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Tertiary flora and vegetation of the locality Záhoří near Žatec (Most Basin, Czech Republic)

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Abstract: Plant fossils of Early Miocene age preserved in silty claystones occur in the incision of the Ohře River. The flora includes 23 taxa (2 conifers, 19 angiosperms and 2 taxa of uncertain systematic affinity). The reconstructed vegetation can be interpreted as a relatively temperate riparian forest with predominance of deciduous elements in moist habitats. According to the floristic analysis it is possible to correlate this flora with those of the Upper Inter-seam Member of the Most Formation from the Pětipsy area. This is also confirmed by similarities in the lithology of fossiliferous deposits in the two areas.

Key words: plant fossils, palaeoecology, fluvial sediments, Most Basin, Early Miocene, Czech Republic

Introduction

The so far undescribed locality of Záhoří near Žatec is situated in a classical palaeobotanical area, which has been studied for more than 100 years (see Teodoridis 2002). B. Brabenec originally collected the investigated material in 1905. However, he had never determined and published it. This paper describes this flora in detail and tries to solve problems of correlation of fluvial deposits of the Most Basin based on the palaeofloristic data.

Geological setting

The locality of Záhoří is situated about 1.5 km northwest of the town of Žatec and 7 km southeast of the dam of the Nechranice Reservoir (Fig. 1.). Individual plant occurrences of the Záhoří locality were probably found in sedimentary outcrops located on the left bank of the incised Ohře River. The plant-bearing sediments are monotonous, mostly grey to whitish silty claystone and yellowish sandstone. A detailed sedimentological study is in preparation (M. Rajchl). Older papers dealing with sedimentological characteristics of this area include those by Malecha (1962) and Bůžek (1971).

Character and preservation of material

Leaf impressions were identified only on the basis of morphological features because cuticles are not preserved. A binocular magnifying glass was used for the observations and studies of leaf material. Currently accepted morphological terminology follows Hickey (1973). The plant fossils are mostly fragmented, only rarely complete, which is typical of fluvial settings with allochthonous plant remains. The studied material is housed in the collections of the National Museum in Prague (NM – G).

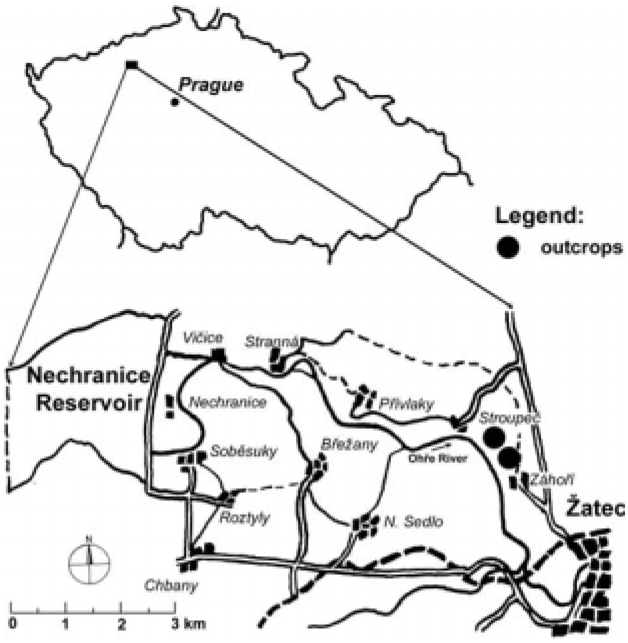

Fig. 1. Position of the locality of Záhoří near Žatec.

Systematic part

Pinophyta

Taxodiaceae

Glyptostrobus Endl.

Glyptostrobus europaeus (Brongniart 1833) Unger 1850
Plate I, figs 2, 3

1833 *Taxodium europaeum* Brongniart; p. 168.
1850a *Glyptostrobus europaeus* (Brongn.) Unger; p. 434.

Material: 2 seed cones (impression)

Remarks: *Glyptostrobus europaeus* is the most common and well-known coal-forming conifer, which occurred in the whole area of northern Bohemia. The unequivocal proof of this taxon is only given by the seed cones or seeds, because the sterile twigs and fertile twigs with pollen cones are morphologically indistinguishable from *Quasisequoia couttsiaei* (Kunzmann 1999). Epidermal patterns of both the mentioned taxa are very similar, but they can be distinguished on the basis of the differences in dimensions of the ordinary cells (Sakala 2000). *Glyptostrobus europaeus* is a typical element of swamp forests and matches extant *Glyptostrobus pensilis* C. Koch, distributed in SE China.

Quasisequoia Srinivasan et Friis emend. Kunzmann

Quasisequoia couttsiae (Heer 1862) Kunzmann 1999
Plate I, fig. 1

1862 *Sequoia couttsiae* Heer; pp. 1051–1055, pl. 59–61.
1999 *Quasisequoia couttsiae* (Heer) Kunzmann; p. 57, pl. 10, figs 5–6, pls 11–13, text-figs 13–14.

Material: 1 immature seed cone.

Remarks: This coal-forming conifer is common in the coal facies. It has been described also from the Břešťany Clay of the Most Basin, similarly as *Glyptostrobus europaeus* (Kvaček and Hurník 2000). The delimitation of both taxa was mentioned above from the epidermal point of view. In the case of seed cones and seeds, the determination is more problematic (for details see, e.g., Mai and Walther 1978, Pingen 1994). *Quasisequia couttsiae* has no extant analogue in modern floras. Ecological interpretation is identical with that for *Glyptostrobus europaeus*.

Magnoliophyta

Lauraceae

Laurophyllum Goeppert

Laurophyllum sp.
Plate I, fig. 10, Plate II, figs 2–5, 7, 9; Figs 1–2

Material: 8 complete or incomplete leaves.

Remarks: Leaves of the family Lauraceae are not so frequent in the Pětipsy area as is the case of other fluvial deposits of central Bohemia. A precise determination of the laurels at hand is problematic because of the poor preservation, which does not allow a detailed study of cuticular structure. Two morphotypes can be distinguished at the Záhoří locality. Oblong to elliptic leaves with an attenuate apex and narrowly cuneate base with long, relatively thick petiole belong to the first morphotype. The second one contains relatively broader elliptic to ovate leaves with a broadly cuneate base (Plate II, figs 3, 7). Kvaček (1971) assigned the material from Čermníky to *Laurophyllum pseudoprinceps* and *Laurophyllum nemejcii* on the basis of the epidermal structure. Both mentioned morphotypes from Záhoří could match these species because the morphological variability of laurel leaves is high.

Daphnogene Unger

Daphnogene cinnamomifolia Unger 1850 f. *cinnamomifolia*
Plate I, figs 5–7; Fig. 3

1850b *Daphnogene cinnamomifolia* Unger; Unger, p. 424.
1949 *Cinnamomum scheuchzeri* (Heer) Frentzen; Němejc, pp. 74–78, pl. 3, figs 12–15, pl. 5, fig. 11, pl. 7, figs 5–6.
1995 *Daphnogene cinnamomifolia* (Brongniart) Unger f. *cinnamomifolia*; Kvaček and Walther, p. 32, pl. 2, fig. 2, text-fig. 4/19.

Material: 5 complete and incomplete leaves.

Remarks: These 3-veined leaves are relatively common contrary to the above-described taxa in fluvial accumulations of central Bohemia. This type of foliage usually occurs in 2 morphological forms, which are due to variations of the leaf shape and width (Kvaček and Walther 1995). The different leaf forms are interpreted as “sun” and “shade” leaves of one taxon. According to Kvaček and Walther (1995), *D. cinnamomifolia* is a “pioneer” plant, colonizing, e.g., tuffite deposits (substrates). Generally, representatives of the genus *Daphnogene* are typical evergreen elements of subtropical oak–laurel forests of the European Tertiary.

Hamammelidaceae

Liquidambar L.

Liquidambar europaea Al. Braun in Buckland 1836
Plate I, figs 4, 8, 9, Plate II, fig. 6; Fig. 7

1836 *Liquidambar europaeum* Al. Br.; Braun in Buckland, p. 513.

Material: 1 complete leaf and 2 fragments, 3 infructescences.

