Acta Musei Nationalis Pragae, Series B, Historia Nataturalis, 50(1994)(1–4): 25–54 issued December 1995

THE OLIGOCENE VOLCANIC FLORA OF SULETICE–BERAND NEAR ÚSTÍ NAD LABEM, NORTH BOHEMIA – A REVIEW

ZLATKO KVAČEK
Faculty of Science, Charles University, Albertov 6, 128 43 Praha 2, Czech Republic

HARALD WALTHER
Staatliches Museum für Mineralogie und Geologie, Landesmuseum des Freistaates Sachsen, Augustusstrasse 2, 01067 Dresden, Federal Republic of Germany

Kvaček, Z. et Walther, H. (1995): The Oligocene volcanic flora of Suletice-Berand near Ústí nad Labem, North Bohemia - a review. - Acta Mus. Nat. Pragae, Ser. B, Hist. Nat., 50(1994)(1-4): 25-54, Praha. ISSN 0036-5343

Abstract. This new revision of the fossil plant locality Suletice-Berand in the České středohoří Mts. is concentrated on material collected in 1896 and 1902 and stored in the State Museum of Mineralogy and Geology, Dresden and National Museum, Praha respectively. The aim is to check the floristic composition, vegetational differentiation and the relationship to other sites in the Oligocene of Central Europe. A general comparison between volcanic and lowland basinal floras is given in the light of environmental conditions.

■ flora, Oligocene, volcanites, Central Europe

Received December 14, 1994

Introduction

Most of the new monographs devoted to the Tertiary floras of Central Europe (e. g. Knobloch et Kvaček 1976, Rüffle et al. 1976, Mai et Walther 1978, 1985, 1991, Knobloch et al. in press) deal with sites connected to lowland deposits of coal basins. However, in the recent years more interest has been focused also on so-called volcanic floras, connected with quite different, upland environment (Bůžek et al. 1990, Knobloch et al. 1993, Walther in press, Bellon et al. work in progress).

Before a synthesis of the numerous sites within volcanic deposits in North Bohemia and Oberlausitz is possible, it is necessary to revise and to interpret in a modern way all local floras, mostly known from the last century. So far only a few such revisions are available (Markvartice - Bůžek et al. 1976, Seifhennersdorf - Walther in press, Bechlejovice - Knobloch 1994, Kleinsaubernitz - Walther et al. work in progress).

The present account is devoted to a classic locality of the České středohoří Mts. (Böhmisches Mittelgebirge) known as Berand, a settlement at Suletice (Engelhardt 1898), or the lower diatomite of Suletice (Sulloditz) (Kafka 1908, 1911). It is not identical with the site known as Suletice, the upper or white diatomite, which crops out some 150 m southwards at the road and has yielded also plant fossils (Laube 1880, Wentzel 1881, Menzel 1897). Still more fossiliferous layers were recovered in tuffitic complexes adjacent or interbedded with the diatomites (Kafka 1908, Gabriel, inedited manuscript). We have not been able to extend our present study on all these sites, which need a separate, more laborious effort.

The earliest collection at Berand was made by Deichmüller and Menzel at one time in 1896 from a well (see pl. 11) and described by Engelhardt (1898). This material is concentrated in the Staatliches Museum für Mineralogie und Geologie in Dresden. Further excavations made by Kafka in 1902 nearby yielded the same kind of fossil material (Kafka 1908, 1911, Brabenec 1910). These are deposited in the National Museum, Praha. We restudied both collections (about 900 and 400 specimens respectively).

New geological mapping carried out by Gabriel and Bůžek in 1964 and 1965 (Gabriel 1970 and manuscript) did not reveal this fossiliferous horizon again, in spite of various test-pits and cores made in the wider surroundings of Berand.

The leaf material is very well preserved in the firm diatomite so that the detailed venation is well seen. Unfortunately, cuticular remains, although adhearing to impressions, are covered by imprints of diatomes, so that the cell structure can be studied only occasionally (e. g. in *Tetraclinis salicornioides, „Libocedrus" suleticensis*). The fruit and seed remains are only partly identifiable as they are preserved as impressions without internal structure.

The present study has been supported by funds from the Humboldt-Stiftung and Deutsche Forschungsgemeinschaft. The authors are indebted to the curators and technical staff of the Staatliches Museum f. Mineralogie und Geologie, Dresden, namely to Mrs. cand. geol. I. Flatter, Mr. dipl. geol. L. Kunzmann, Mr. M. Röthel and Mr. K. Schade for sorting and numbering the collecions studied. Dr. J. Kvaček and Mrs. Pražanová, National Museum, Praha, have kindly helped us with the study of the collection by Kafka.

Geological setting

The České středohoří Mts. stretches in the SWW-NEE direction in North Bohemia and consists of numerous volcanic bodies and intercalated tuffs and sedimentary strata (tuffites, diatomites). The palaeontological localities in the surroundings of Suletice are situated near its centre 10 km E of Ústí nad Labem (text-fig. 1).

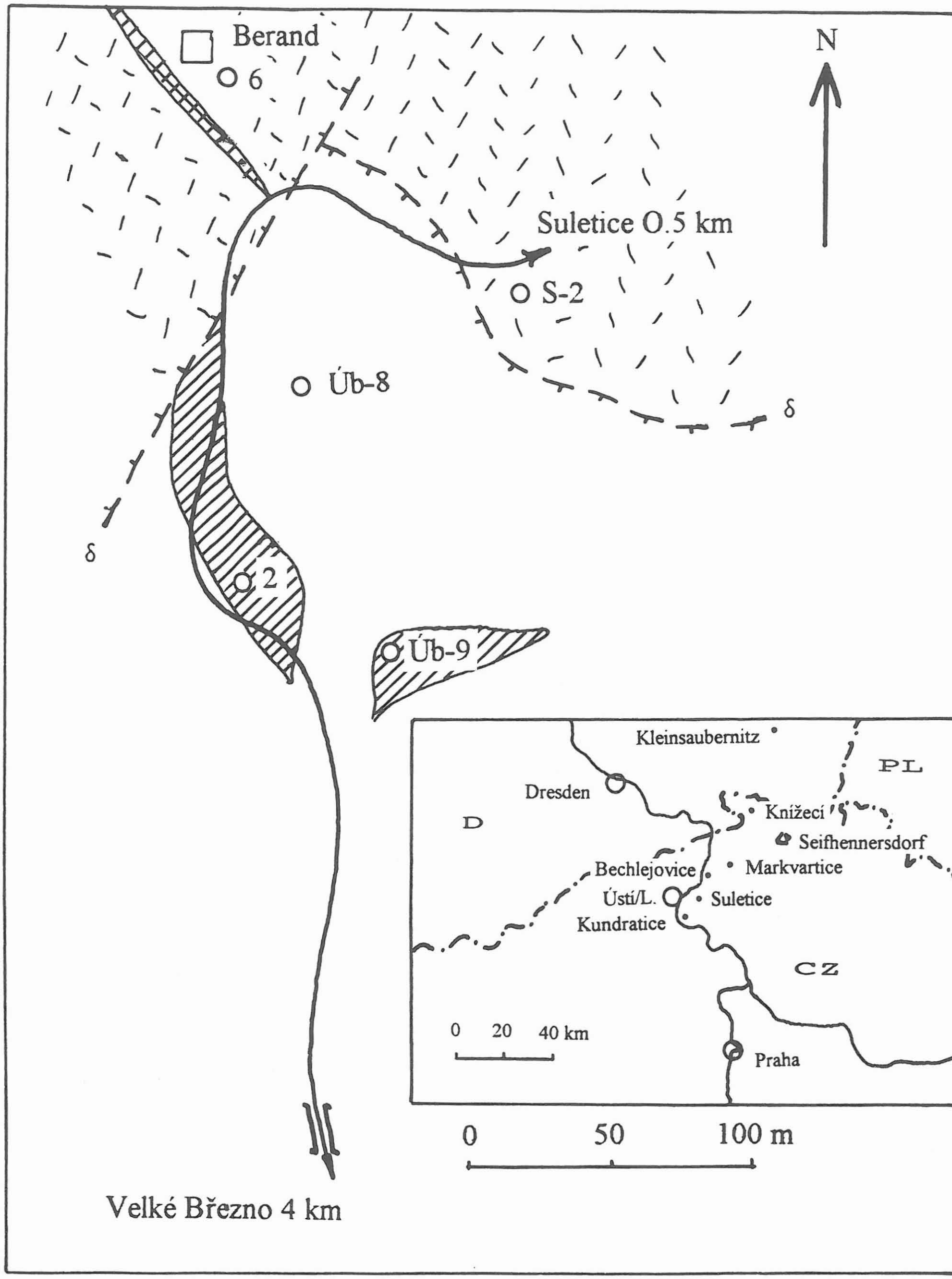
First more detailed information on the geology of Suletice has been given by Hibsch (1903), although more data are scattered in the literature (e. g. Engelhardt 1898, Kafka 1908). Geological mapping by Hibsch was later revised and complemented by cores and test pits by Procházka in 1954 and by Bůžek and Gabriel in 1964-1965 (Gabriel 1970). However, the stratigraphical position and correlation of various diatomite and other plant-bearing strata has not been satisfactorily resolved due to possible tectonics, land slides and complicated local geology (see text-fig. 2). Two main fossil-bearing sites have been known from the vicinity of Suletice. Both local floras can be distinguished easily by the type of rock.

The soft whitish well-bedded diatomite crops out in the road cut on the slope leading from the brook uphill towards Suletice at 320-325 m altitude. This layer was also reexposed by a gallery made by Kafka (1908) and in the test pit 2 by Gabriel in 1964 close to the outcrop. According to Gabriel (MS) the diatomite layer is about 1.5 m thick and underlain by the greygreen tuffite. The flora occurring in this layer are listed or described by Laube (1880), Wentzel (1881), Engelhardt (1896), Menzel (1897) and Procházka (1951). It is called „Suletice" or „upper diatomite". It is not delt with in this paper, although a brief comparison with the described flora is given below (p. 44).

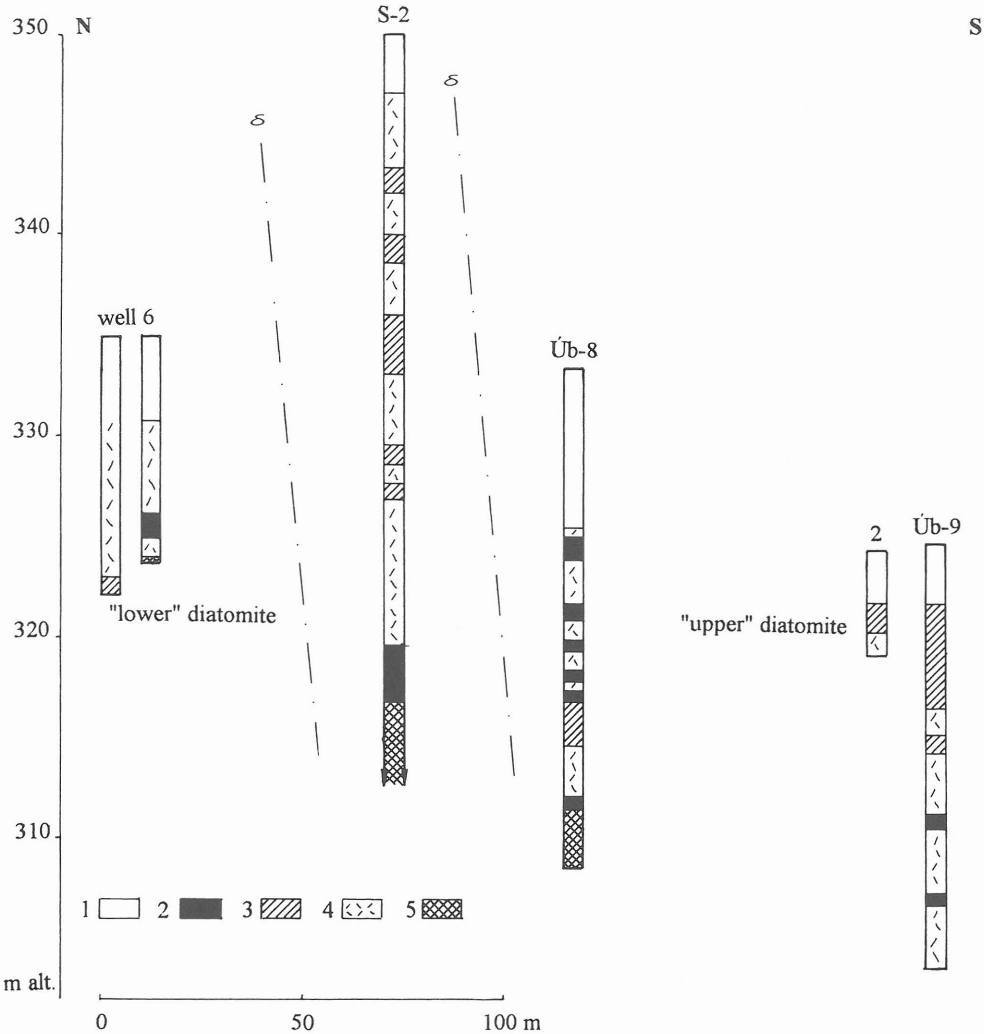
According to Kafka (1908) the underlying tuffites contain several plant horizons, one with the abundant *Comptonia acutiloba* and one with *Cercidiphyllum crenatum*. A dark tuffite, this time with a rather diversified leaf assemblage, was recovered in the test pit 6 at a depth of 9 m by Bůžek. Only a few specimens of the tuffitic layers are available in the collections and thus will be described elsewhere.

