum* Diels also occur — the latter belongs to Mixed Mesophytic Forest at an altitude of 1000—1100 m a.s.l. It grows there together with such species as: *Metasequoia glyptostroboides*, *Cunninghamia lanceolata*, *Castanea sequinii*, *Liquidambar formosana*, *Lindera glauca*, *Meliosma oldhamii*, *Acer davidii*, *Populus adenopoda*, *Nyssa sinensis*, *Taxus chinensis*, *Cyclocarya paliurus*, *Quercus variabilis*, *Cercidiphyllum japonicum*, *Betula luminifera* and *Carpinus laxiflora* (Wang 1961).

Occurrence in fossil floras of Poland. Leaves of this genus have not hitherto been reported. Apart from Mirostowice, they occur in the Pliocene of Domański Wierch, where they have been determined as *Cornus* sp. (Zastawniak 1972). Carpels of *Clerodendrum* sp. cf. *C. trichotomum* Thunb., described by Szafer (1947) from the Pliocene of Krościenko, belong to *Sabia europaea* Czecz. & Skirgiełło (Łańcucka-Środoniowa 1971, unpublished; Gregor 1975).

Family *Asclepiadaceae*

Periploca sp.

Fig. 3, *3*

Material. One leaf fragment with a twin impression (specimen from the Museum of the Institute of Geological Sciences, University of Wrocław).

Description. The upper part of elongate, entire leaf, ca. 3 cm wide, narrowing towards the apex. Nervation brochidodromous. Primary vein stout. Relatively thick secondary veins run parallel to each other, are slightly curved and diverge from the primary vein at 4—6 mm intervals at an angle of 63—68°. Secondary veins are connected with each other by means of regular arches, which form a distinct, slightly curved intramarginal vein, at a distance of 1 mm from the leaf margin. There are simple, short and very fine intersecondary veins. Nervation of further orders almost invisible.

Remarks. The specimen found resembles most leaves of the contemporary East-Asiatic species *Periploca sepium* Bunge (Pl. V, 6). They are of lanceolate to oblong-lanceolate shape, long-acuminate apex, base cuneate or cuneate-rounded. Their size is: 4—10 cm in length and 1·5 cm — 2·5 cm in width (Sokolov 1962), therefore, they are somewhat thinner leaves. There are 24 pairs of secondary veins, diverging from the primary vein at 2—5 mm intervals at an angle of 60—70°.

A fossil species, compared among others to this contemporary taxon, is *Periploca krishtofovichii* Kornilova from the Lower Miocene Kushuk flora in Kazakhstan (Kornilova 1960). In comparison with the specimen from Mirostowice, the leaves of *P. krishtofovichii* Kornilova are somewhat narrower

(up to 2·4 cm), secondary veins diverge from the primary vein at a greater angle (65—75°), besides, there occur numerous intersecondary stout veins, not thinner than secondary veins.

A similar type of nervation was noted in leaves, defined as "*Ficus*" *multinervis* Heer. They are characterized by a regular, parallel system of secondary veins the arched endings of which form a distinct intramarginal vein at a small distance from the margins of the leaves. Their shape is lanceolate or ovate, base rounded or cuneate, apex attenuate. The length of the leaves amounts to 12 cm, and the width to 4 cm (Bůžek 1971). This fossil species, described by Heer (1856) from the Miocene of Switzerland, has been included to the genus *Ficus* in consideration of the similarity of its leaves to those of some contemporary species, e.g. *Ficus elastica* Roxb., *F. parasitica* Schott (Heer 1856; Ettingshausen 1867). A similar type of nervation is also found in the leaves of some genera of the family *Apocynaceae*, *Myrtaceae* and, especially, *Asclepiadaceae* (Rüffle 1963; Bůžek 1971). A marked concurrence of morphological characteristics becomes apparent when they are compared with leaves of the genus *Periploca* which was reported by Rüffle (1963) who found single specimens of this type in the Sarmatian flora of Randecker Maar. The remains of leaves of "*Ficus*" *multinervis* Heer from the Lower Miocene flora of Čermníky in the North-Bohemian Basin (Bůžek 1971) are also similar. It should be mentioned out that in the Bohemian Basin they as a rule accompany fossil communities of marshy and water plants (Bůžek l.c.).