Remarks: Fragments of 3-lobed leaves and rarely complete leaves with a typically crenulate margin belong to a very common element of riparian forests, which is known from fluvial sediments of central Bohemia (Němejc 1949, Teodoridis 2002) and sediments of the Most Basin (e.g., Ettingshausen 1866, 1869; Bůžek 1971, Kvaček and Hurník 2000). The leaves seldom occurred in association with infructescences – e.g., localities Bílina (Ettingshausen 1866, 1869), Holedeč (Brabenec 1904, Teodoridis 2002) and Záhoří near Žatec (this paper). Fragmentary leaf material of *Liquidambar* without preserved marginal area can be easily mistaken for leaves of *Acer* L. *Liquidambar europaea* is a typical riparian element, which usually occupies waterlogged biotopes in association with *Parrotia* *pristina*, *Ulmus pyramidalis* and *Salicaceae*. It often bordered rivers flowing into basins.

Parrotia C. A. Mey

"Parrotia" pristina (Ettingshausen 1851) Stur 1867 sensu Bůžek 1971
Plate II, fig. 1; Fig. 13

1851 *Styrax pristinum* Ettingshausen; p. 19, pl. 3, fig. 9.
1867 *Parrotia pristina* (Ett.) Stur; p. 4, pl. 40, figs 24, 25.
1971 *"Parrotia" pristina* (Ett.) Stur; Bůžek, p. 52, pl. 16, figs 8–12, pl. 17, figs 1–11, text-fig. 4.

Material: 1 complete leaf.

Remarks: *"Parrotia" pristina* is a very common element, which has been described from the Pětipsy area (Bůžek 1971) and the Přívlaky locality (Teodoridis in print). Due to the lack of cuticles and considerable similarity in leaf morphological features to Recent genera (i.e., *Fothergilla* L., *Parrotia* C. A. Mey, *Shaniodendron* Deng, Wei et Wang), it is problematic to safely solve the affinity of the fossil species to the mentioned genera. Similarly, it is possible to interpret *"Parrotia" pristina* as a riparian element, which has identical ecological requirements as *Liquidambar*. Kvaček and Bůžek (1982) defined a similar association of *Parrotia – Ulmus pyramidalis* from the area of the Most Basin, which is represented by fruticose and riparian elements along rivers and deltas.

Juglandaceae

Carya Nutt.

Carya serrifolia (Goeppert 1855) Kräusel 1921
Plate II, fig. 10, Plate III, figs 2, 3, 4; Fig. 9

1855 *Quercus serraefolia* Goeppert; p. 17, pl. 5, fig. 14.
1921 *Carya serraefolia* (Goepp.) Kräusel; p. 389, pl. 5, fig. 2.
1949 *Carya bilinica* (Ung.), Ett.; Němejc, p. 60, pl. 9, figs 4–6a.
1971 *Carya serrifolia* (Goepp.) Kräusel; Bůžek, p. 46, pl. 13, figs 5–7, pl. 23, fig. 2.

Material: 4 incomplete leaflets.

Remarks: These leaflets are very common in clastic deposits of the Most Basin and their fluvial and deltaic equivalents. The suite of fossils studied is identical with the leaf material from the localities of the Pětipsy area, "Hlavačov gravel and sand" and Holedeč (Bůžek 1971, Teodoridis 2002). *Carya serrifolia* usually occurs in association with narrow elliptic leaflets with regularly slightly serrate margin and semicraspedodromous venation – designated as *Carya* cf. *serrifolia* (Goepp.) Kräusel (see below). The differences between the two lie mainly in the leaf form, which can be interpreted as intraspecific variation of compound leaves. This interpretation is supported by the presence of the only one fruit type (i.e., *Carya bohemica* Brabenec). The variability of leaflets in fossil Juglandaceae is well seen also in complete leaf occurrences of *Carya minor* (Saporta et Marion) Saporta from Willershausen in Harz (Knobloch 1998: pl. 25, fig. 4), which contain morphologically different leaflets. On the other hand, it is not acceptable to treat these two morphotaxa as only a single species without a comparative study of their epidermal structure.

Carya cf. *serrifolia* (Goeppert 1855) Kräusel 1921
Plate II, fig. 8; Fig. 12

1859 *Pterocarya denticulata* (Web.) Heer; p. 94, pl. 71, figs 5–7.
1869 *Pterocarya denticulata* (Web.) Heer; Ettingshausen, p. 47, pl. 53, figs 11–15.
1891 *Pterocarya denticulata* (Web.) Heer; Engelhardt, p. 193, pl. 17, figs 15, 17.
1904 *Pterocarya denticulata* (Web.) Heer; Brabenec, p. 10.
1904 *Evonymus proserpinae* Ett.; Brabenec, p. 18.
1904 *Aesculus palaeocastanum* Ett.; Brabenec, p. 22
1971 *Carya* cf. *serrifolia* (Goepp.) Kräusel; Bůžek, p. 45, pl. 12, figs 1–16, pl. 13, figs 1–4.

Material: 3 incomplete leaflets.

Remarks: This leaf material is morphologically very similar to the above described leaflets. The probable relation was commented above. This species, similarly as *Carya serrifolia*, is compared with the Recent North American representatives of *Carya* Nutt (e.g., *C. olivaeformis* Nutt., *C. tomentosa* Nutt.). Ecologically, it can be probably interpreted as a mesophytic element.

Betulaceae

Betula L.

Betula sp.
Plate III, fig 1, 7, 9–11, Plate IV, figs 1, 2; Figs 5, 16

Material: 12 incomplete leaves.

Remarks: Delimitation of particular genera (*Betula*, *Alnus*, *Carpinus*) of the Betulaceae is equivocal due to high interspecific morphological variability, fragmentary character and poor preservation of the studied material and finally the lack of cuticles. Many authors, e.g., Ettingshausen 1851, 1866, Goeppert 1855, Němejc 1949, described numerous leaves from the North Bohemian area as, e.g., *B. prisca* Ett., *B. dryadum* Goepp., *B. subpubescens* Goepp. These are usually elliptic leaves with a broadly cuneate base and with irregular and double-serrated margins. The material from Záhoří includes 2 morphotypes; the smaller leaves are well comparable to the leaf material from the Pětipsy area (Bůžek 1971) and the longer one has affinity to birch leaves from the localities of Přívlaky, Nesuchyně and Holedeč (Teodoridis 2002, in print). However, this difference in the form is explainable within the intraspecific variation. *Betula* sp. is often interpreted as a mesophytic element of riparian forests (e.g., Kvaček and Bůžek 1982).

Alnus B. Ehrh.

Alnus julianiformis (Sternberg 1823) Kvaček et Holý 1974
Plate III, fig. 6, Plate IV, figs 4, 5; Fig. 8

1823 *Phyllites julianaeformis* Sternberg; p. 37, 39, pl. 36 .
1974 *Alnus julianaeformis* (Sternb.) Kvaček et Holý; p. 367, pl. 1, 2, 3, pl. 4, fig. 1, text-fig. 1.

Material: 6 complete leaves and fragments.
Remarks: *A. julianiformis* is a very common element, which was originally described as an oak (e.g., Unger 1845, Ettingshausen 1866, Engelhardt 1891). It is spread not only in the coal seams but also in clastic deposits of the Most Basin and of central Bohemia. It is ecologically interpreted as a typical swamp or riparian element, which can survive periodical, relatively long-lasting floods (approximately 3 or 4 months).

cf. *Alnus* sp. sensu Bůžek 1971
Plate III, fig. 8

Material: 1 incomplete leaf (impression).
Remarks: This incomplete leaf part of the basal area shows affinities to another alder, which is a dominant element of the Betulaceae in the Pětipsy area (Bůžek 1971) and is characterized by a relatively broad cuneate base and higher distances between interspaced secondaries than *Betula* sp. *Alnus* sp. can be interpreted as a mesophytic element.

Myricaceae

Comptonia L' Hérit. in Aiton

Comptonia difformis (Sternberg 1825) Berry 1906
Plate II, figs 11–12; Fig. 15

1825 *Aspleniopteris difformis* Sternberg; p. 33, pl. 24, fig. 1.
1906 *Comptonia diformis* (Sternb.) Berry; p. 495.