The second main site is called Berand (in this paper „Suletice-Berand"), or Suletice, the „lower diatomite". As stated above, the fossiliferous layer, a firm light brown diatomite was found in the well at a depth of 12 m (Engelhardt 1898). In a test pit made by Kafka (1908), the same type of rock was recovered at a depth of 13.5 m. The exact position of this test pit is unknown. A similar petrological type of diatomite was found in the core Úb 8 under tuffite and coaly clays at a depth of 17-18 m by Gabriel in 1965 but no samples survived.

The light brown „lower" diatomite, which is the object of our paper, was found originally in the well at a higher altitude than the layer of whitish diatomite by the road. But Kafka (1908) found it underneath the whitish „upper" layer. This discrepancy is probably due to fossil land slides or true tectonic movements. Gabriel (1970) expects the two localities Suletice-Berand (light brown diatomite) and Suletice (whitish diatomite) to be separated by faults (see text-figs. 1-2). However, both the sites do not differ fundamentally by the composition of the flora (see below). Hence it cannot be ruled out Hibsch's view (Hibsch 1903) that the outcropping layer has changed its aspect due to weathering processes and represents the identical (or approximately corresponding) horizon with that of Suletice-Berand.



Text-fig. 1. Geographical and geological situation at Suletice, according to Gabriel (1970). For explanations see text-fig. 2



Text–fig. 2. Geological sections of cores and test pits at Suletice (1 – Quaternary, 2 – dark clay/tuffite, 3 – diatomite, 4 – tuff/tuffite, 5 – basaltoid rock, δ – fault)

Systematic review

The following part includes critical taxa safely occurring at Suletice–Berand, whether revised or left open. The lack of cuticles prevented us from progressing in the cuticular studies. Such attempts must be postponed until anatomical data are available from other sites (e. g. Kundratice). For practical reasons the taxa are listed in alphabetical order. The synonyms are related to particular specimens described by Engelhardt (1898), Kafka (1908), Brabenec (1910) and others, if they are available in the collections. Abbreviations (HOLO) and (SYN) mean holotypes and syntypes.

Acer angustilobum Heer sensu Walther
Pl. 10, fig. 1

1898 *Acer angustilobum* Heer; Engelhardt, p. 30, pro parte.

For details of morphology and anatomy see Walther (1972).

Acer cf. ***dasycarpoides*** Heer

1898 *Platanus aceroides* Goeppert; Engelhardt, p. 17.

A doubtful species without known epidermal features. Morphological limits to *Acer tricuspidatum* and *A. palaeosaccharinum* are uncertain.

Acer palaeosaccharinum Stur

Pl. 8, fig. 3, text-fig. 4/3

1898 *Vitis teutonica* A. Braun; Engelhardt, p. 26.
1898 *? Platanus aceroides* Goeppert; Engelhardt, p. 17.
1898 *Acer angustilobum* Heer; Engelhardt, p. 30, pro parte.
1898 *Acer grosse-dentatum* Heer; Engelhardt, p. 30.
1898 *Acer trilobatum* (Sternberg) Heer; Engelhardt, p. 30 pro parte.
1972 *Acer palaeosaccharinum* Stur; Walther, p. 97, pl. 21, figs. 1-3, pl. 52, figs. 2-3.
1975 *Acer palaeosaccharinum* Stur; Procházka et Bůžek, p.51, pl. 20, figs. 1-3.

These coarsely dentate leaves occur typically in our volcanic floras (Walther 1972). Similar forms of *Acer haselbachense* (Mai et Walther 1991) differ in distinctly papillate lower leaf side. On the other hand, the fragmentary specimens of *A. palaeosaccharinum* have a smooth lower cuticle (Walther 1972). These two species grew in different habitats - riparian forest and mesophytic vegetation respectively.

Acer cf. ***decipiens*** A. Braun

Pl. 10, fig. 2, text-fig. 4/15

1898 *Acer decipiens* A. Braun; Engelhardt, p. 30.

Only one fragmentary specimen (with its counterimpression) which cannot be safely identified. Such forms with entire margin occur extremely rarely in the volcanic floras in question (Suletice, whitish diatomite - as *Acer pseudomonspessulanum* Unger - Procházka et Bůžek 1975, Seifhennersdorf - as *Acer loclense* Hantke, nom. superfl. - Walther 1967; as *Acer decipiens* A. Braun sensu novo - Walther 1972).

Acer tricuspidatum Bronn

Pl. 8, fig. 1

1898 *Acer trilobatum* (Sternberg) Heer; Engelhardt, p. 30.
1972 *Acer tricuspidatum* Bronn; Walther, p. 77, pl. 16, figs. 9-13, pl. 40, figs 6-9.

This species is widely distributed in swamp vegetation in the Oligocene to Pliocene, associated with *Taxodium* and *Alnus*. It is rare in mesophytic vegetation of volcanic localities (Kundratice, Seifhennersdorf).

Acer sp. (folia)

1898 *Vitis teutonica* A. Braun; Engelhardt, p. 26, pro parte.
1898 *Acer trilobatum* (Sternberg) Heer; Engelhardt, p. 30, pro parte.

Fragmentary leaves assignable to maples.

Acer sp. (fructi)

Pl. 8, fig. 5, text-fig. 4/18

1898 *Acer trilobatum* (Sternberg) Heer; Engelhardt, p. 30, pro parte.
1898 *Acer angustilobum* Heer; Engelhardt, p. 30, pro parte.

These fruit impressions do not show details important for specific determination (D.H. Mai - personal communication).

Ailanthus sp.

Pl. 8, fig. 2

1898 *Castanea kubinyi* Kovats; Engelhardt, p. 15, pro parte, non pl. 1, figs. 21-22.

Similar simple dentate leaf fossils with abmedially directed teeth occur typically in several volcanic localities. Those from Kleinsaubernitz bear cuticles suggesting an affinity to *Ailanthus* Desf., particularly to *A. altissima* (Mill.) Swingle (Walther et al. work in progress).

Ampelopsis hibschii Bůžek, Kvaček et Walther

Pl. 6, figs. 7-8

1898 *Cissus nimrodi* Ettingshausen; Engelhardt, p. 27.

This vine occurs in several Oligocene floras in volcanic as well as lowland habitats (Bechlejovice, Kundratice, Haselbach) and represents an index taxon for the Oligocene (Bůžek et al. 1981). A higher morphological variation has appeared also at the studied locality.

cf. ***Apocynophyllum*** sp.

1898 *Myrica acuminata* Unger; Engelhardt, p. 13.

Two fragmentary specimens recalling *Apocynophyllum helveticum* Heer (Mai et Walther 1978). Their affinities are doubtful.

Apocynospermum striatum Reid et Chandler

Pl. 9, fig. 2

1898 *Cypselites quadricostatus* Engelhardt, p. 22, pl. 1, figs.42, 44-45, 51.
1908 *Cypselites costatus* Heer; Kafka, p. 45.

These characteristic seeds with pappus are surely identical with the type material from the Late Eocene Bembridge Marl (Reid et Chandler 1926). For priority reasons Engelhardt's taxon should be given preference

cf. ***Betula*** vel ***Alnus*** sp.

Pl. 3, fig. 7

A fragmentary leaf of betulaceous venation but with the badly preserved margin.

Bryophyta gen. et sp. indet.

Pl. 1, fig. 2

1898 *Hypnum capillarifolium* Engelhardt, p. 10, pl. 1, fig. 12.
1898 *Hypnum parvifolium* Engelhardt, p. 10, pl. 1, fig. 26.

The necessary anatomical and morphological details are not preserved so that a more precise determination is not possible.

Carpinus grandis Unger

Pl. 4, fig. 1, text-fig. 4/1

1898 *Betula brongniartii* Ettingshausen; Engelhardt, p. 14.
1898 *Carpinus pyramidalis* Gaudin; Engelhardt, p. 14.
1898 *Corylus insignis* Heer; Engelhardt, p. 14.
1898 *Ulmus braunii* Heer; Engelhardt, p. 16.
1908 *Carpinus grandis* Unger; Kafka, p. 45.

This form species cannot be specifically differentiated due to uniform leaf morphology. It occurs only at Seifhennersdorf in greater quantities, elsewhere (also at Suletice-Berand) as an accessory mesophytic element.

Carpinus mediomontana Mai

Pl. 4, fig. 4

1898 *Carpinus neilreichii* Kovats; Engelhardt, p. 14, pl. 1, fig. 13.

According to Mai (in Mai et Walther 1978) this unique specimen from Suletice-Berand belongs most probably to *C. mediomontana,* typical of Oligocene floras of Central Europe. Indeed, by its size and form it matches well with the type specimens from Haselbach.

Carpolithes sp. div.

Pl. 6, fig. 1, pl. 10, fig. 3

1898 *Carya ventricosa* Sternberg sp.; Engelhardt, p. 35, pl. 3, figs. 66-67.
1898 *Castanea kubinyi* Kovats; Engelhardt, p. 15, pl. 1, figs. 21-23, 25.
1898 *Embothrium salicinum* Heer; Engelhardt, p. 21.
1908 *Juglans costata* Unger; Kafka, p. 45.
1908 *Andromeda narbonensis* Saporta; Kafka, p. 45.

Several impressions of bigger and smaller fruit and seed remains do not show the necessary characteristics to be safely identified (D. H. Mai, personal communication). We do not list the full synonymy from Engelhardt (1898), which partly refer to objects without any value.

Carya serrifolia (Goeppert) Kräusel

Pl. 4, fig. 3, pl. 6, figs. 2-3, text-fig. 4/9

1898 *Juglans bilinica* Unger; Engelhardt, p. 34, pro parte.
1898 *Juglans palaeoporcina* Engelhardt, p. 35.
1898 *Pterocarya denticulata* Heer; Engelhardt, p. 36, pro parte.
1908 *Pterocarya denticulata* Unger; Kafka, p. 45.

Leaflets of such a form are generally assigned to *Carya*, although a specific differentiation is not guaranteed. This element is only rarely bound to the riparian forest as the Recent *C. pecan* (Walther 1975 - „Pekan-Eichenwald" in Seifhennersdorf). In the case of volcanic floras it occurs also in the mesophytic vegetation (Walther 1974).

Celtis sp.

Pl. 3, fig. 6

1898 *Celtis bohemica* Engelhardt, p. 16, pl. 1, fig. 55.

Fossil species of *Celtis* cannot be distinguished without a wider revision of European records. These remains occur very sporadically in the volcanic floras.

cf. ***Cephalotaxus*** sp.

Pl. 1, fig. 4

1898 *Mimosites cassiaeformis* Ettingshausen; Engelhardt,p. 42, pl. 2, fig. 37.
1898 ? *Podocarpus eocenica* Unger; Engelhardt, p. 13.
1909 *Podocarpus eocenica* Unger; Menzel, p. 106, pl. 5, figs. 9-10.