Another taxon, representing probably the genus *Periploca*, is *Apocynophyllum helveticum* Heer from the Miocene of Chłapowo (Heer 1869, p. 88, Pl. 26, figs 12—14). The size of the leaves, their shape and character of nervation are similar to those in *P. sepium* Bunge. Leaves of *Apocynophyllum elongatum* Heer from the Miocene of Chłapowo (Heer l.c.), on the other hand, seem to approach another East-Asiatic species *Periploca calophylla* Falc., because of its more numerous and denser secondary veins.

Periploca sepium Bunge is a twining, deciduous shrub, growing in forest of the river valleys of northern China, Manchuria and partially, Mongolia (Sokolov 1962).

Occurrence in fossil floras of Poland. The genus hitherto not reported, probably present in the Miocene of Chłapowo as *Apocynophyllum helveticum* Heer and *A. elongatum* Heer (Heer 1869).

Family *Oleaceae*

Fraxinus praedicta Heer

Fig. 3, *1*

1859. *Fraxinus praedicta* Heer, O. Heer, Flora tertiaria Helvetiae, p. 22, Pl. 104, fig. 13

Material. Five impressions of leaflets or their fragments, including one with twin impression.

Description. The most complete specimen is the impression of a leaflet of narrow elliptic shape with a damaged apex. Leaflets slightly asymmetric at the

base, is widest in the lower half. Petiole of the leaflet damaged, its visible fragment is 1·5 mm wide. The leaflet is ca. 6 cm long (the length of the preserved fragment — 5·5 cm) and 2 cm wide. The width of the remaining leaves ranges from 1·8 to 2·3 cm. The margins of the leaflets within the base entire or serrate, fairly regularly serrate higher up. Teeth at intervals of ca. 2·3 mm, very small, rounded at the ends and directed upwards. The apical sides of the teeth (0·3 mm long) and basal sides are convex, sinuses angular. Nervation brochidodromous. Primary vein more or less straight, in the lower part of the leaflets 0·5 mm wide, much thinner higher up. Secondary veins 6 (7) pairs angles of 37—40° with the primary vein at the base, and up to 60° in the upper part of the leaflets. They diverge from the primary vein at irregular intervals, mostly opposite, and are connected with each other by arches, remote from the margins of the leaflets. On the outside of the secondary arches there are tertiary arches, from which small branches of veins diverge running into the sinuses between the teeth or in the teeth. There are also intersecondary veins. The nervation of the third order is irregular, in the form of a network of polygons, filled with a network of quaternary veins (Fig. 3, *1'*).

Remarks. The characteristics distinguishing leaflets of the genus *Fraxinus* are as follows: an irregular arrangement of secondary and tertiary veins, the presence of the endings of veins in sinuses between the teeth and smaller angles between the primary vein and secondary veins in the lower part of the leaflets and larger in the middle and upper parts. A slight asymmetry of the leaflets, very small, blunt teeth and flat arches of secondary veins, removed from the margins of the leaflets are characteristic of the genus *Fraxinus praedicta*, described by Heer (1859) from the Miocene of Oehningen. The only specimen of an almost whole leaflet from Mirostowice is nearly identical with the leaflet presented in Heer's paper in Pl. 104, fig. 13f. The same fossil species occurs, according to Kornilova (1960), in the Lower Miocene flora of Kushuk. A special characteristic of the nervation of leaflets of this flora is the presence of distinct, single or double branched secondary veins. Though nervation of this type occurs in some species of *Fraxinus* (e.g. *Fraxinus ungeri* (Gaudin in Gaudin & Strozzi) Knobl. & Kvaček), it is not characteristic of *F. praedicta* Heer.

A contemporary species, similar, according to Heer (1859), to the fossil one, is *Fraxinus oxycarpa* Willd. The leaflets of this species however, have a different character of secondary nervation. Secondary veins do not connect with each other but run into sinuses between the teeth; besides, they are much more numerous. Nervation of the same type as in the fossil specimens, has only been found in the available herbarium materials in *Fraxinus caroliniana* Mill. (Pl. V, 5). The shape and serration of the margins of this contemporary species are also similar, as in leaves of *Fraxinus praedicta* Heer.

Fraxinus caroliniana Mill. occurs in the south-east part of Northern America. This deciduous tree grows on swamplands (Vines 1960).

Occurrence in fossil floras of Poland. The Miocene of Chłapowo, Heer 1869.