Material: 2 incomplete leaves.
Remarks: This mesophytic fruticose element is characterized by pinnately lobed leaves and their venation of the lobes. *Comptonia difformis* occurs in the deposits of the Most Basin, mainly from the base of the Overlying Member of the Most Formation, Břešťany Clay and sand-clay facies of the Žatec delta (Kvaček and Bůžek 1982). It has been also described from the localities of the "Hlavačov gravel and sand" (Teodoridis 2002) and Přívlaky (Teodoridis in print).

Salicaceae

Salix L.

cf. *Salix haidingeri* Ettingshausen 1866 emend. Bůžek 1971
Plate IV, figs 10, 11

?1866 *Salix haidingeri* Ettingshausen; p. 88, pl. 29, figs 9–13, 15, 16, non fig. 8.
?1971 *Salix haidingeri* Ett. emend. Bůžek; p. 66, pl. 35, figs 1–10, pl. 36, figs 1–12, text-fig. 8.

Material: 2 incomplete leaves.
Remarks: Fragmentary narrow, elongate, entire leaves with dense eucamptodromous venation are a common element in the Most Basin. They have been usually described as *Salix haidingeri*. This willow is interpreted as an element of riparian forests.

Populus L.

Populus populina (Brongniart 1822) Knobloch 1964
Plate II, fig. 13, Plate IV, fig. 3; Fig. 18

1822 *Phyllites populina* Brongniart; p. 237, pl. 14, fig. 4.
1964 *Populus populina* (Brongn.) Knobloch; p. 601.

Material: 2 incomplete leaves.
Remarks: These incomplete leaves are assigned to *Populus populina* (Brongn.) Knobloch on the account of the leaf form, venation type (mainly branching of the first basal secondaries), entire base and simple dentate margin. Similarly as willows, these poplars are interpreted as elements of riparian forests and are also spread in the clastic complexes of the Most Basin and the river system of central Bohemia.

Ulmaceae

Ulmus L.

Ulmus pyramidalis Goeppert 1855
Plate III, fig. 5, Plate IV, fig. 8

1855 *Ulmus pyramidalis* Goeppert; p. 29, pl. 13, figs 10–12.

Material: 2 incomplete leaves.
Remarks: The leaves of *Ulmus pyramidalis* Goepp. are characterized by a distinctly dentate margin and numerous, closely spaced parallel secondaries. The leaves have been found very rarely in association with samaras, e.g., Želenky (Kvaček and Hurník 2000), Čermníky (Bůžek 1971) and Holedeč (Brabenec 1904). According to Kvaček and Bůžek (1982), *Ulmus pyramidalis* can be compared with the Recent species *U. americana* L., which is distributed in eastern and southeastern USA as an element of riparian forests.

Zelkova Spach

Zelkova zelkovifolia (Unger 1843) Bůžek et Kotlaba in Kotlaba 1963
Plate IV, fig. 6

1843 *Ulmus zelkovaefolia* Unger; pl. 24, figs 9–13, non fig. 7 (fructus).
1963 *Zelkova zelkovaefolia* (Ung.) Bůžek et Kotl.; Kotlaba, p. 59, pl. 3, figs 7, 8.

Material: 1 complete leaf.

Remarks: *Zelkova zelkovifolia* is characteristic of its coarse simple-serrate margin. The margin varies from coarsely to finely serrated forms, which are usually mistaken for shorter leaves of *Ulmus pyramidalis*. According to Kvaček and Bůžek (1982), *Zelkova zelkovifolia* can be compared with the Recent species *Zelkova carpinifolia* (Pal.) K. Koch. from relic deciduous and mesophytic forests of Colchis.

Leguminosae

Podocarpium Al Braun ex Stizenberger

Podocarpium podocarpum (Al. Braun in Buckland 1836) Herendeen 1992b
Plate IV, fig. 7; Fig. 4

1836 *Gleditschia podocarpa* Al. Br.; Braun in Buckland, p. 513.
1971 *Podogonium oehningense* (Koenig) Kirchheimer; Bůžek, pp 98–99, pl.47, fig. 9, pl. 50, figs 1–27, pl. 51, figs 1–12, text-fig. 16.
1992b *Podocarpium podocarpum* (Al. Br.) Herendeen; p. 732.

Material: 1 incomplete leaflet.

Remarks: Shortly petioluled, elliptic to oval leaflets have recently been described in association of fruits from the Pětipsy area (Bůžek 1971), Nesuchyně (Teodoridis 2002) and Přívlaky (Teodoridis in print). Gregor and Hantke (1980) pointed to a direct affinity between fruits of the genus *Podogonium* Heer (i.e., *Podocarpium* Br. ex Sitzenber.) and fruits of *Gleditsia aquatica* Marsh. and *Gleditsia heterophylla* Buge, distributed in swamps in southeastern USA. However, Herendeen (1992a) compares it with African tropical to subtropical representatives of the genera *Gilletiodendron* Vemoesen, *Cryptosepalum* Benth. and *Tessmannia* Harms. Although extinct, *Podocarpium podocarpum* is usually interpreted as a mesophytic shrub.

Wisteria Nutt.

cf. *Wisteria* aff. *fallax* (Nathorsi 1883) Tanai et Onoe 1961
Plate V, figs 4–8; Fig. 10

1883 *Sophora* (?) *fallax* Nathorst; Nathorst, p. 58, pl. 10, figs 11, 12, pl. 11.
1961 *Wisteria fallax* (Nath.) Tanai et Onoe; p. 45, pl. 10, fig. 6, pl. 14.

Material: 5 incomplete leaflets.

Remarks: The incomplete leaflets are morphologically comparable with the material from the Pětipsy area (Bůžek 1971) and Holedeč (Teodoridis 2002). Main diagnostic features are the size and form of entire leaflets and the character of venation. Tanai and Onoe (1961) and Baranova (1967) suggested *Wisteria floribunda* (Willd.) DC. as the extant relative. This liana is distributed in association of riparian forests in the southeastern and eastern USA and East Asia (Kvaček and Bůžek 1982).

Rhamnaceae

Paliurus Mill.

Paliurus tiliaefolius (Unger 1847) Bůžek 1971

Material: 1 incomplete leaf G7635 and 1 fruit G 2564 – for details see Brabenec (1904) and Teodoridis (2002).

Aceraceae

Acer L.

Acer integerrimum (Viviani 1833) Massalongo 1858
Plate V, figs 1, 2; Figs 11, 17

1833 *Acerites integerrima* Viviani; pl. 11, fig. 6.
1858 *Acer integerrimum* (Viv.) Massalongo; p. 94.

Material: 2 incomplete leaves.

Remarks: *Acer integerrimum* is typically entire-margined, with triangular lobes. It does not occur frequently in the deposits of the Most Basin. Leaves of the same type were described from Čermníky (Bůžek 1971), Nesuchyně and Holedeč (Tedodridis 2002). Procházka (1952) referred the leaf material which was originally described as *Acer nervatum* Vel. (e.g., Velenovský 1881, Brabenec 1904) to *Acer integerrimum*. This fossil maple is comparable with extant *A. cappadocicum* Gleditsch, which is an element of East Asian mesophytic deciduous forests and the Mixed Mesophytic Forest in China (Kvaček and Bůžek 1982).

Acer dasycarpoides Heer 1859 sensu Procházka et Bůžek 1975
Plate IV, fig. 9, Plate V, fig. 10; Fig. 14

1859 *Acer dasycarpoides* Heer; p. 198, pl. 114, figs 3, 9, pl. 115, fig. 6, pl. 155, figs 6–8.
1975 *Acer dasycarpoides* Heer sensu Procházka et Bůžek; pp. 36–42, pl. 21, figs 6–10, text-figs 4a-c, 14, 15.

Material: 2 incomplete leaves.

Remarks: This type of maple leaves has a typically simple serrate margin with relatively long and acute teeth. It corresponds to the leaf material from Čermníky, Zabrušany and Holedeč (Bůžek 1971, Kvaček and Hurník 2000, Brabenec 1904, Teodoridis 2002). Kvaček and Bůžek (1982) and Procházka and Bůžek (1975) suggested *Acer saccharinum* L. to be a modern analogue, which dominates in riparian forests of the eastern USA, but not directly in swamps.

Plantae incertae sedis

"Viburnum" atlanticum Ettingshausen 1868
Plate V, fig. 3; Fig. 6

1868 *Viburnum atlanticum* Ettingshausen; p. 209, pl. 36 .