Cephalotaxus-like leaf remains without epidermal characters are hardly determinable, which is also the case of few remains found at Suletice-Berand. „*Amentotaxus*" *parvifolia* Walther (Kundratice, Seifhennersdorf) belongs to such type of fossils (Kvaček 1984, Walther 1975), although small specimens of *Torreya bilinica* Sap. et Mar. are also morphologically similar

Cornus studeri Heer

Pl. 8, fig. 7, text-fig. 4/8

1898 *Cornus rhamnifolia* Weber; Engelhardt, p. 27.
1898 *Ficus lereschii* Heer; Engelhardt, p. 17.
1898 *Laurus agathophyllum* Unger; Engelhardt, p. 18.
1898 *Laurus fuerstenbergii* A. Braun; Engelhardt, p. 18.
1898 *Persoonia firma* Heer; Engelhardt, p. 21.
1898 *Populus mutabilis* Heer; Engelhardt, p. 17.
1898 *Rhamnus graeffii* Heer; Engelhardt, p. 34.
1898 *Terminalia radobojensis* Unger; Engelhardt, p. 37.

This characteristic leaf form (Heer 1859) occurs in most volcanic floras (Kundratice, Seifhennersdorf, Bechlejovice, Knížecí) but exceptionally elsewhere as a mesophytic element.

Craigia bronnii (Unger) Kvaček, Bůžek et Manchester

Pl. 6, fig. 6, text-fig. 4/16

1898 *Hiraea bohemica* Engelhardt, p. 30, pl. 1, fig. 66 (HOLO).
1898 *Ptelea intermedia* Ettingshausen; Engelhardt, p. 37, pl. 2, fig. 19.
1898 *Ptelea microcarpa* Ettingshausen; Engelhardt, p. 37.
1898 *Ulmus bronnii* Unger; Engelhardt, p. 16.
1989 *Pteleaecarpum bronnii* (Unger) Weyland; Bůžek, Kvaček et Manchester, p. 484, text-figs. 7-9.

Craigia-fruits occur rarely at Suletice-Berand and also in other volcanic floras (Bůžek et al. 1989, as *Pteleaecarpum*). In the Most Basin these plants grew in connection with swamp assemblages but surely tolerated less humid habitats as well.

cf. ***Cyclocarya cyclocarpa*** (Schlechtendal) Knobloch

Pl. 6, fig. 4

1898 *Corylus insignis* Heer; Engelhardt, p. 14, pro parte.
1898 *Pterocarya denticulata* Heer; Engelhardt, p. 36, pro parte.

A few leaf fragments recall by the marginal dentation this alluvial element, known particularly from the Thierbach Complex (Mai et Walther 1991). It occurs sporadically also at Knížecí (Pirskenberg) and Seifhennersdorf (Knobloch 1961, Mai 1963, Walther 1964).

Daphnogene cinnamomifolia (Brongniart) Unger (forma „***cinnamomifolia***")

Pl. 1, fig. 2, text-fig. 4/19

1898 *Cinnamomum buchii* Heer; Engelhardt, p. 19.
1898 ? *Cinnamomum retusum* Heer; Engelhardt, p. 19.
1898 *Cinnamomum scheuchzeri* Heer; Engelhardt, p. 19.
1898 *Smilax moskenbergensis* Ettingshausen; Engelhardt, p. 12, pl. 1, fig. 18.
1898 *Cinnamomum* with *Sphaeria menzelii* Engelhardt, p. 8, pl. 1, fig. 2 (HOLO).

This form represents shade leaves of the following entity (Kvaček et Walther 1976, Kunzmann, Kvaček et Walther work in progress). It occurs in smaller quantity.

Daphnogene cinnamomifolia (Brongniart) Unger (forma „***lanceolata***")

Text-fig. 4/10

1898 *Banksia deikeana* Heer; Engelhardt, p. 22, pl. 1, fig. 56.
1898 *Cinnamomum lanceolatum* A. Braun; Engelhardt, p. 19.
1898 *Cinnamomum rossmaessleri* Heer; Engelhardt, p. 19.
1898 *Daphnogene lanceolata* (Unger) Heer; Engelhardt, p. 19.
1898 *Daphnogene ungeri* Heer; Engelhardt, p. 20.
1898 *Eucalyptus peridis* Ettingshausen; Engelhardt, p. 37, pl. 3, fig. 4.
1898 *Phyllites myrtaceoides* Engelhardt, p. 43, pl. 3, fig. 28 (HOLO).
1908 *Cinnamomum polymorphum* A. Braun sp.; Kafka, p. 45.

The more or less elongate forms of *Daphnogene cinnamomifolia* prevail at most Oligocene localities of Europe and obviously represent sun leaves (Kvaček et Walther 1976). In volcanic floras this element occurs abundantly, but also as an accessory plant fossil and it is lacking at Bechlejovice. In Hammerunterwiesenthal and Valeč in the Doupov Mts. it prevails in tuffite deposits as a possible „pioneer" plant.

Dicotylophyllum maii Bůžek, Holý et Kvaček

Pl. 9, fig. 7, pl. 10, fig. 4, text-fig. 4/17

1898 *Diospyros brachysepala* A. Braun; Engelhardt, p. 17.
1898 *Ficus arcinervis* Rossmässler; Engelhardt, p. 25.
1898 ? *Maytenus deichmuelleri* Engelhardt, p. 33, pl. 2, fig. 11 (HOLO).
1898 *Piscidia antiqua* Unger; Engelhardt, p. 40, pl. 3, fig. 71.
1898 *Sapotacites townshendii* Gaudin; Engelhardt, p. 25, pl. 2, fig. 4.
1898 *Terminalia radobojensis* Unger; Engelhardt, p. 37.

In spite of the lack of epidermal features, this characteristic entire-margined leaf form, as described by Bůžek et al. (1976), is recognizable. Its relationship remains obscure.

Dicotylophyllum sp. div.

Pl. 9, fig. 6, pl. 10, fig. 6

1898 *Dicotylophyllum* sp. with *Sphaeria ettingshausenii* Engelhardt, p. 8, pl. 1, fig. 5 (HOLO of the latter).
1898 *Ficus lanceolata* Heer; Engelhardt, p. 17.
1898 *Populus mutabilis* Heer; Engelhardt, p. 17.
1898 *Porana ungeri* Heer; Engelhardt, p. 24.
1898 *Sterculia tenuinervis* Heer; Engelhardt, p. 28, pl. 2, fig. 28.
1898 *Styrax ambra* Ludwig; Engelhardt, p. 25, pl. 2, fig. 16.

Various entire-margined or even trilobate leaf forms, usually as fragments, cannot be safely distinguished as specific entities. They are referred to here to show Engelhardt's doubtful identifications.

Dombeyopsis sp.

Pl. 9, fig. 1, text-fig. 4/24

1898 *Dombeyopsis dechenii* Weber; Engelhardt, p. 29, pl. 3, fig. 8.
1898 *Sterculia labrusca* Unger; Engelhardt, p. 28.

Lobate leaves with palmate venation, which occur in association with *Cragia*-fruits elsewhere (Kvaček 1993), differ from the above quoted specimens by wider lobes.

cf. ***Dusembaya*** sp.

Pl. 2, fig. 7

1898 *Smilax* (fructus); Engelhardt, p. 12, pl. 1, fig. 28.

The roundish seed imprint recalls some Cabombaceae, revised recently by Mai (1988) from Seifhennersdorf.

„***Elaeodendron***" sp.

Pl. 8, fig. 4

1898 *Celastrus andromedae* Unger; Engelhardt, p. 32.
1898 *Celastrus cassinaefolius* Ettingshausen; Engelhardt, p. 32.
1898 *Celastrus dubius* Unger; Engelhardt, p. 32.
1898 *Celastrus dubius* with *Xylomites celastrae* Engelhardt, p. 9, pl. 1, fig. 16 (HOLO of the latter).
1898 *Celastrus palaeo-acuminata* Engelhardt; Engelhardt, p. 32.
1898 *Celastrus persei* Unger; Engelhardt, p. 32.
1898 *Elaeodendron degener* Unger; Engelhardt, p. 33.
1898 *Elaeodendron europaeus* Ettingshausen; Engelhardt, p. 29.
1898 *Evonymus latoniae* Unger; Engelhardt, p. 33, pl. 2, fig. 12, 22.
1898 *Ilex aspera* Unger; Engelhardt, p. 34, pl. 1, fig. 70.
1898 *Maytenus engelhardtii* Menzel with *Phyllerium mayteni* Engelhardt, p. 8, pl. 1, fig. 7 (HOLO of the latter).
1898 *Psidium tertiarium* Engelhardt, p. 38, pl. 3, fig. 10 (HOLO).
1898 *Quercus mediterranea* Unger; Engelhardt, p. 15.
1898 *Ternstroemia bilinica* Ettingshausen; Engelhardt, p. 29.
1908 *Elaeocarpus europaeus* Ettingshausen; Kafka, p. 45.

The systematic position of this characteristic simple glandular dentate form, which occurs in most volcanic floras in North Bohemia and Oberlausitz, can be possibly elucidated only with the aid of cuticular study.

Engelhardia orsbergensis (Wessel et Weber) Jähnichen, Mai et Walther

Pl. 5, figs. 1-2, 7, text-fig. 4/11

1898 *Ardisia myricoides* Ettingshausen; Engelhardt, p. 25.
1898 *Banksia haeringiana* Ettingshausen; Engelhardt, p. 21, pl. 1, fig. 39.
1898 *Banksia longifolia* Ettingshausen; Engelhardt, p. 21.
1898 *Callicoma microphylla* Ettingshausen; Engelhardt, p. 28.
1898 *Carya elaenoides* Unger; Engelhardt, p. 35.
1898 *Celastrus ettingshausenii* Heer; Engelhardt, p. 32.
1898 *Engelhardtia detecta* Saporta; Engelhardt, p. 36, pl. 3, fig. 7.
1898 *Fraxinus excelsior* Ettingshausen; Engelhardt, p. 23, pl. 1, fig. 59.
1898 *Hakaea gaudinii* Heer; Engelhardt, p. 22, pl. 1, fig. 40.
1898 *Ilex ambigua* Unger; Engelhardt, p. 35.
1898 *Myrsine clethrifolia* Saporta; Engelhardt, p. 24.
1898 *Myrsine celastroides* Unger; Engelhardt, p. 24.
1898 *Myrica acuminata* Unger; Engelhardt, p. 13.
1898 *Myrica banksiaefolia* Unger; Engelhardt, p. 14.
1898 *Myrica laevigata* Heer; Engelhardt, p. 13.
1898 *Myrica lignitum* (Unger) Saporta; Engelhardt, p. 13.
1898 *Panax longissimum* Unger; Engelhardt, p. 26.
1898 *Rhus elaeodendroides* Unger; Engelhardt, p. 37.
1898 *Rhus juglandogene* Ettingshausen; Engelhardt, p. 37.
1898 *Rhus stygia* Unger; Engelhardt, p. 37, pl. 3, fig. 3.
1898 *Sapindus falcifolius* Weber; Engelhardt, p. 31.
1898 *Sapindus pythii* Unger; Engelhardt, p. 31.
1898 *Xanthoxylon braunii* Weber; Engelhardt, p. 36, pl. 3, fig. 30.
1908 *Carya elaenoides* Unger; Kafka, p. 45.

1908 *Engelhardia detecta* Saporta; Kafka, p. 45.
1908 *Leguminosites* sp.; Kafka, p. 45.
1977 *Engelhardia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther, p. 329, pl. 43, figs. 1-3, pl. 44, figs. 1-4.

The *Engelhardia*-group has become complicated by having been split into variously interpreted generic entities (Manchester 1987, Iljinskaja in Budantsev 1994). We employ the older interpretation of Jähnichen et al. (1977) of *Engelhardia* sensu lato, subdivided into infrageneric taxa.