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STRESZCZENIE

GÓRNOMIOCEŃSKA FLORA LIŚCIOWA Z MIROSTOWIC DOLNYCH

Flora kopalna w Mirostowicach Dolnych pochodzi ze spągu serii poznańskiej, z poziomu szarych iłów nad pokładem węgla brunatnego. Opis geologiczny stanowiska podaje Dyjor (1978), natomiast wstępne wyniki badań paleobota-

nicznych Sadowska & Zastawniak (1978). Wiek iłów z florą datowany jest na górny torton (Dyjor & Sadowska 1977; Sadowska 1977).

Rośliny są zachowane wyłącznie w postaci odcisków. Wśród nich przeważają: *Glyptostrobus europaeus* (Brongn.) Ung. i *Taxodium dubium* (Sternb.) Heer, składniki lasów bagiennych. Drzewa i krzewy liściaste reprezentuje 8 taksonów, znaleziono ponadto pnącza i rośliny jednoliścienne. Jako nowe dla trzeciorzędu opisano: *Clerodendrum silesiacum*, *Photinia szaferi* i *Prunus microserrata*.

Pod względem klimatycznym flora ma charakter umiarkowany i umiarkowanie ciepły. Podobnie jak i inne górnomioceńskie flory liściowe opisane z iłów poznańskich (Engelhardt 1892; Menzel 1910; Zabłocki 1924; Raniecka-Bobrowska 1954), flora z Mirostowic Dolnych jest pochodzenia autochtonicznego i reprezentuje zbiorowiska roślinne, które zajmowały brzegi śródlądowego zbiornika wodnego.