Material: 1 incomplete leaf.

Remarks: The incomplete leaf can be referred to *"Viburnum" atlanticum* on the basis of its typical irregularly crenulated margin. This species was originally described from the localities of Žichov (Ettingshausen 1868) and Kundratice (Engelhardt 1885). Bůžek (1971) noted that a comparison of *"Viburnum" atlanticum* with the Recent genus *Viburnum* L. is improbable and suggested potential affinities to the families *Theaceae* (e.g., *Camellia* L.) The potential affinity to *Theaceae* is supported by the seeds of *Eurya stigmosa* (Ludw.) Mai from the Most Basin and the České středohoří Mts. (Bůžek and Holý 1964) and by the similarity in epidermal patterns (Kvaček and Hurník 2000). In the opinion of the latter mentioned authors, this plant is more or less a mesophytic element, connected with the riparian forests of alluvial plains and levees.

"Ficus" truncata Heer 1859 sensu Bůžek 1971
Plate V, fig. 9

1859 *Ficus truncata* Heer; p. 183, pl. 152, fig. 15.
1971 *"Ficus" truncata* Heer sensu Bůžek; p. 92–94, pl. 46, figs 1–9, pl. 47, figs 1–8, pl. 48, figs 1–4, text-fig. 15.

Material: 1 incomplete leaf.

Remarks: This incomplete leaf can be assigned to *"Ficus" truncata* on the basis of the entire margin and character of venation. A new content was given to this taxon by Bůžek (1971), who connected the leaf material from Čermníky and morphologically similar original material described under different names, such as *Ficus truncata* Heer 1859, *Ficus rüminiana* Heer 1859, *Ficus titanum* Ett. and *Populus mutabilis* Heer (Ettingshausen 1866). Similar material was described from the locality of Holedeč (Brabenec 1904, Teodoridis 2002). According to Bůžek (1971), it is morphologically comparable to Recent *Halesia diptera* Ellis from North America. According to epidermal structure, *"Ficus" truncata* has an affinity to the order Malvales (Worobiec 2000).

Conclusion

The locality of Záhoří near Žatec yielded 23 taxa of higher plants: 2 conifers, 19 angiosperms and 2 taxa of uncertain systematic affinity (Tab. 1 and Fig. 2). Generally, the reconstructed vegetation of the Záhoří locality can be interpreted as a relatively temperate riparian forest with dominance of deciduous elements (Fig. 3). Similarly as in the case of the plant assemblages from Přívlaky, Holedeč or "Hlavačov gravel and sand" (Teodoridis 2002, in print), it is possible to distinguish 3 relatively specific associations, which differ in their plant compositions (depending on specific ecological conditions of biotopes) and mutually integrate on their ecotons. The first association is a swamp forest, which is typical of plants more or less preferring environment with stagnant water or periodical, relatively long-lasting floods. Such associations are typical for basins or oxbow lakes. It contains *Glyptostrobus europaeus* (E3), *Quasisequoia couttsiae* (E3), *Alnus julianiformis* (E3). The next association is characterized by plants which permanently occupy waterlogged substrate. It is a wet-soils association, typical of riparian ecosystems containig *"Parrotia" pristina* (E2), *Ulmus pyramidalis* (E3), *Liquidambar europaea* (E3), *Alnus julianiformis* (E3), *Salix haidingeri* (E2) and *Populus populina* (E3). The last defined association is that of slopes. It is characterized by the diversity of mesophytic elements, which generally occupied humid environment but did not tolerate too much waterlogged soils. It includes *Laurophyllum* sp. (E3), *Daphnogene cinnamomifolia* f. *cinnamomifolia* (E3), *Carya serrifolia* (E4), *Carya* cf. *serrifolia* (E4), *Betula* sp. (E3), *Alnus* sp. (E3), *Comptonia difformis* (E2), *Acer integerrimum* (E3), *Acer dasycarpoides* (E3), *Zelkova zelkovifolia* (E4), *"Ficus" truncata* (E3), *"Viburnum" atlanticum* (E3), *Paliurus tiliaefolius* (E2), *Wisteria* aff. *fallax* (E2), *Podocarpium podocarpum* (E2) [vegetative storeys: (E1) herbs, (E2) shrubs and lianas, (E3) trees lower than 25 m, (E4) trees higher than 25 m].

According to the floristic analysis of the locality of Záhoří near Žatec, this flora has close affinities to that of the Pětipsy area (Bůžek 1971). Bůžek (1971) described three floristic associations, which correspond to various strati-

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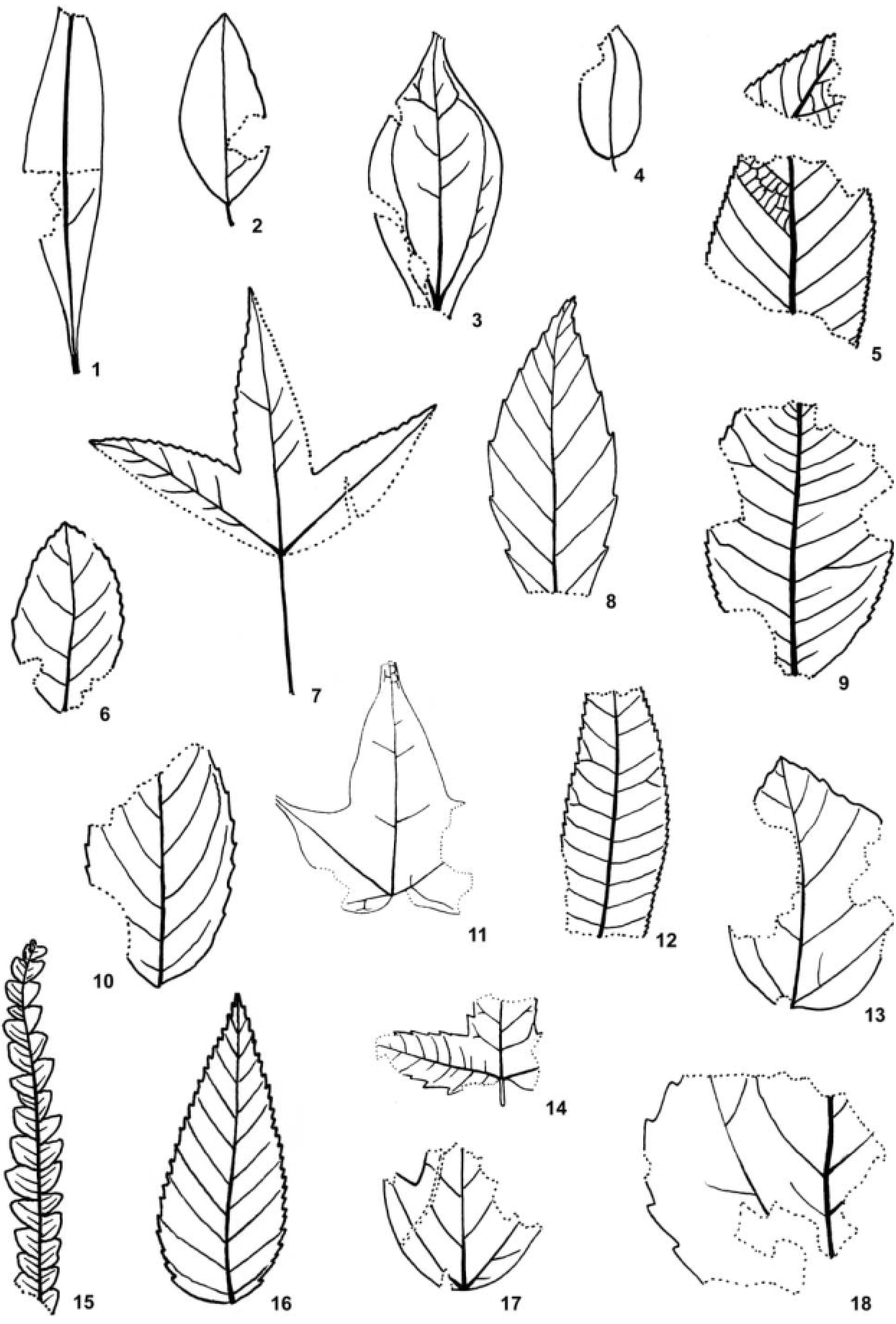
Fig. 2. Floral picture of the locality of Záhoří near Žatec (× 0.75).
1 – *Laurophyllum* sp., G 8091; 2 – *Laurophyllum* sp., G 8094a; 3 – *Daphnogene cinnamomifolia* Unger f. *cinnamomifolia*, G 8085; 4 – *Podocarpium podocarpum* (Al. Br.) Herendeen, G 8096; 5 – *Betula* sp., G 7637; 6 – *"Viburnum" atlanticum* Ett., G 7636a; 7 – *Liquidambar europaea* Al. Braun, G 2231; 8 – *Alnus julianiformis* (Sternberg) Z. Kvaček et Holý, G 8063; 9 – *Carya serrifolia* (Goepp.) Kräusel, G 8073; 10 – cf. *Wisteria* aff. *fallax* (Nathorst) Tanai et Onoe, G 8080; 11 – *Acer integerrimum* (Viviani) Massalongo, G 3582, Procházka et Bůžek (1975: p. 17, text-fig. 1a); 12 – *Carya* cf. *serrifolia* (Goepp.) Kräusel, G 8071; 13 – *"Parrotia" pristina* (Ett.) Stur sensu Bůžek, G 8061; 14 – *Acer dasycarpoides* Heer sensu Procházka et Bůžek, G 3579, Procházka and Bůžek (1975: p. 29, text-fig. 4c), 15 – *Comptonia difformis* (Sternberg) Berry, G 8084; 16 – *Betula* sp, G 3583; 17 – *Acer integerrimum* (Viviani) Massalongo, G 3581; 18 – *Populus populina* (Brongniart) Knobloch, G 8098.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Tab. 1. Summary of the floristic composition at the localities of Záhoří near Žatec, Soběsuky, Nechranice, Čermníky, Chotěnice, Lomazice, Dolany (Pětipsy area – UM /Underlying Member/, UISM /Upper Inter-seam Member/, OM /Overlying Member of the Most Formation/), Přívlaky, Holedeč and "Hlavačov gravel and sand" (compiled from Bůžek 1971; Teodoridis 2002, in print; partly corrected)