The *Engelhardia*-foliage dominates at Suletice-Berand (mostly leaflets, but also several leaf fragments) and shows greater size variation. Unusually large specimens are common, in contrast to other Tertiary localities (e. g. the Haselbach Complex), where small forms prevail. At Suletice-Berand, larger forms may indicate that these mesophytic trees grew on the very border of the lake. Their foliage growing in the lower part of the crown and on rejuvenilized shoots could easily reach the place of fossilisation (as in *Zelkova*). In basinal regions (Haselbach) *Engelhardia* has been interpreted as a mesophytic element (Mai et Walther 1978), which rarely grew in river-side habitats (Kunzmann 1994).

Engelhardia macroptera (Brongniart) Unger

Pl. 5, fig. 6, text-fig. 4/7

1898 *Engelhardtia brongniartii* Saporta; Engelhardt, p. 36.
1908 *Engelhardtia brongniartii* Saporta; Kafka, 1908, p. 45.
1977 *Engelhardia macroptera* (Brongniart) Jähnichen, Mai et Walther, p. 346, pl. 54, figs. 6-10.

In contrast to the foliage, the fruits of *Engelhardia* occur much more rarely at Suletice-Berand.

Hydrangea microcalyx Sieber

Pl. 7, fig. 5

1898 *Porana ungeri* Heer; Engelhardt, p. 24, pl. 2, fig. 7.
1898 *Viburnum oligocaenicum* Engelhardt, p. 34, pl. 1, fig. 10 (HOLO).
1898 *Ziziphus protolotus* Unger; Engelhardt, p. 34, pl. 1, fig. 10.
1908 *Porana oeningensis* Heer; Kafka, p. 45, text-fig. 20.

Mai (1985) recognized these petaloid calycis at the type locality Kučlín as well as at Suletice-Berand and Seifhennersdorf. No corresponding foliage is known.

Icaciniphyllum artocarpites (Ettingshausen) Kvaček et Bůžek

Pl. 8, figs. 1-2, pl. 10, fig. 5, text-fig. 4/5

1898 *Ampelopsis bohemica* Engelhardt, p. 27, pl. 2, figs. 23-26 (SYN)
1898 *Amygdalus persicifolia* Weber; Engelhardt, p. 38, pl. 3, fig. 11.
1898 *Ceanothus ebuloides* Weber; Engelhardt, p. 35.
1898 *Cheilanthes oeningensis* Heer; Engelhardt, p. 10, pl. 2, fig. 39.
1898 *Celastrus europaeus* Unger; Engelhardt, p. 32, pl. 2, fig. 15.
1898 *Celastrus microtropoides* Ettingshausen; Engelhardt, p. 33.
1898 *Cissus nimrodi* Ettingshausen; Engelhardt, p. 27.
1898 *Cupania neptuni* Unger; Engelhardt, p. 31, pl. 2, fig. 39.
1898 *Elaeodendron grandifolium* Engelhardt, p. 33, pl. 2, fig. 30 (HOLO).
1898 ? *Ficus lanceolata* Heer; Engelhardt, p. 16.
1898 *Grewiopsis saportana* Lesquereux; Engelhardt, p. 29, pl. 2, fig. 27.
1898 ? *Hippocratea bilinica* Ettingshausen; Engelhardt, p. 34.
1898 *Ilex stenophylla* Unger; Engelhardt, p. 34, pl. 2, fig. 33.
1898 *Juglans acuminata* A. Braun; Engelhardt, p. 35.
1898 *Juglans vetusta* Heer; Engelhardt, p. 35.
1898 *Laurus agathophyllum* Unger; Engelhardt, p. 18.
1898 *Monocera europaea* Ettingshausen; Engelhardt, p. 29.
1898 *Phyllites amphirocifolius* Engelhardt, p. 42, pl. 3, figs. 47, 68, 75 (SYN).
1898 *Phyllites quercioides* Engelhardt, p. 42, pl. 3, fig. 29 (HOLO).
1898 *Phyllites symplocoides* Engelhardt, p. 42, pl. 3, fig. 38 (HOLO).
1898 *Quercus artocarpites* Ettingshausen; Engelhardt, p. 16.
1898 *Quercus charpentieri* Heer; Engelhardt, p. 15.
1898 *Quercus gmelinii* A. Braun; Engelhardt, p. 15.
1898 *Styrax acuminatifolius* Engelhardt, p. 25, pl. 2, fig. 8 (HOLO).

1898 *Viburnum oligocaenicum* Engelhardt, p. 22, pl. 1, fig. 61 (HOLO).
1908 *Quercus furcinervis* Rossmässler sp.; Kafka, p. 45.

Kvaček et Bůžek (1995) have shown that this variable type of foliage, well represented in Suletice-Berand, should belong to the fruits of *Palaeohosiea* Kvaček et Bůžek. *Palaeohosiea suleticensis* Kvaček et Bůžek occurs abundantly e. g. in the test pit 2 at Suletice-Berand.

Juglandaceae amenta

Pl. 5, figs. 3-5, pl. 6, fig. 5

1898 *Myrica* (amenta), Engelhardt, in sched.

Two small catkins, one of them (Kafka collection) yielding the pollen in situ of the *Engelhardia*-type (*Engelhardtioidites microcoryphaeus* (R.Potonié) R. Potonié). The pollen is triporate, subtriangular, 16 to 20 µm across, smooth.

Laurocarpum sp.

Pl. 2, figs. 6, 8

1898 *Cinnamomum polymorphum* A. Braun; Engelhardt, p. 19, pl. 3, fig. 65.
1908 *Aristolochia aesculapi* Heer; Kafka, 1908, p.45, text-fig. 21.

The fruit impressions quoted above recall *Cinnamomum* Boehmer and *Litsea* Lamarck respectively (cf. Mai 1971).

Laurophyllum cf. ***acutimontanum*** Mai

Pl. 2, fig. 3, text-fig. 4/14

1898 ? *Acerates veterana* Heer; Engelhardt, p. 23.
1898 *Banksia cuneifolia* Heer; Engelhardt, p. 21, pl. 1, fig. 57.
1898 *Cassia zephyri* Unger; Engelhardt, p. 40.
1898 *Daphne protogaea* Ettingshausen; Engelhardt, p. 20.
1898 *Echitonium cuspidatum* Heer; Engelhardt, p. 23, pl. 2, figs. 1-2.
1898 *Elaeagnus acuminata* Weber; Engelhardt, p. 20.
1898 *Eucalyptus oceanica* Unger; Engelhardt, p. 37.
1898 *Labatia salicites* Wessel et Weber; Engelhardt, p. 34, pl. 2, fig. 20.
1898 *Laurus buchii* Ettingshausen; Engelhardt, p. 18.
1898 *Laurus ocoteaefolia* Ettingshausen; Engelhardt, p. 18, pro parte.
1898 *Laurus primigenia* Unger; Engelhardt, p. 17.
1898 *Laurus reussii* Ettingshausen; Engelhardt, p. 18, pro parte.
1898 *Laurus stenophylla* Ettingshausen,; Engelhhardt, p. 18, pl. 1, fig. 43.
1898 *Nectandra arcinervia* Ettingshausen; Engelhardt, p. 20, pro parte.
1898 *Salix angusta* A. Braun; Engelhardt, p. 17, pro parte.

The laurophyllous leaves are approximately differentiated according to the venation and form but the lack of cuticle prevents us from giving precise identifications.

Laurophyllum cf. ***medimontanum*** Bůžek, Holý et Kvaček

Pl. 2, fig. 5, text-fig. 4/13

1898 *Euonymus tenuifolius* Engelhardt, p. 33, pl. 2, fig. 34 (HOLO).
1898 *Laurus ocoteaefolia* Ettingshausen; Engelhardt, p. 18, pro parte.
1898 *Laurus reussii* Ettingshausen; Engelhardt, p. 10, pro parte.
1898 *Laurus stenophylla* Ettingshausen; Engelhardt, p. 18, pl. 1, fig. 41.
1898 *Salix angusta* A. Braun; Engelhardt, p. 17.
1898 *Salix longa* A. Braun; Engelhardt, p. 17.

Laurophyllum cf. ***pseudoprinceps*** Weyland et Kilpper

Pl. 2, fig. 4

1898 *Laurus lalages* Unger; Engelhardt, p. 18.
1898 *Laurus primigenia* Unger; Engelhardt, p. 17.
1898 *Laurus protodaphne* Weber; Engelhardt, p. 18.
1898 *Nectandra arcinervia* Ettingshausen; Engelhardt, p. 20, pro parte.
1898 *Laurus* sp., Engelhardt in sched.

Leguminosae gen. et sp. indet. (forma 1)

Pl. 7, figs. 1-2

1898 *Acacia dubia* Engelhardt, p. 41, pl. 3, fig. 24 (HOLO).
1898 *Acacia sotzkiana* Unger; Engelhardt, p. 41.
1898 *Caesalpinia haidingeri* Ettingshausen; Engelhardt, p. 42.
1898 *Caesalpinia norica* Unger; Engelhardt, p. 42, pro parte.
1898 *Caesalpinia townshedii* Heer; Engelhardt, p. 41.
1898 *Cassia berenices* Unger; Engelhardt, p. 40.

Numerous entire-margined more or less elliptic leaflets with a short petiolule occur quite often at Suletice-Berand. They are partly very small, partly more or less asymmetric (forma 1), or oval (forma 2), medium sized (forma 3), or quite large (forma 4). A natural classification cannot be done on the available characteristics.

Leguminosae gen. et sp. indet. (forma 2)

Pl. 7, fig. 8, text-fig. 4/6

1898 *Andromeda protogaea* Unger; Engelhardt, p. 26.
1898 *Caesalpinia norica* Unger; Engelhardt, p. 25, pro parte.
1898 *Caesalpinia haidingeri* Ettingshausen; Engelhardt, p. 42, pl. 3, figs. 31, 35-36.
1898 *Caesalpinia townshedi* Heer; Engelhardt, p. 41.
1898 *Cassia ambigua* Unger; Engelhardt, p. 40.
1898 *Cassia lignitum* Unger; Engelhardt, p. 40.
1898 *Cassia stenophylla* Heer; Engelhardt, p. 40.
1898 *Colutea salteri* Heer; Engelhardt, p. 39, pl. 3, fig. 14.
1898 *Inga oligocaenica* Engelhardt, p. 39, pl. 3, fig. 12 (HOLO).
1898 *Leguminosites erythrinioides* Engelhardt, p. 41.
1898 *Leguminosites proserpinae* Heer; Engelhardt, p. 41, pl. 3, figs. 17, 20, 23.
1898 *Podocarpum lyellianum* Heer; Engelhardt, p. 39.
1898 *Sapotacites minor* Ettingshausen; Engelhardt, p. 24.
1898 *Vaccinium acheronticum* Unger; Engelhardt, p. 25.

Leguminosae gen. et sp. indet (forma 3)

Text-fig. 4/25

1898 *Caesalpinia falkoneri* Heer; Engelhardt, p. 42, pl. 3, fig. 28.
1898 *Cassia berenices* Unger; Engelhardt, p. 40.
1898 *Cassia fischeri* Heer; Engelhardt, p. 40, pl. 3, fig. 19.
1898 *Cassia lignitum* Unger; Engelhardt, p. 40.
1898 *Cassia phaseolites* Unger; Engelhardt, p. 40 pro parte.
1898 *Cassia stenophylla* Heer; Engelhardt, p. 40.
1898 *Leguminosites erythrinoides* Engelhardt, p. 41.
1898 *Leguminosites proserpinae* Heer; Engelhardt, p. 41.
1898 *Leguminosites rotundatus* Heer; Engelhardt, p. 41, pl. 3, fig. 22.
1898 *Palaeolobium haeringianum* Unger; Engelhardt, p. 39.
1898 *Palaeolobium heterophyllum* Unger; Engelhardt, p. 39, pl. 3, fig. 5.
1898 *Robinia regelii* Heer; Engelhardt, p. 39.

Leguminosae gen. et sp. indet. (forma 4)

Pl. 7, fig. 6

1898 *Cassia phaseolites* Unger; Engelhardt, p. 40, pro parte.
1898 *Leguminosites sancti-martinii* Heer; Engelhardt, p. 41, pl. 3, fig. 25.
1898 *Palaeolobium sturii* Ettingshausen; Engelhardt, p. 39.
1898 *Rhamnus aizoon* Unger; Engelhardt, p. 34, pl. 2, fig. 40.