PLATES

Plate I

Taxodium dubium (Sternb.) Heer
Specimen No 132/69; × 1.5

Phot. M. Kleiberowa

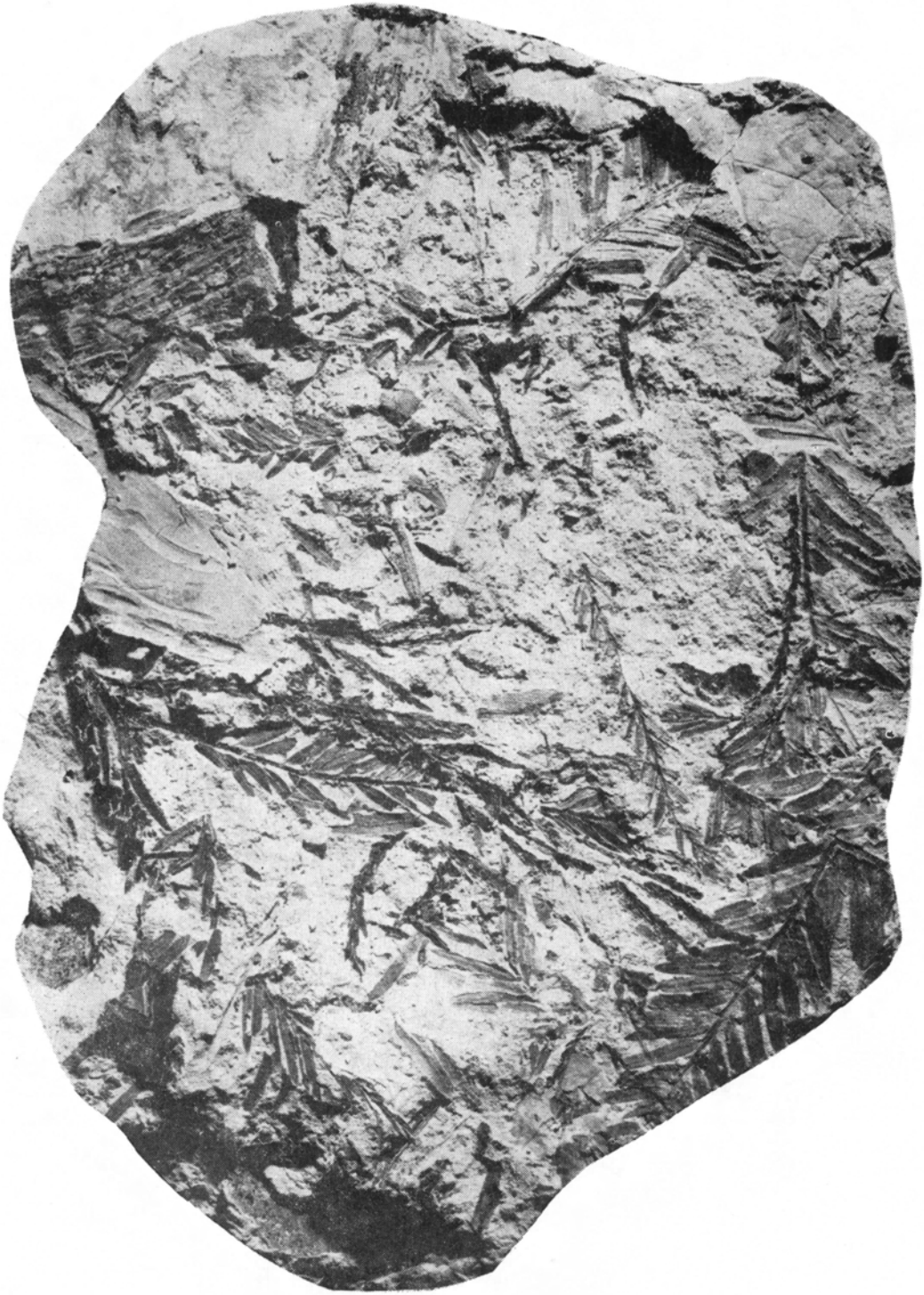

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Plate II

Glyptostrobus europaeus (Brongn.) Ung.
Taxodium dubium (Sternb.) Heer

1. Specimen No 132/89; × 1·5
2. Cone of *Glyptostrobus*, specimen No 132/30; × 1·5
3. Specimen No 132/114; × 1·5

Phragmites oehningensis A. Br.