Taxa	**Localities**						
		Pětipsy area					
	Záhoří near Žatec	UM	UISM	OM	Přívlaky	Holedeč	"Hlavačov gravel and sand"
Acer dasycarpoides	*		*		*	*	*
Acer integerrimum	*		*			*	*
Acer pseudomonospessulanum						*	
Acer tricuspidatum			*			*	*
Ailanthus confucii						*	*
Alnus julianiformis	*					*	*
Alnus kefersteinii			*			*	*
Alnus sp.	*		*	*	*	*	*
cf. *Ampelopsis* sp.			*				
Betula sp.	*		*	*	*	*	*
Carpinus grandis			*		*	*	*
Carya cf. *serrifolia*	*		*			*	*
Carya serrifolia	*		*			*	*
cf. *Castanea atavia*							*
Celtis sp.			*				
Cercidiphyllum crenatum			*	*			
Comptonia difformis	*		*	*	*	*	*
cf. *Corylus insignis*			*				
Craigia bronnii			*				
Crategus sp.			*				
Daphnogene cinnamomifolia	*		*	*		*	*
Diospyros brachysepala			*		*		
Dombeyopsis lobata			*				
Fagus deucalionis						*	*
Fagus saxonica					*	*	*
"Ficus" lobkowitzii			*				
"Ficus" multinervis			*				
"Ficus" truncata	*		*				*
cf. *Fraxinus* sp.			*			*	
Glyptostrobus europaeus	*		*	*		*	*
Juglans acuminata			*			*	
Juglans juglandiformis			*				
Koelreuteria reticulata			*			*	
Laurophyllum pseudoprinceps	?*		*				
Laurophyllum sp. 1	?*		*				
Laurophyllum sp. 2	?*		*				
Leguminosites tobischii			*			*	
Liquidambar europaea	*	*	*		*	*	*
Mahonia bilinica			*				*
Myrica sp.			*	*	*		*
Nyssa sp.			*				
Osmunda parschlugiana			*				
Ostrya atlantidis			*				
Paliurus tiliaefolius	*		*			*	
"Parrotia" pristina	*		*		*		
"Persea" speciosa			*				

Tab. 1, continued

Taxa	**Localities**						
		Pětipsy area					
	Záhoří near Žatec	UM	UISM	OM	Přívlaky	Holedeč	“Hlavačov gravel and sand”
? *Persoonia* sp.						*	
Phyllites kvacekii			*				
Pinus sp.				*			*
Poaceae vel *Cyperaceae*			*			*	*
Podocarpium podocarpum	*		*		*	*	
Populus populina	*		*		*	*	
Populus zaddachii var. *brabenecii*			*			*	*
“Porana” macrantha var. *punctata*			*			*	
Pseudolarix schmidtgenii							*
Quasisequoia couttsiae	*						
Quercus lusatica			*				
Pungiphyllum cruciatum				*			
Rosa europaea			*		*	*	
Rubus meriani						*	
Salix haidingerii	*		*		*	*	
Salix macrophylla			*				*
Salix varians			*				
Salvinia reussii			*			*	*
Sapindus falcifolius			*		*	*	*
Smilax weberi			*				
Stratiotes kaltennordheimensis						*	
Taxodium dubium		*	*			*	*
Tetraclinis salicornioides							*
Tilia brabenecii							*
cf. *Toxicodendron* sp.			*		*		
Trapa sp.			*				
cf. *Trigonobalanopsis rhamnoides*							*
Ulmus pyramidalis	*	*	*	*	*	*	*
Ulmus sp.			*				
“Viburnum” atlanticum	*		*			*	*
Vitis stricta					*	*	*
Wisteria aff. *falax*	*		*			*	
Woodwardia muensteriana			*				*
Zelkova zelkovifolia	*		*		*	*	*
Zingiberoideophyllum liblarense			?*				*

graphical positions (Underlying Member, Upper Inter-seam Member and Overlying Member of the Most Formation – Early Miocene). The floras from the Upper Inter-seam Member of the Most Formation are the most numerous and identical with the flora from Záhoří. This floristic congruity is also accompanied by similar lithologies of the two areas (Rajchl, personal communication). On the other hand, these floras are also similar in their composition to the flora from Holedeč and more or less to the floras of “Hlavačov gravel and sand” (Tab. 1). These floras differ only in relatively frequent occurrences of *Fagus saxonica* Z. Kvaček et Walther and *Fagus deucalionis* Unger. These taxa are very important elements of the Late Oligocene floras in central Europe (Kvaček et al. 1989, Mai and Walther 1991, Walther 1999), which are correlated with the floristic assemblage of Rott-Thierbach (Mai 1995). Therefore, it is also possible to correlate the floras of Holedeč, Přívlaky and “Hlavačov gravel and sand” with this floristic assemblage (Lotsch et al. 1994, Teodoridis 2002, in print). This fact opens a large problem of the mutual correlation and age of fluvial deposits of central Bohemia and clastic sediments of the Most Basin. There are two probable interpretations. The first one is based on the above mentioned correlation of fluvial sediments (i.e., localities from the “Hlavačov gravel and sand” and Holedeč) to the Thierbach Floristic Assemblage and supposes a connection of the Thierbach deposits within the same river system (Lotsch et al. 1994, Teodoridis 2002). Konzalová (1976) described *Fagus* pollen from basal beds of the Most Formation, which proved a direct relation with fluvial clastic sediments and the Most Basin. The second interpretation explains the presence of Fagaceae at Holedeč and in the "Hlavačov gravel and sand" as an ecological phenomenon bound only to riparian forests, and correlates these river sediments with the Upper Inter-seam Member of the Most Formation. Both interpretations are relevant in some respects, but a final conclusion is beyond the scope of this paper and is subjected to the results of the investigations in progress.