Leguminosae gen. et spec. indet. (fructi)

Pl. 7, fig. 7

1898 *Ailanthus oxycarpa* Saporta; Engelhardt, p. 36, pl. 3, figs. 15-16.

Small one-seeded legums occur quite rarely in contrast to the frequency of the foliage of the Leguminosae.

„Libocedrus" suleticensis Brabenec

Pl. 1, figs. 6-7, text-fig. 4/23

1898 *Callitrites brongniartii* Endlicher; Engelhardt, p. 13.
1898 *Libocedrus salicornioides* (Unger) Heer; Engelhardt, p. 13.
1898 *Libocedrus salicornioides* with *Sclerotium libocedri* Engelhardt, p. 9, pl. 1, fig. 4 (HOLO of the latter).
1908 *Libocedrus suleticensis* Bayer; Kafka, p. 49, text-fig. 23.
1910 *Libocedrus suleticensis* Brabenec, p. 60, text-fig. 42 (HOLO).
1989 *Tambovskia suleticensis* (Brabenec) Kvaček, p. 51, pl. 4, figs. 5-8.

This curious *Libocedrus*-like sterile foliage recalls some early Tertiary taxa of the Arctic (e. g. *Mesocyparis* McIver et Basinger, *Cupressinocladus interruptus* (Newberry) Schweitzer). The only other locality of *„Libocedrus" suleticensis* beside Suletice-Berand appears at Kiseged (Early Oligocene of Hungary - as *Thuites* sp. in Novák 1950). Kvaček (1989) included this plant into *Tambovskia* Sveshnikova (1980), which falls into a category of *Cupressinocladus* Seward.

Liriodendron haueri Ettingshausen

Pl. 2, figs. 9-10

1898 *Fraxinus juglandina* Saporta; Engelhardt, p. 23, pl. 1, fig. 52.

These fruits have been recognized as belonging to *Liriodendron* already by Bůžek et al. (1976). An incomplete leaf with two side lobes may belong to the same plant. It differs from the type of *L. haueri* by slender lobes.

Magnolia sp.

Pl. 2, figs. 9-10

1898 *Ficus arcinervis* Rossmässler; Engelhardt, p. 17.
1898 *Ficus hercules* Ettingshausen; Engelhardt, p. 17.
1898 *Ficus lanceolata* Heer; Engelhardt, p. 16.
1898 *Laurus lalages* Unger; Engelhardt, p. 18.
1898 *Laurus primigenia* Unger; Engelhardt, p. 17.
1898 *Malpighiastrum laurifolium* Unger; Engelhardt, p. 30.
1898 *Sterculia grandifolia* Engelhardt; Engelhardt, p. 28.
1898 *Terminalia radobojensis* Unger; Engelhardt, p. 37.

This lanceolate leaf form with camptodromous venation and intersecondaries recalls the foliage of *Magnolia*. A similar foliage is known from Seifhennersdorf as *Magnolia dianae* Unger associated with seeds of *Magnolia* (Mai 1963). Cuticular structure of the fossil *Magnolia* leaves is known from Kleinsaubernitz (Walther work in progress).

Mahonia sp.

Pl. 3, fig. 2

A single leaflet has been found in the indetermined collection of Kafka. Faintly visible secondaries looping midway towards the simple widely dentate margin and palmate basal veins are the features of *Mahonia* Nutt. Similar remains have been found at Suletice-Berand (the tuffite of the test pit 6) and at Bechlejovice (as *Ilex* sp. in Bůžek et al. 1990).

cf. ***Matudaea*** sp.

Pl. 3, fig. 1

1898 ? *Paliurus tenuifolius* Heer; Engelhardt, p. 35, pl. 2, fig. 17.

Very few leaves recalling *Daphnogene*, but with basal acrodromous secondaries on the very base of the leaf, may be compared with *Matudaea* Lundell (see Mai et Walther 1978, Walther 1980).

Mimosites haeringianus Ettingshausen

1898 *Mimosites haeringianus* Ettingshausen; Engelhardt, p. 42.

Very typical narrow leaflets with asymmetrical basis and with steep camptodromous venation correspond with those found on complete leaves from Kundratice (Engelhardt 1885). This type of Leguminosae suggests another mesophytic element in the Oligocene floras.

Monocotyledonae gen. et sp. indet.

Pl. 9, fig. 3

1898 *Poacites aequalis* Ettingshausen; Engelhardt, p. 11.
1898 *Typha latissima* A. Braun; Engelhardt, p. 12.
1898 *Pinus hepios* Engelhardt, p. 12, pl. 1, fig. 19.
1901 *Pinus laricioides* Menzel, p. 66, pl. 3, fig. 16 (HOLO).
1908 *Phragmites* sp.; Kafka, p. 45.

Beside wider monocot leaves showing grass-like parallel venation, some remains of obviously monocotyledonous nature were identified erroneously as the foliage of Pines by Engelhardt (1898) followed by Menzel (1901). The latter may represent even axes with a leaf sheath.

cf. ***Osmunda*** sp.

Pl. 1, fig. 2

A fragment of the *Osmunda*-like foliage.

Ostrya atlantidis Unger

Pl. IV, fig. 2

1898 *Ostrya atlantidis* Unger; Engelhardt, p. 14.
1898 *Corylus grosse-dentata* Heer; Engelhardt, p. 14.

A few longly sharply dentate leaves, recalling the *Ostrya* foliage e. g. from Kundratice, but without associated fruit remains.

„***Palaeolobium***" sp.

Pl. 9, fig. 5

This type of entire-margined leaves (? leaflets) with steep side veins at ends of the secondaries occur rarely in the Oligocene floras, more frequently e. g. at Kundratice (Engelhardt 1885, as *Palaeolobium haeringianum* Ung.). Its affinities are obscure.

Platanus neptuni (Ettingshausen) Bůžek, Holý et Kvaček
(folia, stipulae, stamina, female inflorescences)

Pl. 3, fig. 3, text-fig. 4/21

1898 *Belangera obtusifolia* Ettingshausen; Engelhardt, p. 28.
1898 *Benzoin paucinerve* A. Braun; Engelhardt, p. 19.
1898 *Bombax chorisiaefolium* Ettingshausen; Engelhardt, p. 28.
1898 *Celastrus acherontis* Ettingshausen; Engelhardt, p. 32.
1898 *Celastrus deucalionis* Ettingshausen; Engelhardt, p. 32.
1898 *Celastrus hippolyti* Ettingshausen; Engelhardt, p. 32
1898 *Ceratopetalum bilinicum* Ettingshausen; Engelhardt, p. 28.
1898 *Ceratopetalum cundraticiense* Engelhardt; Engelhardt, p. 27.
1898 *Ceratopetalum haeringianum* Ettingshausen; Engelhardt, p. 27.
1898 *Cunonia bilinica* Ettingshausen; Engelhardt, p. 28.
1898 *Equisetites ettingshausenii* Engelhardt, p. 11, pl. 1, figs. 6, 8, 11, 30-31, 36-37 (SYN).
1898 *Eugenia haeringiana* Unger; Engelhardt, p. 38.
1898 *Hippocratea bilinica* Ettingshausen; Engelhardt, p. 34.
1898 *Juglans bilinica* Unger; Engelhardt, p. 35.
1898 *Juglans bilinica* Unger mit *Xylomites juglandis* Engelhardt, p.9, pl. 1, fig. 24 (HOLO).
1898 *Maytenus europaea* Ettingshausen; Engelhardt, p. 33.
1898 *Myrica acuminata* Unger; Engelhardt, p. 13.
1898 *Myrsine clethrifolia* Ettingshausen; Engelhardt, p. 24.
1898 *Persoonia daphnes* Ettingshausen; Engelhardt, p. 21.
1898 *Prunus bilinica* Unger with *Xylomites juglandina* Engelhardt, p. 9, pl. 1, fig. 24 (HOLO).
1898 *Quercus lonchitis* Unger; Engelhardt, p. 15.
1967 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček, p. 205, pl. 1, fig. 1 (non fig. 5).
1970 *Platanus neptuni* (Ettingahsuen) Bůžek, Holý et Kvaček; Kvaček, p. 435, pl. 56, fig. 6 (non fig. 1).

This common Tertiary plant is well represented at Suletice-Berand, mostly by leaves and by fragmentary stipules (as *Equisetites* in Engelhardt 1898).

Polypodiaceae gen. et sp. indet.
Rare fragments of the fern foliage.

Populus zaddachii Heer
Pl. 4, fig. 5
Fragmentary leaves with conspicuous acrodromous secondaries, a flat broad petiole and glandular marginal dentation match with *P. zaddachii,* which has also been recorded at Knížecí/Pirskenberg (Knobloch 1961), Bechlejovice (Knobloch 1994) and Seifhennersdorf (Walther in press). It differs from similar leaves of *Cercidiphyllum* and *Celtis* by a flattened petiole. This plant is characteristic of lowland vegetation in the Thierbach Complex, Late Oligocene (Mai et Walther 1991).

Pronephrium stiriacum (Unger) Knobloch et Kvaček
Pl. 1, fig. 1, text-fig. 4/20
1898 *Goniopteris stiriaca* (Unger) Heer; Engelhardt, p. 10.
The fossils at hand are very fragmentary, still the identification of this azonal element is safe.

„Quercus" cruciata A. Braun
Pl. 8, fig. 6, text-fig. 4/4
1898 *Quercus cruciata* A. Braun; Engelhardt, p. 15, pl. 1, fig. 27.
1981 *„Quercus" cruciata* A. Braun; Kvaček et Walther, p. 85, pl. 7, figs. 2-4.
A single specimen is available of this characteristic plant of dubious affinities (Kvaček et Walther 1981).

Rosa lignitum Heer
Pl. 7, fig. 9
1898 ? *Gleditsia bohemica* Engelhardt, p. 39, pl. 3, fig. 6, 9 (SYN).
Only a few fragments of leaflets prove that this mesophytic shrub grew at Suletice-Berand, while in other Oligocene floras it was sometimes widespread (Bechlejovice).

Smilax sp.
Pl. 9, fig. 4
1898 *Smilax grandifolia* Heer; Engelhardt, p. 11.
1898 *Smilax paliformis* Heer; Engelhardt, p. 12, pl. 1, fig. 17.
1898 *Smilax* sp., Engelhardt, p. 12, pl. 1, fig. 20.
Due to high variation of the foliage of *Smilax,* the specific determination of the specimens at hand is not realistic.

Tetraclinis salicornioides (Unger) Kvaček
Pl. 1, figs. 5, 8-10, text-fig. 4/2
1898 *Callitris brongniartii* Endlicher; Engelhardt, p. 13, pl. 2, fig. 9.
1898 *Libocedrus salicornioides* (Unger) Heer; Engelhardt, p. 13.
1901 *Callitris brongniartii* Endlicher; Menzel, p. 98, pl. 5, figs. 31, 34.
1989 *Tetraclinis salicornioides* (Unger) Kvaček, p. 48, pl. 2, fig. 9.
Among numerous twigs and twig fragments (also with cuticular structure) that bearing two small cones with decussate two pairs of flat cone scales is noteworthy. For other details see Kvaček (1989).

Zelkova zelkovifolia (Unger) Bůžek et Kotlaba
Pl. 3, figs. 4-5, 8, text-figs. 3 and 4/22
1898 *Planera ungeri* Kovats; Engelhardt, p. 16.
1898 *Pyrus phytali* Unger; Engelhardt, p. 38, pl. 2, fig. 21.
1908 *Planera ungeri* Ettingshausen; Kafka, p. 45.
This quite frequent leaf type of the Suletice-Berand flora shows polymorphic foliage (see text-fig. 3), including the *„ungeri"* and *„praelonga"* forms. As a mesophytic element it

Text-fig. 3. *Zelkova zelkovifolia* (Ung.) Bůžek et Kotlaba, Suletice–Berand, leaf form variation (scale bar = 1 cm) migrated from Central Asia (Eocene records in Zhilin 1989) into the Oligocene volcanic floras of Central Europe (Kundratice, Bechlejovice, Seifhennersdorf). Its ancestors are known from the Early Palaeogene of North America (Burnham 1986).