4. Specimen No 132/14; × 1·5

Phot. M. Kleiberowa

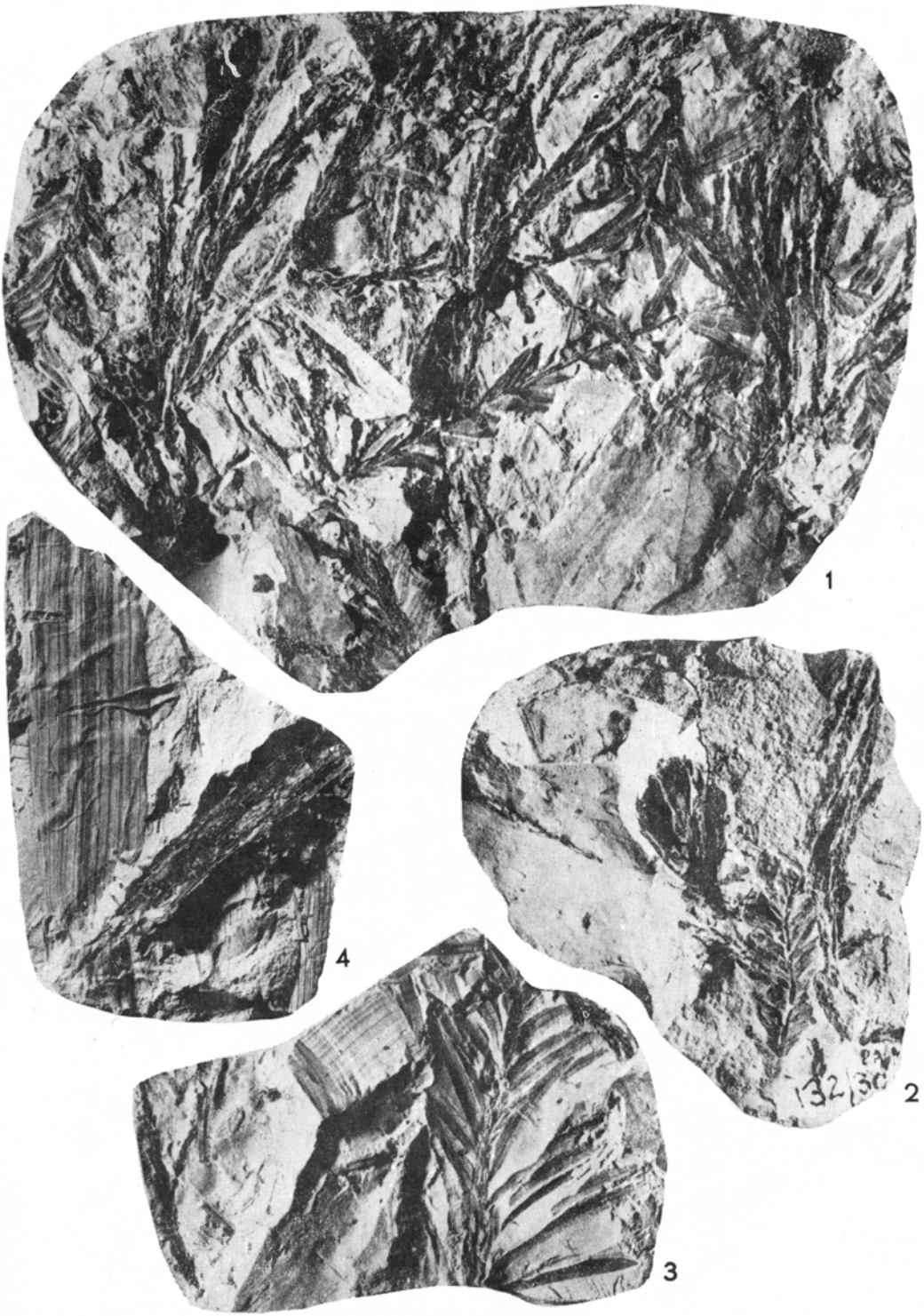

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Plate III

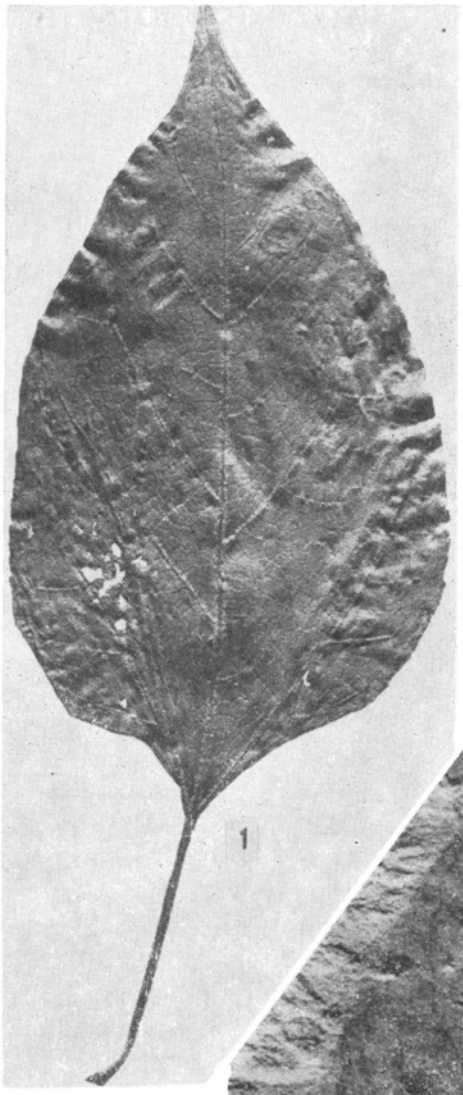
Clerodendrum trichotomum Thunb.

1. Photograph a recent leaf

Prunus microserrata n. sp.