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Plate I

1 – *Quasisequoia couttsiae* (Heer) Kunzmann, cone (G 1648), × 2.; 2 – *Glyptostrobus europaeus* (Brongniart) Unger, cone (G 1116), × 2.; 3 – *Glyptostrobus europaeus* (Brongniart 1833) Unger, cone (G 8087), × 2.; 4 – *Liquidambar europaea* Al. Braun, infructescence (G 8095), × 2.; 5 – *Daphnogene cinnamomifolia* Unger f. *cinnamomifolia*, leaf, (G 887), × 1.5.; 6 – *Daphnogene cinnamomifolia* Unger f. *cinnamomifolia*, leaf, (G 8085), × 1.; 7 – *Daphnogene cinnamomifolia* Unger f. *cinnamomifolia*, leaf, (G 8086), × 1.; 8 – *Liquidambar europaea* Al. Braun, leaf, (G 2230), × 1.; 9 – *Liquidambar europaea* Al. Braun, leaf, (G 2231), × 1.; 10 – *Laurophyllum* sp., leaf, (G 8091), × 1.5

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Plate II

1 – “*Parrotia” pristina* (Ett.) Stur sensu Bůžek, leaf, (G 8061), × 1.; 2 – *Laurophyllum* sp., leaf, (G 8093), × 1; 3 – *Laurophyllum* sp., leaf, (G 8089), × 1.5; 4 – *Laurophyllum* sp., leaf, (G 8092), × 2.5; 5 – *Laurophyllum* sp., leaf, (G 8088), × 1; 6 – *Liquidambar europaea* Al. Braun, leaf, (G 2233), × 1; 7 – *Laurophyllum* sp., leaf, (G 8090), × 2; 8 – *Carya* cf. *serrifolia* (Goepp.) Kräusel, leaflet, (G 8071), × 1.; 9 – *Laurophyllum* sp., leaf, (G 8094a), × 1.; 10 – *Carya serrifolia* (Goepp.) Kräusel, detail of leaflet margin, (G 8071), × 2.; 11 – *Comptonia difformis* (Sternberg) Berry, leaf, (G 8084), × 1.; 12 – *Comptonia difformis* (Sternberg) Berry, leaf, (G 357), × 1.5.; 13 – *Populus populina* (Brongniart) Knobloch, leaf, (G 8098), × 1.

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Plate III

1 – *Betula* sp, leaf, (G 8066), × 1; 2 – *Carya serrifolia* (Goepp.) Kräusel, leaflet, (G 8073), × 1; 3 – *Carya serrifolia* (Goepp.) Kräusel, leaflet, (G 8075), × 1; 4 – *Carya serrifolia* (Goepp.) Kräusel, leaflet, (G 8074), × 2; 5 – *Ulmus pyramidalis* Goepp., leaf, (G 354), × 1; 6 – *Alnus julianiformis* (Sternberg) Z. Kvaček et Holý, leaf, (G 8063), × 1; 7 – *Betula* sp., leaf, (G 3583), × 1; 8 – cf. *Alnus* sp. sensu Bůžek, leaf, (G 8071), × 1; 9 – Betula sp., leaf, (G 8068), × 2.75; 10 – Betula sp., leaf, (G 8069), × 1; 11 – Betula sp., leaf, (G 7638), × 1.

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Plate IV

1 – *Betula* sp, leaf, (G 8067), × 2; 2 – *Betula* sp., leaf, (G 8069), × 1; 3 – *Populus populina* (Brongniart) Knobloch, leaf, (G 8097), × 1.3; 4 – *Alnus julianiformis* (Sternberg) Z. Kvaček et Holý, leaf, (G 8065l), × 1; 5 – *Alnus julianiformis* (Sternberg) Z. Kvaček et Holý, leaf, (G 8064), × 1; 6 – *Zelkova zelkovifolia* (Ung.) Bůžek et Kotlaba, leaf, (G 80100), × 1.5; 7 – *Podocarpium podocarpum* (Al. Br.) Herendeen, leaflet, (G 8096), × 2; 8 – *Ulmus pyramidalis* Goepp., leaf, (G 8099), × 1; 9 – *Acer dasycarpoides* Heer sensu Procházka et Bůžek, leaf, (G 2234a), × 1; 10 – cf. *Salix haidingeri* Ett. emend. Bůžek, leaf, (G 8077), × 2.3; 11 – cf. *Salix haidingeri* Ett. emend. Bůžek, leaf, (G 8078), × 2.3.

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Plate V

1 – *Acer integerrimum* (Viviani) Massalongo, leaf, (G 3582), × 1; 2 – *Acer integerrimum* (Viviani) Massalongo, leaf, (G 3581), × 1.5; 3 – *“Viburnum” atlanticum* Ett., leaf, (G 7636a), × 1; 4 – cf. *Wisteria* aff. *fallax* (Nathorsi) Tanai et Onoe, leaflet, (G 8082), × 1; 5 – cf. *Wisteria* aff. *fallax* (Nathorsi) Tanai et Onoe, leaflet, (G 8083), × 0.5; 6 – cf. *Wisteria* aff. *fallax* (Nathorsi) Tanai et Onoe, detail of leaflet margin, (G 8080), × 1; 7 – cf. *Wisteria* aff. *fallax* (Nathorsi) Tanai et Onoe, leaflet, (G 8080), × 1; 8 – cf. *Wisteria* aff. *fallax* (Nathorsi) Tanai et Onoe, leaflet, (G 8081), × 2.5; 9 – *“Ficus” truncata* Heer sensu Bůžek, leaf, (G 8062), × 1.5; 10 – *Acer dasycarpoides* Heer sensu Procházka et Bůžek, leaf, (G 3579), × 2.