Taphonomy, palaeoecology and palaeoclimatology

Various kinds of fossilisation is known within fossil sites of volcanic complexes for both plant and animal fossils. In the České středohoří Mts. tuffs very rarely include fossiliferous layers (e. g. Březiny/Birkigt near Děčín). Fossils occur more often in tuffites (e. g. Soutěsky/Natternstein near Děčín, Hammerunterwiesenthal in Saxony). In these situations, where sedimentation proceeded in a quickly changing landscape due to volcanic activity, a climax vegetation is hardly reflected in the assemblage. Such sites include rather early stages of successions, where certain pioneer plant elements dominate (e. g. *Ulmus, Daphnogene*). Calm periods without eruptions are indicated by mighty layers of diatomites or oil shale. The sediments of this kind are known under various names (diatomites, bituminous shales, Polierschiefer, Brandschiefer, leštivé břidlice, hořlavé břidlice of earlier authors). A detailed study of petrology is beyond the scope of the present study. All such deposits differ as to their extent according to local conditions of sedimentary setting.

In such sites, where we know detailed sections from cores (Kleinsaubernitz, Seifhennersdorf), various phases of volcanic activity can also be traced (Ahrens 1959, Walther 1980). Usually the collecting took place only at limited exposed parts of the section. Hence a more extensive taphonomic study (as e. g. in open-cast mines) cannot be realized (Walther in press). In exceptional cases (Markvartice - Bůžek et al. 1976) a large diatomite complex could by sampled from two sides of the hill. On the other hand, as it is shown in the case of Suletice, diatomite lenses can be of a limited extent. In Suletice-Berand, this lense was recovered only twice, in spite of intense prospection over the whole area. Such limited sedimentary bodies may reflect local vegetation only. It is extremely difficult to deduce a more general picture of the whole plant cover. Transport by water (in streams, lakes) took place surely within short distances and only a short wind transport must have prevailed. This is seen in quite undeformed leaf fossils as well as aggregations of fine plant organs, like flowers, or preservation of foliage twigs (e. g. *Zelkova, Engelhardia* in Suletice-Berand). Plant remains must have been buried very quickly, because they do not show signs of decomposition. Also insect feeding traces are rare. Leaves lie flat on the bedding planes. Phenomena of running water sedimentation, like folding or rolling up, are not observed. We can expect that the sedimentary settings were very calm, standing and shallow waters. Plant organs including leaves, flowers, winged fruits, come from the surrounding vegetation, mainly from the very borders of the lake. Such floristic sites are called subautochthonous (Gastaldo et al. in press).

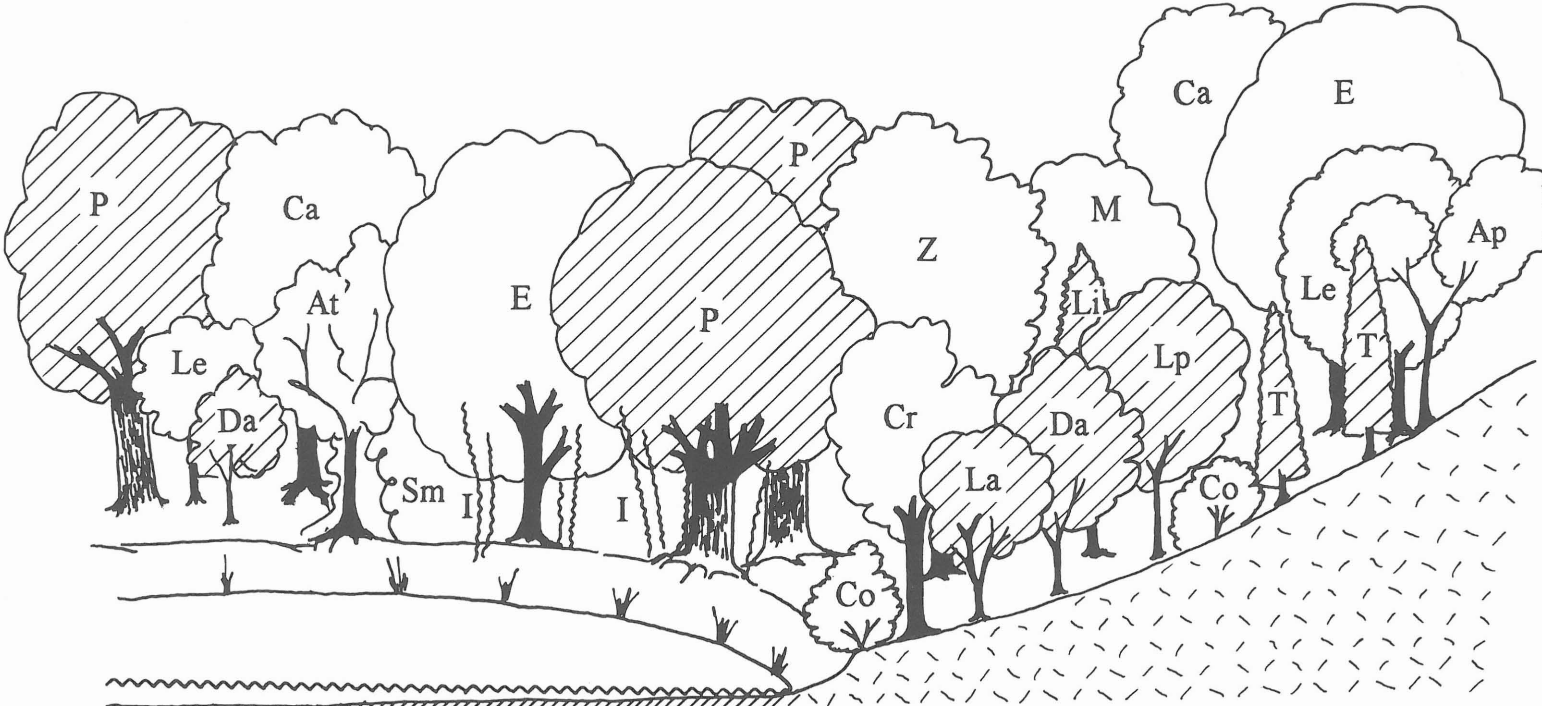
The occurrence of several leaves of the same species on one bedding plane suggests various periods of leaf shedding in different plant taxa. This phenomenon has been noticed outside volcanic areas (Walther in Mai et Walther 1991, Kunzmann 1994). Seasonal shedding of leaves do not very often coincide with shedding of fruits and this is shown in the relative abundance of both organs in one site. In Suletice-Berand it is recognizable particularly in *Engelhardia*, where foliage is obviously overrepresented. Such discrepances demonstrate that the relative natural abundance of a species cannot be directly derived from the abundace of fossils.

Another specific feature of deposits within the volcanic areas in North Bohemia and Oberlausitz is the limited extent of coal seams, represented only in rare localities. Thin coal seams are known to be worked for some time e. g. in Seifhennersdorf (Walther 1988), Markvartice (Bůžek et al. 1976) and Zálezly (Hibsch 1903). These kinds of seams do not suggest an extensive mire vegetation, but rather a „Verlandung“ phase of lakes and, in the case of Seifhennersdorf, grass coal (Hein et Schwab 1959). Unfortunately, petrological studies of the coal from these abandoned mines are mostly not available.

In the locality of Suletice-Berand pure coal formation is not known. In the tuffite complex, thin, more centimeters thick layers of coaly claystones or clayey coal rarely occur. In the plant association there are no indications of extensive azonal vegetation (in contrast to e. g. Seifhennersdorf).

The following picture can be obtained when analysing floral elements (see text-fig. 4).

Text-fig. 4. Floral picture of the site Suletice–Berand. 1 - *Carpinus grandis* Unger, MMG SuBe 25b, 2 - *Tetraclinis salicornioides* (Unger) Kvaček, MMG SuBe 254, 3 - *Acer palaeosaccharinum* Stur, MMG SuBe 759a, 4 - *„Quercus" cruciata* A. Braun, MMG SuBe 26:1 (see Engelhardt 1898, pl. 1, fig. 27), 5 - *Icaciniphyllum artocarpites* (Ettingsh.) Kvaček et Bůžek, MMG SuBe 1a, 6 - Leguminosae gen. et sp. indet. (forma 2), MMG SuBe 15, 7 - *Engelhardia macroptera* (Brongn.) Unger, MMG SuBe 263, 8 - *Cornus studeri* Heer, MMG SuBe 147, 9 - *Carya serrifolia* (Goepp.) Kräusel, MMG SuBe 102b, 10 - *Daphnogene cinnamomifolia* (Brongn.) Unger (forma *„lanceolata"*), MMG SuBe 42a, 11 - *Engelhardia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther, MMG SuBe 805a, 12 - *Magnolia* sp., MMG SuBe 119:1, 13 - *Laurophyllum* cf. *medimontanum* Bůžek, Holý et Kvaček, SuBe 201c, 14 - *Laurophyllum* cf. *acutimontanum* Mai, MMG SuBe 133b, 15 - *Acer* cf. *decipiens* A. Braun sensu Walther, MMG SuBe 825:2, 16 - *Craigia bronnii* (Unger) Kvaček, Bůžek et Manchester, MMG SuBe 466, 17 - *Dicotylophyllum maii* Bůžek, Holý et Kvaček, MMG SuBe 174b, 18 - *Acer* sp., MMG SuBe 269a, 19 - *Daphnogene cinnamomifolia* (Brongn.) Unger (forma *„cinnamomifolia„*), MMG SuBe 76, 20 - *Pronephrium stiriacum* (Unger) Knobloch et Kvaček, MMG SuBe 189:1a, 21 - *Platanus neptuni* (Ettingsh.) Bůžek, Holý et Kvaček, MMG SuBe 392a, 22- *Zelkova zelkovifolia* (Unger) Bůžek et Kotlaba, MMG SuBe 20a, 23 - *„Libocedrus" suleticensis* Brabenec, MMG SuBe 762a, 24 - *Dombeyopsis* sp., MMG SuBe 658, 25 - Leguminosae gen. et sp. indet. (forma 3), MMG SuBe 113a. (scale bar = 3 cm)



Text-fig. 5. **Reconstruction of the Oligocene plant cover at Suletice-Berand (Ap –** ***Acer palaeosaccharinum*****, At –** ***Acer tricuspidatum,*** **Ca –** ***Carya serrifolia*****, Co –** ***Cornus studeri,*** **Cr –** ***Craigia bronnii,*** **Da –** ***Daphnogene cinnamomifolia*****, E –** ***Engelhardia orsbergensis/macroptera*****, I –** ***Icaciniphyllum artocarpites*****, La –** ***Laurophyllum*** **cf.** ***acutimontanum,*** **Le – Leguminosae gen. et sp. indet., Li –** ***„Libocedrus“ suleticensis*****, Lp –** ***Laurophyllum*** **cf.** ***pseudoprinceps,*** **M –** ***Magnolia*** **sp., P –** ***Platanus neptuni,*** **T –** ***Tetraclinis salicornioides*****, Z –** ***Zelkova zelkovifolia.*** **Hatched trees were evergreen. For substrate see explanation in text-fig. 2**

An overwhelming quantity of plant fossils belong to mesophytic elements (arranged according to frequency of fossils): *Engelhardia orsbergensis, Platanus neptuni, Icaciniphyllum artocarpites, Laurophyllum* cf. *acutimontanum*, Leguminosae gen. et sp. indet., *Tetraclinis salicornioides, Daphnogene cinnamomifolia, Zelkova zelkovifolia, „Elaeodendron"* sp., *Craigia bronnii, Cornus studeri, Laurophyllum* cf. *pseudoprinceps* , *Acer palaeosaccharinum, „Libocedrus" suleticensis, Magnolia* sp., *Carya serrifolia*. All others occur less frequently (see Table 1). Elements tolerating more moist soils are less diversified - *Daphnogene cinnamomifolia, Carya serrifolia, Craigia bronnii, Acer tricuspidatum,* Bryophyta gen. et sp. indet., *Pronephrium stiriacum, Smilax* sp. Also *Platanus neptuni* is to be added to this group (Walther 1985). Typical swamp forest elements, such as *Taxodium, Nyssa, Alnus, Ulmus* are lacking. A few monocot fragments may originate from the border of a lake with aquatic or swamp herbs.