2. Specimen No 132/26
3. Specimen No 132/65, holotype
3a. Fragment of the nervation from the holotype, × ca. 4

Phot. A. Pachoński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2


3

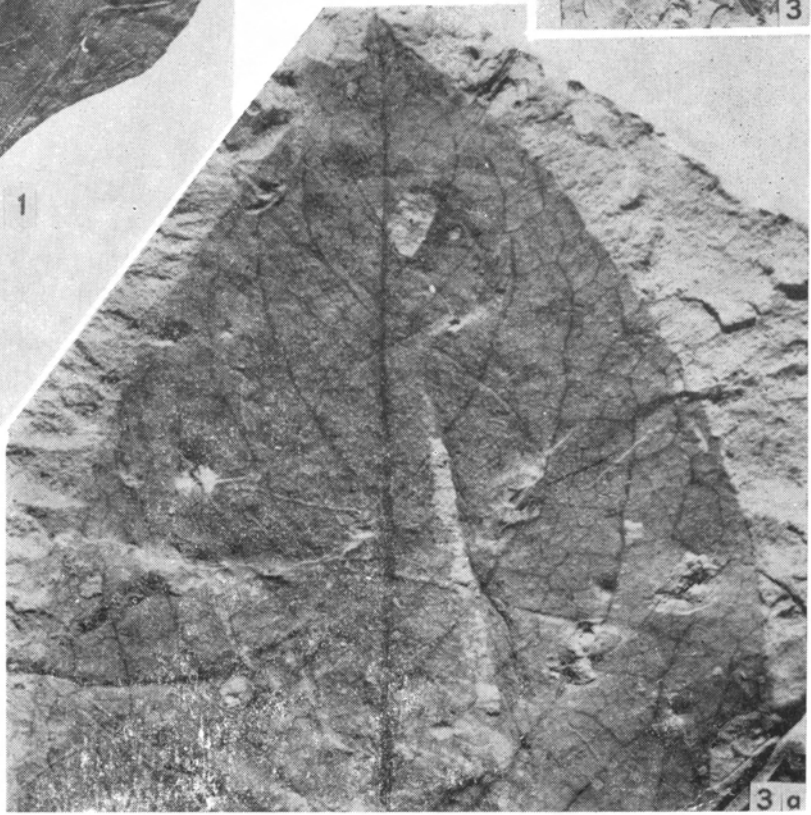

3 a

Plate IV

Photinia szaferi n. sp.

1. Specimen No 132/221, fragment of the nervation of the leaf; × ca. 5
2. Specimen No 132/160, holotype
3. Specimen No 132/61

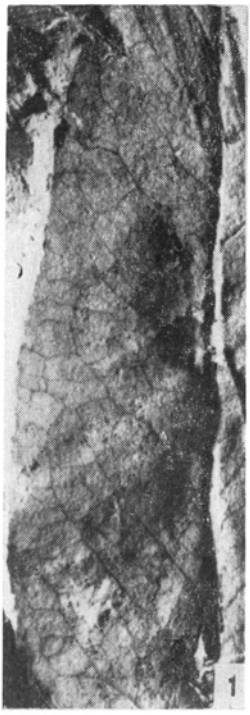
3a. Fragment of the nervation and leaf margin from the specimen No 132/61; × ca. 6

4. Specimen No 132/158

Photinia glabra (Thunb.) Maxim.

5. Photograph a recent leaf

Phot. A. Pachoński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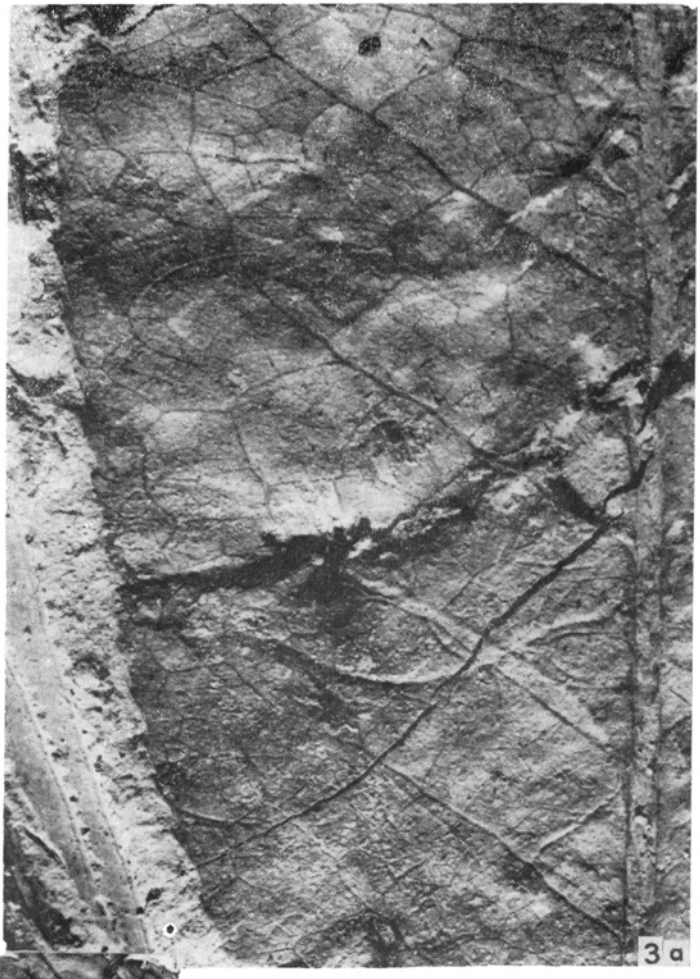
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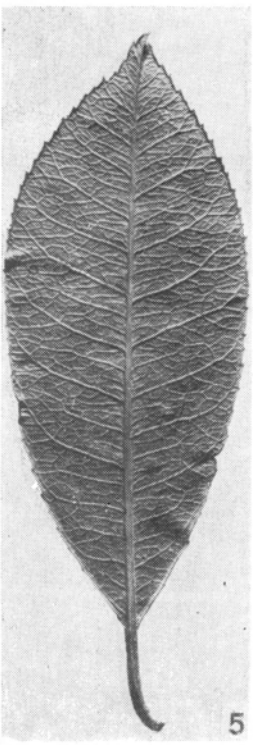
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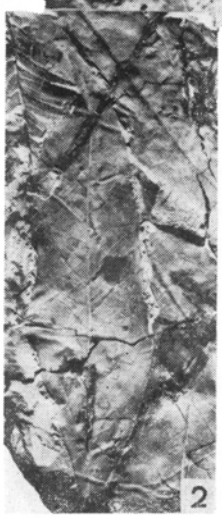
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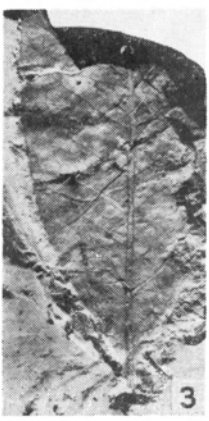
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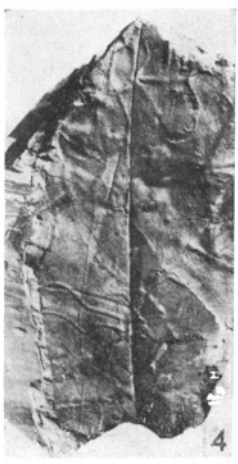