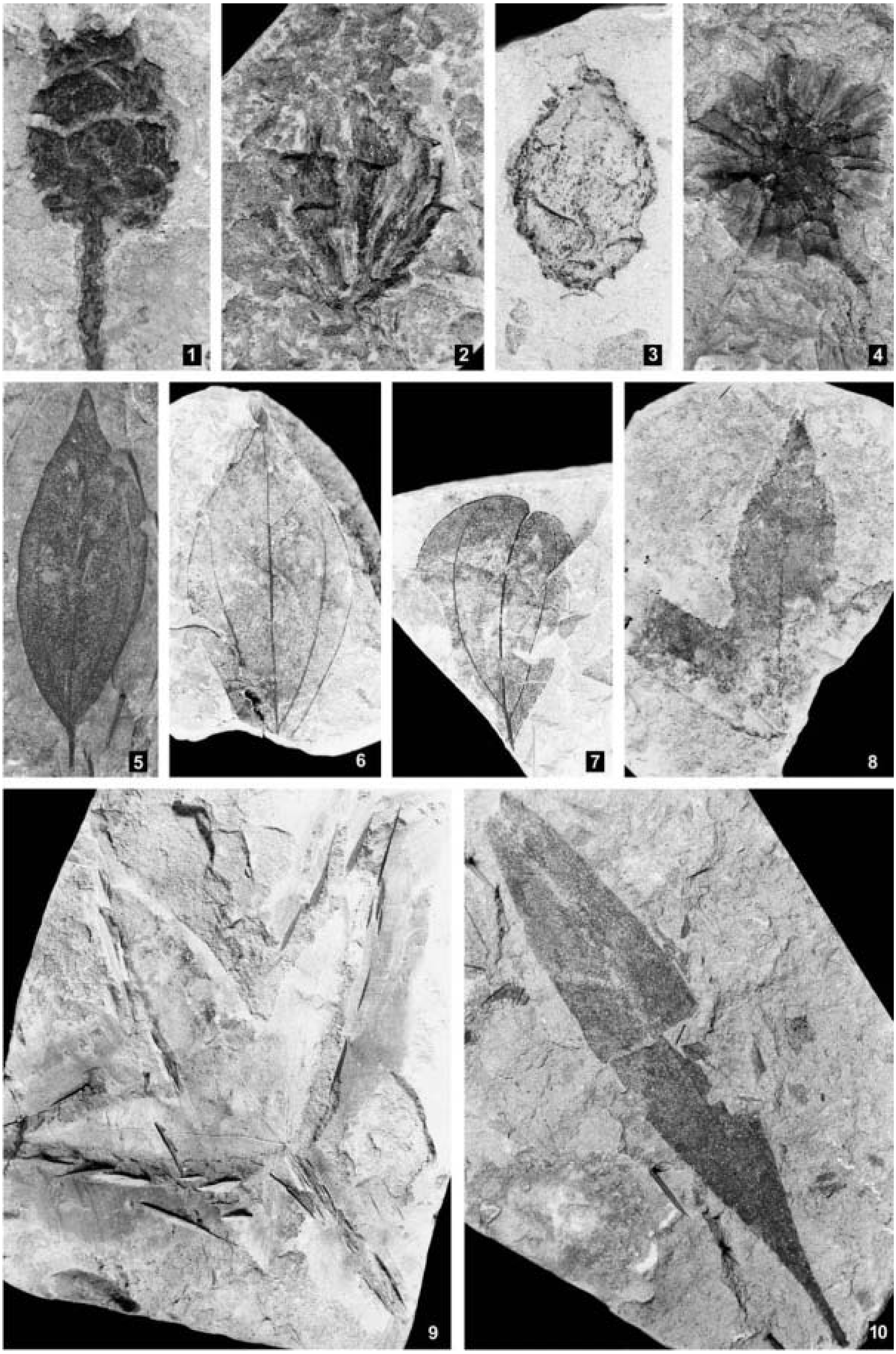

Plate I

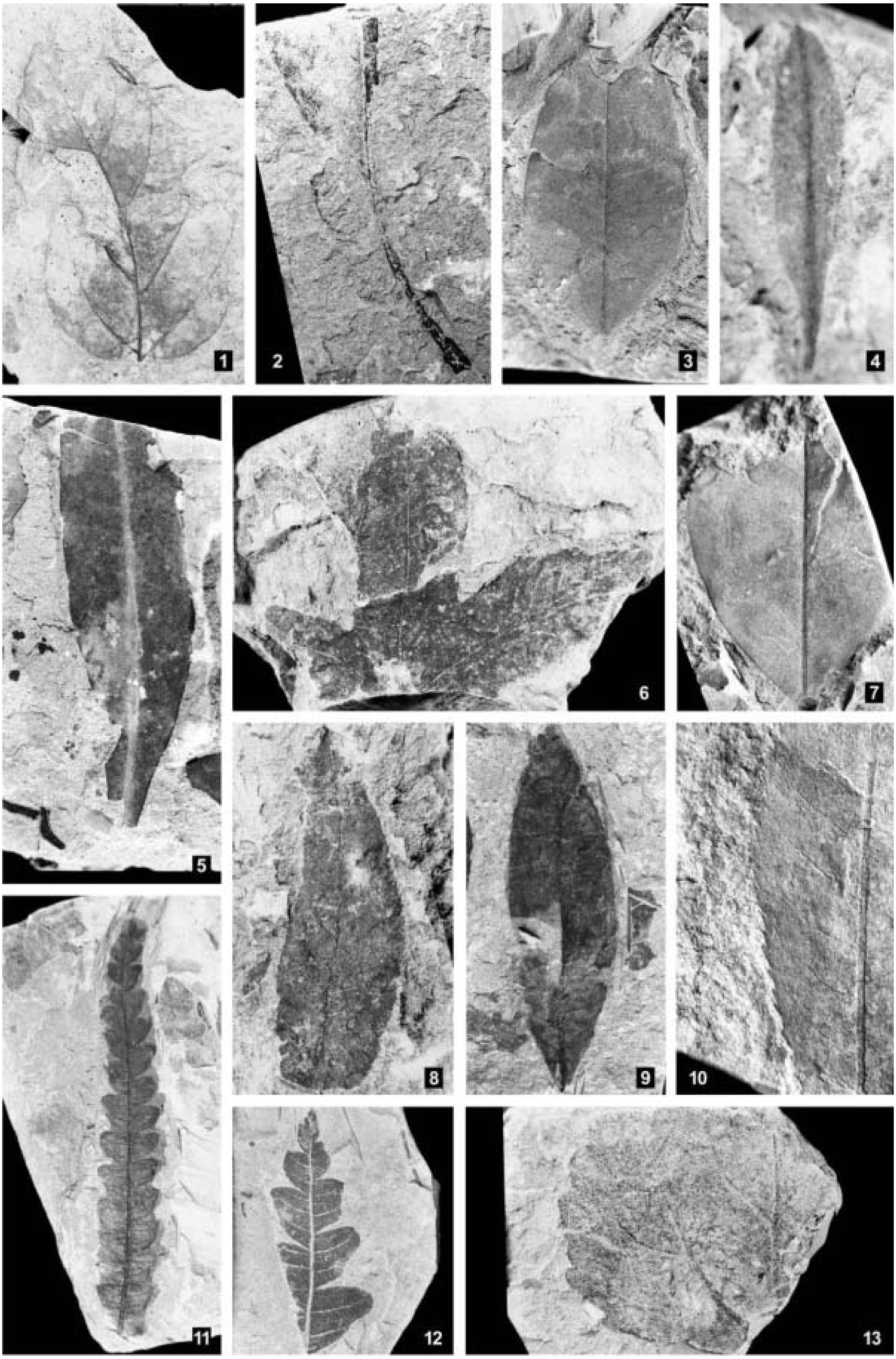

Plate II

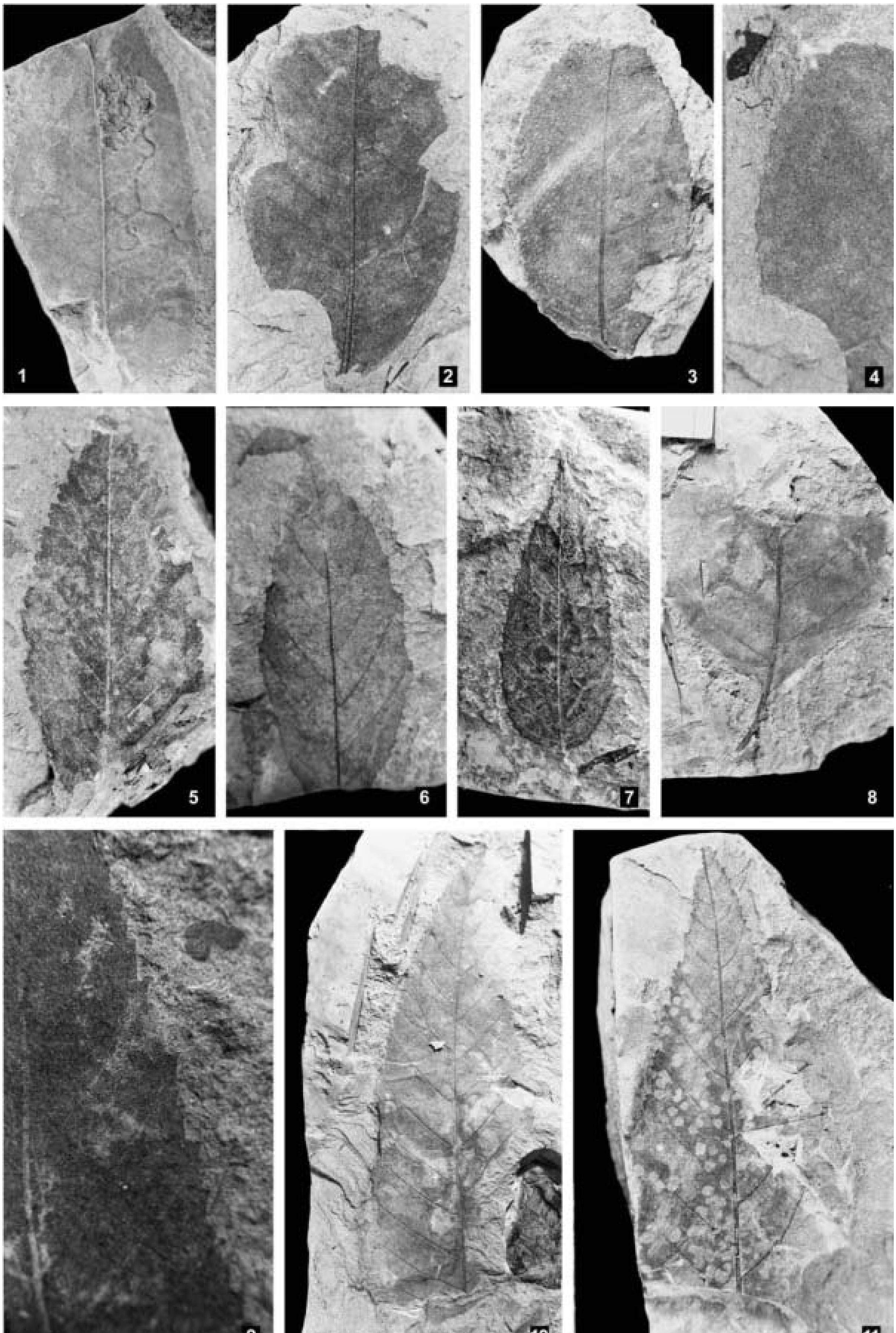