The picture given above suggests that the borders of the lake were not flat, because the typical succession of aquatic plants, swamp, riparian and mesophytic forests (like at Seifhennersdorf - Walther 1988, in press) is lacking. In the case of Suletice-Berand, banks were surely steeper, like around maar or crater lakes, covered directly with the mesophytic forest (see text-fig. 5).

A preliminary comparsion of the floras from Suletice-Berand and other sites at Suletice

A brief survey of plant fossils from the sites at Suletice other than Suletice-Berand itself includes collections from the National Museum (Kafka 1908), Natural Science Faculty of Charles University (Laube 1880, Wentzel 1881) and Czech Geological Survey (test pits 2 and 6, leg. Č. Bůžek), only partly also Staatliches Museum f. Mineralogie und Geologie, Dresden (Menzel 1897). The whitish diatomite from the road cut (and the test pit 2) was exposed for free collecting for a long time and thus collections are extensive, but less valuable due to bad state of preservation.

The white diatomite flora includes a quantitatively slightly different but qualitatively nearly identical assemblage with that of Suletice-Berand. *„Libocedrus" suleticensis* and *Tetraclinis salicornioides* are present, the former more frequently (test pit 2). Among angiosperms *Engelhardia, Daphnogene, Laurophyllum, Icaciniphyllum* and *Platanus neptuni*, the latter two less numerously recorded, make a parallel of thermophilous elements, *Acer palaeosaccharinum, A. angustilobum* , *Ampelopsis hibschii, Betula* vel *Alnus, Carpinus, Carya, Craigia, Cornus studeri*, *Tilia* and *Zelkova* are corresponding Arctotertiary elements. Numerous Leguminosae, *Mimosites, Hydrangea, Celtis, „Quercus" cruciata* and *„Elaeodendron"* are equally represented, while *Cercidiphyllum, Comptonia* and *Tilia*, are lacking at Suletice-Berand. Kafka (1908) notes also *Sabal lamanonis* in the floral list of the sites at Suletice but the pertinent specimen has not been recovered. A brown tuffite interbed within the diatomite in the test pit 2 was rich in fruits of *Palaeohosiea* and *Carya*.

Some dark fine-grained tuffite layers deviate by more or less monotonous composition. The flora found by Kafka (1908) in these layers included either *Cercidiphyllum* or *Comptonia*. The test pit 6 (leg. Č. Bůžek, inedited manuscript) brought another dark tuffite with *Alnus* (an infructescence), *Ostrya atlantidis, Carpinus grandis, Acer tricuspidatum, A. palaeosaccharinum, Daphnogene, Laurophyllum,* Leguminosae, *Platanus neptuni, Engelhardia, Liriodendron* fruits, *Mahonia*, cf. *Crataegus, Rosa, Cornus studeri, Craigia, Zelkova,* cf. *Ulmus,* cf. *Cercidiphyllum, Smilax,* fragments of *Tetraclinis salicornioides.* Leaf fossils of this layer bear partly cuticle remains. The collection has not been presently accessible except for *Platanus neptuni.* This assemblage shares most species with Suletice-Berand, but we cannot compare quantitative representation of the components.

The position of the flora of Suletice-Berand within the volcanic floras in North Bohemia and Oberlausitz

As mentioned above the site of Suletice-Berand belongs to the České středohoří volcanic complex (Kopecký 1966). The older part of the main volcanic phase spans the older Palaeogene to the uppermost Eocene. The floras of this time interval (Kučlín, Hlinná, Lbín, Mrtvý vrch near Kostomlaty) decidedly differ from the rest of the main phase by prevailingly palaeotropical character and the occurrence of *Doliostrobus* (Bůžek, Kvaček et Walther 1978, Bůžek et al. 1990, Bellon et al. work in progress). The younger floras of the main phase are connected with appearance of new elements. Particularly, invasions of various modern Arctotertiary arboreal elements (in sense of Kvaček 1994), which occurred in waves from the East, can be well observed (Knobloch et al. 1993, Walther in press). The local floras differ from each other particularly in the rate between deciduous (summergreen) and laurophyllous (evergreen) plants as well as between mesophytic and riparian (azonal) elements.

The flora of Suletice-Berand belong to those volcanic floras, where conifers are very rare. Similar aspects (with prevailing broad-leaved trees) are met with in some other sites, as Kundratice, Markvartice and Bechlejovice (no conifers at all in the latter site). These floras are connected with the centre of volcanic complexes of the České středohoří Mts. The sites on the periphery, however, include *Tetraclinis, Torreya, Cephalotaxus* as well as *Taxodium* in increasing frequencies (Hrazený/Pirskenberg near Knížecí, Seifhennersdorf, Kleinsaubernitz). This partly abundant occurrence of *Taxodium*, together with the typical swamp elements (*Athrotaxis couttsiae, Nyssa, Alnus, Ulmus, Acer tricuspidatum*) is known particularly at Seifhennersdorf, in certain degree also at Kleinsaubernitz. It testifies different ecological conditions at these sites (Walther 1988, in press). Noteworthy is the nearly endemic occurrence of some conifers, stressing the local character of the volcanic floras („*Libocedrus*" *suleticensis* at Suletice, *Taxus engelhardtii* at Kundratice).

The most common evergreen elements, which occur in most sites, are *Daphnogene cinnamomifolia, Laurophyllum acutimontanum, L. pseudoprinceps, L. medimontanum, Platanus neptuni, Magnolia* sp., partly also *Icaciniphyllum artocarpites* ,„*Elaeodendron*" sp. To this thermophilous group belongs certainly *Engelhardia.* Due to taphonomic processes the abundance of the fossils may not express the natural frequency of the elements. That is why the above plants are variously represented in the local floras.

At Suletice-Berand the thermophilous group prevails. Only specific determinations of laurophyllous taxa are uncertain in view of the lack of cuticles. A predominance of *Engelhardia*-fossils in the assemblage is very striking. Only one other site in the Střezov Formation (volcanic complex underneath the Most Basin), a maar fill near Bílina (Bůžek et al. 1992), makes an analogy.

According to the floristic composition the Suletice-Berand flora shows closest similarities with that of Markvartice (Bůžek, Holý et Kvaček 1976), but for *Engelhardia* which is nearly lacking in the latter. The other sites (Kundratice, Knížecí, Seifhennersdorf, Kleinsaubernitz) differ in their smaller representation of thermophilous taxa. Among volcanic floras that of Bechlejovice is unique due to the absolute predominance of Arctotertiary elements.

In the volcanic floras discussed summergreen Arctotertiary elements are differently represented both quantitatively and qualitatively. Generally spread taxa are *Carpinus, Carya, Cyclocarya, Cercidiphyllum, Craigia, Zelkova, Rosa, Ampelopsis* and *Acer.* The other taxa, such as *Liriodendron, Cornus, Tilia, Betula, Crataegus, Ulmus, Alnus* are represented unequally. The Suletice-Berand flora does not deviate from the others qualitatively (only *Tilia* and *Cercidiphyllum* is lacking, but they both occur in the white diatomite). An abundant occurrence of *Zelkova* is noteworthy.

Between the groups of thermophilous and Arctotertiary plants are those which can be called „neutral", such as Leguminosae and *Ailanthus*, which are most characteristic of our volcanic floras. These plants can be interpreted as pioneer vegetation. (A similar character can be ascribed to *Daphnogene* in tuffites and freshwater limestones in Valeč in the Doupov volcanic complex and Hammerunterwiesenthal.) „*Quercus*" *cruciata*, which occurs very rarely in the floras studied, belongs very probably to the same „neutral" group. In no case can its unique morphology allow it to assume semiarid conditions (Krutzsch 1992).

In the Suletice-Berand flora, the summergreen species are quantitatively much less frequent, but specifically diversified, while thermophilous taxa prevail. The same situation can be found in the flora of Markvartice. In many other floras of the volcanic areas the deciduous arboreal elements are predominant (Kundratice, Seifhennersdorf, Bechlejovice).

A quite specific flora has been recently studied in the diatomite at Kleinsaubernitz at Bautzen (Walther work in progress). Among thermophilous taxa, those typical of early Palaeogene lowland floras (*Eotrigonobalanus, Trigonobalanopsis*) appear together with new („Miocene") elements, e. g. *Illicium ceriferum, „Castanopsis" bavarica, Fagus saxonica, Quercus praekubinyi, Q. praerhenana, Ulmus pyramidalis, U. carpinoides*, which were partly evergreen, partly summergreen. The combination of the Fagaceae (*Eotrigonobalanus furcinervis* f. *haselbachensis, Trigonobalanopsis rhamnoides, Lithocarpus saxonica*) is not known in any other volcanic flora. The flora of Kleinsaubernitz shows some common links with the Oligo/Miocene lowland flora at Witznitz in the Weisselster Basin, but the latter includes almost no summergreen elements (Mai et Walther 1991).

The dating of the volcanic floras within the České středohoří and Oberlausitz has been ambiguous for a long time. New radiometric data of volcanic bodies (Bellon et al. work in progress) range from 38 to 20 Ma. The younger floras of the main phase are first represented by that of Kundratice (32 Ma) and Seifhennersdorf (30 Ma). Both sites show vegetation of the East Asiatic Mixed Mesophytic Forest type (Mai et Walther 1978, Mai 1981). At Seifhennersdorf and to a lesser degree also at Kundratice azonal swamp vegetation appears (*Taxodium, Nyssa, Alnus* a. o.)(Walther in press).

The sites at Suletice link up in the time span of 29 to 26 Ma as the next stage. According to its similar floristic composition the site at Markvartice belongs to the same stage. These floras represent a mesophytic type of forest vegetation, nearly without azonal elements, which corresponds to Mixed Mesophytic Forest with a greater representation of thermophilous elements. The lack of azonal plants can be misinterpreted as major climatic change towards warming. On the other hand, the youngest flora from Bechlejovice (25 Ma) shows a different picture with prevailingly summergreen trees. It may indicate a cooling phase within the Oligocene.

In the volcanic landscapes the microclimate and soil must have influenced the composition of vegetation to a great extent. These factors make the macroclimatic interpretation of local plant assemblages extremely difficult.

The Kleinsaubernitz flora is not radiometrically dated. The scarcity of azonal elements suggests a mesophytic vegetation in the surroundings of a maar lake. According to the floristic composition it falls into a warming phase of the Eochattian, which is indicated by an influx of new thermophilous as well as Arctotertiary elements into a subtropical relict flora with *Eotrigonobalanus* etc.

A comparison between volcanic and lowland floras in Central Europe

The Palaeogene lowland floras have been thoroughly studied particularly in the Weisselster Basin and its periphery and climatologically and geobotanically intepreted since 70th (Krutzsch 1976, Mai 1976, Rüffle et al. 1976, Mai et Walther 1978, 1983, 1985, 1991, Krutzsch 1992). Recent taphonomical and sedimentological research (Gastaldo et al. in press, Halfarth 1994, Kunzmann 1994, Pöppelreiter 1992) brought evidence of particular vegetational units and corresponding landscapes within alluvial systems. A para-autochthonous character of many „leaf floras“ has been stated within the channel and still water deposits.

The differences between the volcanic and lowland floras have been noticed many time (Mai et Walther 1976, Bůžek et al. 1981, Walther in press). New revisions (Knobloch 1994, Walther in press) allow more precies comparisons between the Oligocene floras of North Bohemia and Oberlausitz on the one side and those from the Weisselster Basin on the other side. The dating of the lowland floras (the floral complexes Haselbach, Thierbach and partly Mockrehna-Witznitz - Mai et Walther 1983, Walther 1990) is unfortunately only very approximate. The Haselbach Complex is correlatable with the sites at Seifhennersdorf, Kundratice and Knížecí (Walther in press). The thermophile flora of Kleinsaubernitz shows some links with the Complex Mockrehna-Witznitz (Oligo-Miocene boundary according to Mai et Walther 1991).