4

Plate V

Clerodendrum silesiacum n. sp.

1. Specimen No 132/233, holotype; below to the right, fragment of the middle lobe of *Vitis strictum* (Goepp.) Knobl.
2. Specimen No 71/318 from Domański Wierch

Clerodendrum serratum Spreng.

3. Photograph a recent leaf

Vaccinium uliginosum L.

4. Photograph a recent leaf

Fraxinus caroliniana Mill.

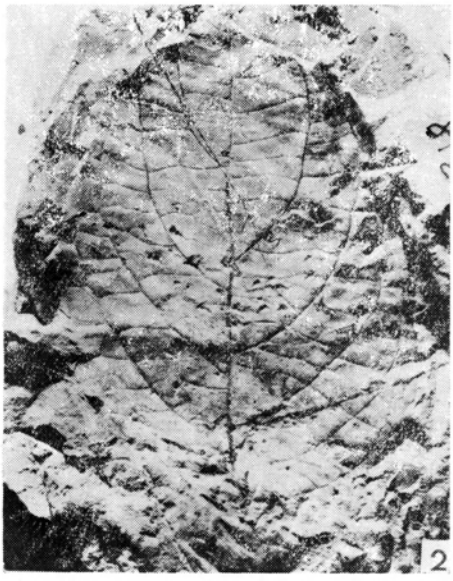
5. Photograph a recent leaflet

Periploca sepium Bunge

6. Photograph a recent leaf

Phot. A. Pachoński


1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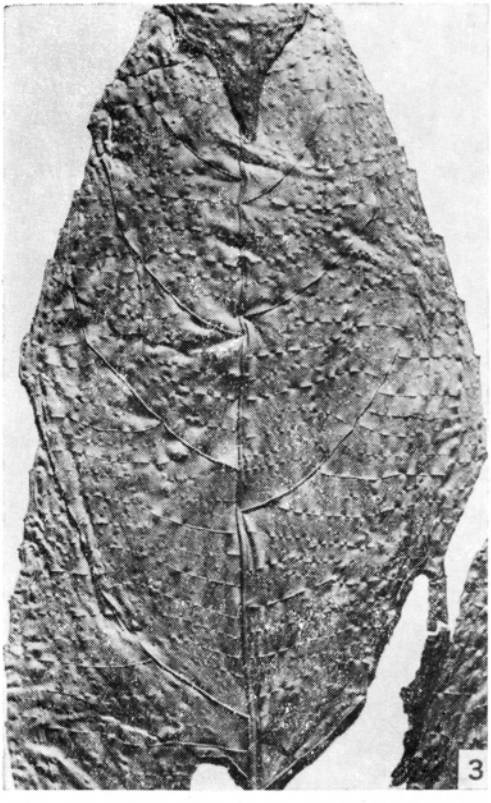
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