Plate III

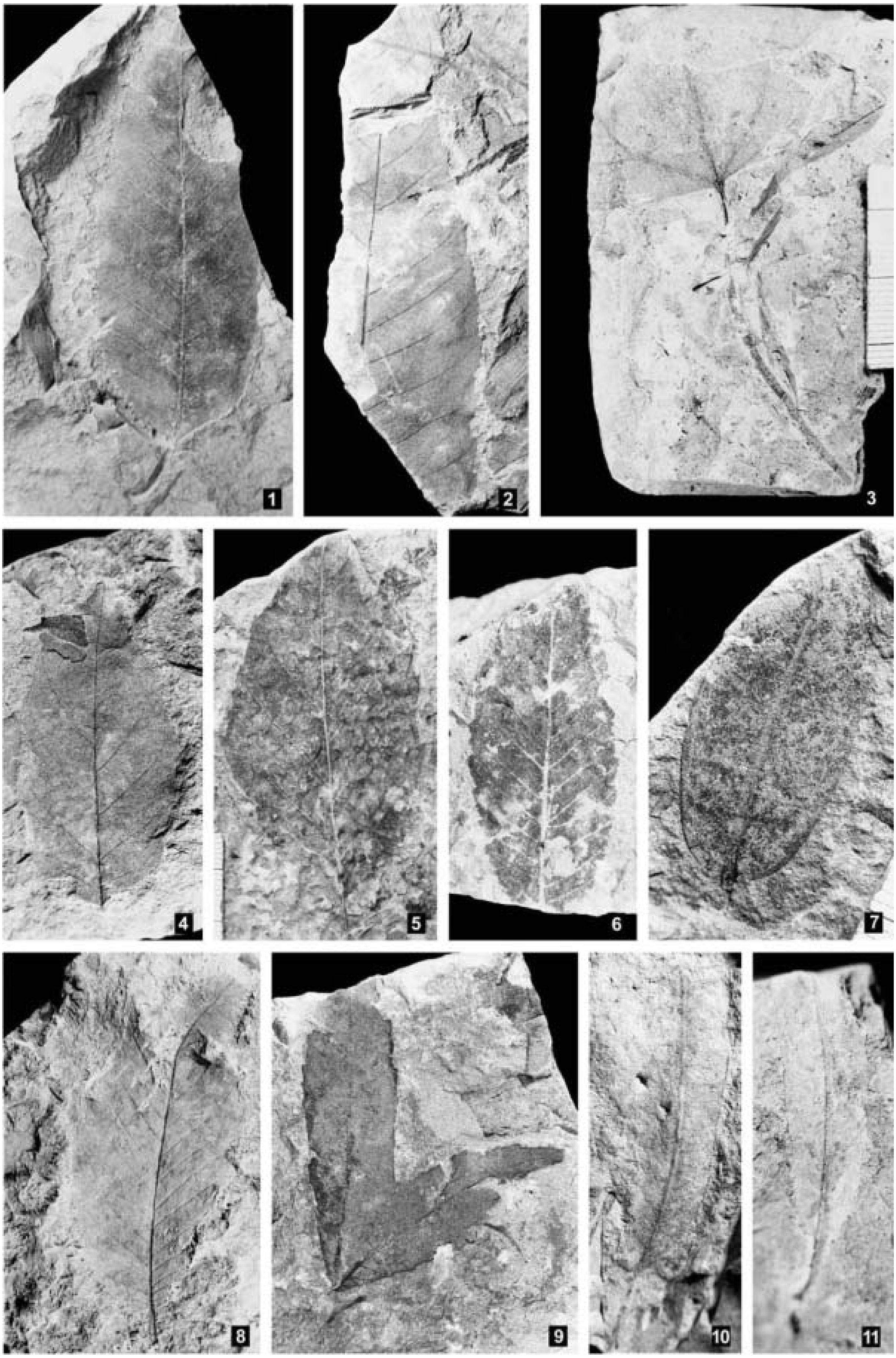

Plate IV

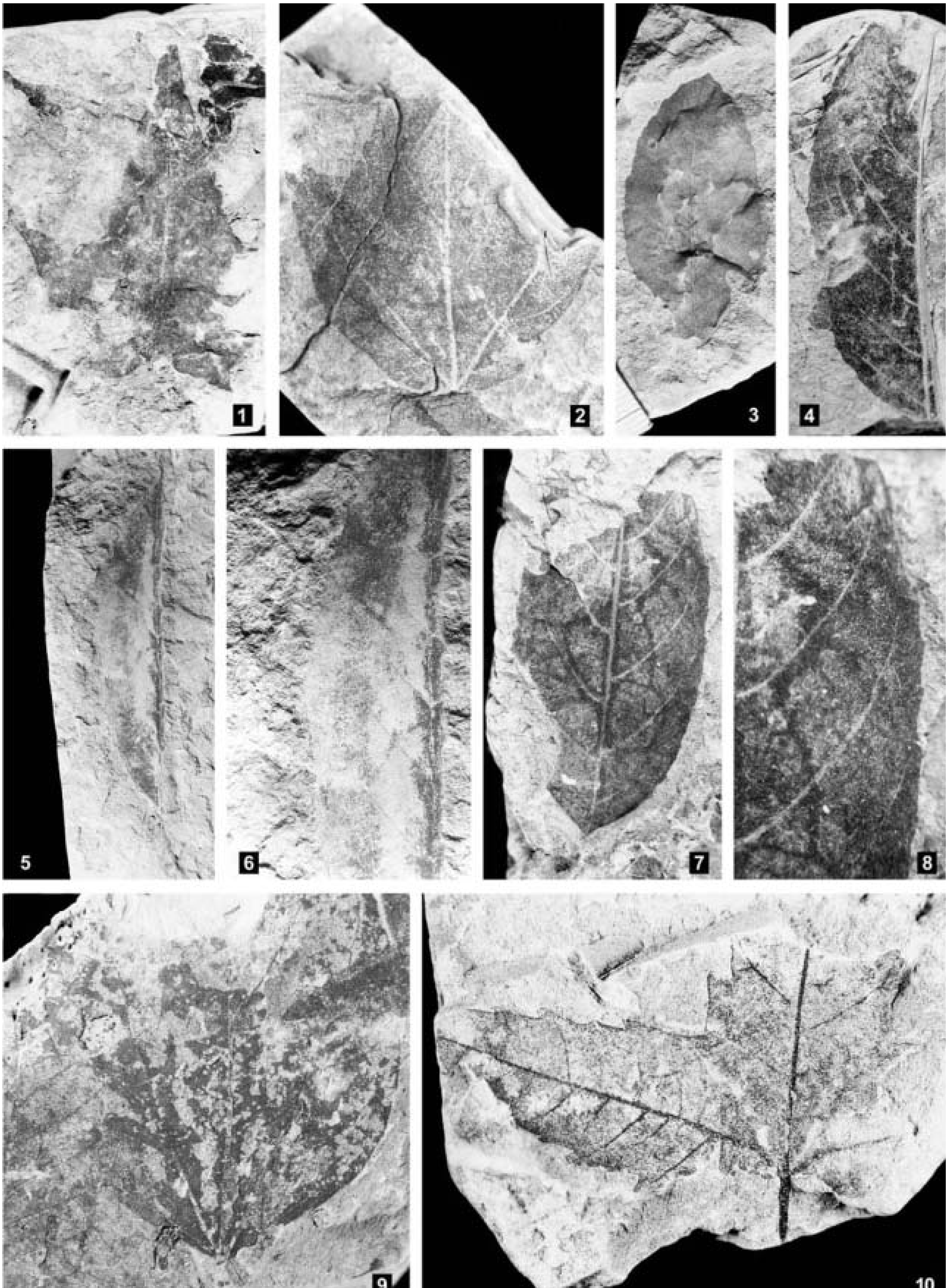

Plate V