The Oligocene assemblages of the Weisselster Basin mostly reflect azonal vegetation as aquatic and mire vegetation, swamp and riparian forests (Mai et Walther 1978, Mai 1981). A widely spread unit corresponds to the *Taxodium–Nyssa* swamp forest (*Taxodium balticum, Nyssa ornithobroma, Nyssa altenburgensis*), which survives until the Late Oligocene in NW Saxony (Walther 1988). *Taxodium balticum* vel *Taxodium dubium* prevails in Seifhennersdorf as well as in a younger site at Kleinsaubernitz. Besides, riparian forests of the lowland Weisselster Basin include *Populus, Salix, Alnus, Ulmus, Acer (A. haselbachense)* and *Daphnogene* for the first time in the Haselbach Complex. Such forests are not known in this composition in volcanic floras. Fragments of riparian forests with *Alnus, Ulmus* (*U. fis-*

cheri/drepanodonta-complex) and *Salix* occur e. g. in Seifhennersdorf, always in low frequency. These riparian forests inhabited periodically flooded soils of flat river-sides.

Mesophytic elements are well represented in the Haselbach Complex (Mai et Walther 1978, Walther in press), but less diversified or bound to another soil type (sandy oligotrophic) - e. g. *Carpinus* (*C. grandis, C. mediomontana, C. cordataeformis*), *Mastixia, Eomastixia, Mastixicarpum, Engelhardia, Eurya, Magnolia, Manglietia, Phoebe, Persea, Laurophyllum acutimontanum, L. pseudoprinceps, Distylium, Symplocos, Rosa lignitum,* as well as a vine *Ampelopsis hibschii*. The latter two species, which occur rarely in the Haselbach Complex, are typically developed in the volcanic sites, as Seifhennersdorf, Kundratice, Bechlejovice as well as Suletice-Berand (Bůžek et al. 1981). The mesophytic forest of Haselbach is prevailingly laurophyllous, with a smaller amount of Arctotertiary elements. It cannot be included into a pure Nothophyllous Evergreen Forest type. Mai and Walther (1978) suggested it be classified as a transitional formation between the Evergreen Broad-leaved and Mixed Mesophytic Forests in Central China.

The thermophilous forests with Mastixiaceae differ distinctly from more or less summergreen Mixed Mesophytic Forests of volcanic sites at Kundratice, Seifhennersdorf and Knížecí (as well as Bechlejovice). The more thermophilous assemblages from Suletice-Berand and Markvartice also differ (? due to soil type) in the floristic composition (lack of Mastixiaceae). Only a dominance of *Engelhardia* at Suletice-Berand makes an analogy to the Haselbach Complex.

The Kleinsaubernitz mesophytic elements link partly with the Complex Thierbach (*Fagus saxonica*) as well as with the Complex Mockrehna-Witznitz (*Eotrigonobalanus, Trigonobalanopsis, Laurophyllum, Daphnogene, Cunninghamia*). However, the latter lowland complex does not include *Ailanthus, Torreya*, for example, which occur in Klaunsaubernitz.

These comparisons show enough differentation between the two types of landscapes/vegetation - volcanic and basinal. Among factors that may have invoke these discrepances are surely microclimate, geomorphic features (exposition of slopes) as well as soil types. Particularly edaphic properties in connection with underlying rock types or mineral springs may drastically influce vegetation in volcanic regions (Spicer 1989).

Table 1

Systematic list of the flora with the species frequences
(I = more than 300 specimens, II = 100–299, III = 40–99, IV = 10–39, V = 1–9).

taxon	frequence group
Bryophyta fam. inc.	
Bryophyta gen. et sp. indet	V
?Osmundaceae	
cf. *Osmunda* sp.	V
Polypodiaceae	
Polypodiaceae gen. et sp. indet.	V
Cupressaceae	
'Libocedrus' suleticensis Brabenec	IV
Tetraclinis salicornioides (Unger) Kvaček	III
?Cephalotaxaceae	
cf. *Cephalotaxus* sp.	V
Magnoliaceae	
Magnolia sp.	IV
Liriodendron haueri Ettingshausen	V
Cabombaceae	
cf. *Dusembaya* sp.	V

taxon	frequence group
Lauraceae	
Laurophyllum cf. *acutimontanum* Mai	II
Laurophyllum cf. *medimontanum* Bůžek et Holý, Kvaček	V
Laurophyllum cf. *pseudoprinceps* Weyland et Kilpper	IV
Laurocarpum sp.	V
Daphnogene cinnamomifolia (Brongniart) Unger (forma *'lanceolata'*)	III
Daphnogene cinnamomifolia (Brongniart) Unger (forma *'cinnamomifolia'*)	IV
Berberidaceae	
Mahonia sp.	V
Hamamelidaceae	
cf. *Matudaea* sp.	V
Platanaceae	
Platanus neptuni (Ettingshausen) Bůžek, Holý et Kvaček	II
Ulmaceae	
Celtis sp.	V
Zelkova zelkovifolia (Unger) Bůžek et Kotlaba	III
Betulaceae	
cf. *Betula* vel *Alnus* sp.	V
Corylaceae	
Carpinus grandis Unger	IV
Carpinus mediomontana Mai	V
Ostrya atlantidis Unger	V
Juglandaceae	
Engelhardia orsbergensis (Wessel et Weber) Jähnichen, Mai et Walther	I
Engelhardia macroptera (Brongniart) Jähnichen, Mai et Walther	IV
Carya serrifolia (Goeppert) Kräusel	IV
cf. *Cyclocarya cyclocarpa* (Schlechtendal) Knobloch	V
Juglandaceae gen. et sp. indet. (amenta)	V
Salicaceae	
Populus zaddachii Heer	V
Tiliaceae	
Craigia bronnii (Unger) Kvaček, Bůžek et Manchester	III
Dombeyopsis sp.	V
Saxifragaceae	
Hydrangea microcalyx Sieber	V
Leguminosae	
Mimosites haeringianus Ettingshausen	V
Leguminosae gen. et sp. indet. (forma 1)	IV
Leguminosae gen. et sp. indet. (forma 2)	III
Leguminosae gen. et sp. indet. (forma 3)	IV
Leguminosae gen. et sp. indet. (forma 4)	IV
Leguminosae gen. et sp. indet. (fructi)	V
Rosaceae	
Rosa lignitum Heer	V
Simaroubaceae	
Ailanthus sp.	V
Aceraceae	
Acer angustilobum Heer	V
Acer cf. *dasycarpoides* Heer	V

taxon	frequence group
Acer cf. *decipiens* A. Braun	V
Acer palaeosaccharinum Stur	IV
Acer tricuspidatum Bronn	IV
Acer sp. (folia)	IV
Acer sp. (fructi)	IV
Cornaceae	
Cornus studeri Heer	IV
Icacinaceae	
Icaciniphyllum artocarpites (Ettingshausen) Kvaček et Bůžek	II
Vitaceae	
Ampelopsis hibschii Bůžek, Kvaček et Walther	V
Apocynaceae	
Apocynospermum striatum Reid et Chandler	V
Dicotyledonae fam. inc.	
Dicotylophyllum maii Bůžek, Holý et Kvaček	IV
Dicytylophyllum sp. div.	V
'Apocynophyllum' sp.	V
'Elaeodendron' sp.	III
'Palaeolobium' sp.	V
'Quercus' cruciata A. Braun	V
Carpolithes sp. div.	V
Smilacaceae	
Smilax sp.	V
Monocotyledonae fam. inc.	
Monocotyledonae gen. et sp. indet.	IV

REFERENCES

Ahrens, H. (1959): Stratigraphisch-tektonische Untersuchungen im Tertiär von Seifhennersdorf. - Geologie, 8: 340.

Brabenec, B. (1910): Souborná květena českého útvaru třetihorního. - Arch. přír. prozk. Čech, 14(3-4): 1-377.

Budantsev, L., Ju., ed. (1994): Fossil flowering plants of Russia and adjacent states. Vol. 3. Leitneriaceae - - Juglandaceae. - Nauka, St. Petersburg, 106 pp.

Burnham, R., J. (1986): Foliar morphological analysis of Ulmoideae (Ulmaceae) from the early Tertiary of western North America. - Palaeontograhica, B, 201: 135-167.

Bůžek, Č., Holý, F., Kvaček, Z.(1967): Eine bemerkenswerte Art der Familie Platanaceae Lindl. (1836) im nordböhmischen Tertiär. - Mber. Dtsch. Akad. Wiss., 9(3): 203-215.

Bůžek, Č., Holý, F., Kvaček, Z.(1976): Tertiary flora from the Volcanogenic Series at Markvartice and Veselíčko near Česká Kamenice (České středohoří Mts.). - Sbor. geol. Věd, Paleont., P, 18: 69-132.

Bůžek, Č., Kvaček, Z., Walther, H. (1978): Tertiary floras from the surroundings of Kundratice in relation to the volcanic phases of the České středohoří Mts. - Věst. Ústř. Úst. geol., 53(6): 347-356.

Bůžek, Č., Kvaček, Z., Walther, H. (1981): Blattreste von Vitaceae aus dem Oligozän Mitteleuropas. - Palaeontographica, B, 175: 126-155.

Bůžek, Č., Kvaček, Z., Manchester, S. R. (1989): Sapindaceous affinities of the Pteleaecarpum fruits from the Tertiary of Eurasia and North America. - Bot. Gaz., 150: 477-489.

Bůžek, Č., Fejfar, O., Konzalová, M., Kvaček, Z. (1990): Floristic changes around Stehlin's Grande Coupure in Central Europe. - In: Knobloch, E., Kvaček, Z. (eds.): Proceed. Symp. Paleofl. Paleoclim. Changes Cret. Tert. Prague 1989, Geological Survey, Prague, 167-182 pp.

Bůžek, Č., Dvořák, Z., Kvaček, Z., Prokš, M. (1992): Tertiary vegetation and depositional environments of the „Bilina delta" in the North-Bohemian brown-coal basin. - Čas. Mineral. Geol., 37: 117-134.

Engelhardt, H. (1885): Die Tertiärflora des Jesuitengrabens bei Kundratitz in Nordböhmen. - N. Acta Leop. Carol. Acad., 48: 259-408.

Engelhardt, H. (1896): Zur Kenntnis der Tertiärpflanzen von Sulloditz. - Sitz.-Ber. Lotos, N. F., 16: 145-181.
Engelhardt, H. (1898): Die Tertiärflora von Berand im Böhmischen Mittelgebirge. - Lotos, Abh., 1: 75-123.
Gabriel, M. (1970): Diatomové horniny střední části Českého středohoří. - Věst. Ústř. Úst. geol., 45: 27-37.
Gastaldo, R. A., Walther, H., Riegel, W. (1992): Plant taphonomic character of an Oligocene channel-fill sequence: Tagebau Bockwitz. - 4th Conf. Int. Org. Paleobot. Abstracts, Paris, p. 65.
Halfar, J. (1994): Faziescharacter und Sedimentologie eines paläogenen fluviatilen Systems im Tagebau Schleenhain bei Leipzig. - Dipl. Thesis, Georg-August-Univ., Göttingen.
Heer, O.(1859): Die tertiäre Flora der Schweiz. III. - J. Wurster Comp., Winterthur, 378 pp.
Hein, L., Schwab, G. (1959): Über Verkieselungserscheinungen in der Braunkohle von Seifhennersdorf/Oberlausitz. - Geologie, 7(8): 1020-1056.
Hibsch, E. (1903): Geologische Karte des Böhmischen Mittelgebirges, Blatt V (Grosspriesen) nebst Erläuterungen. - A. Hölder, Wien, 465-590 pp.
Jähnichen, H., Mai, D. H., Walther, H. (1977): Blätter und Früchte von Engelhardia Lesch. ex Bl. (Juglandaceae) aus dem europäischen Tertiär. - Feddes Repert., 88: 323-363.
Kafka, J. (1908): Studie v oboru třetihorního útvaru v Čechách. - Arch. přír. Prozk. Čech, 14(4): 1-77.
Kafka, J. (1911): Einige Profile aus den Braunkohlenbecken Nordböhmens. - Archiv naturwiss. Landesdurchforsch. Böhmens, 14(4): 1-92. Prag.
Knobloch, E. (1961): Die oberoligozäne Flora des Pirskenberges bei Šluknov in Nord-Böhmen. - Sbor. Ústř. Úst. geol., Odd. paleont., 26: 214-315.
Knobloch, E. (1994): Einige neue Erkenntnisse zur oligozänen Flora von Bechlejovice bei Děčín. - Věst. Čes. geol. Úst., 69(3): 63-67.
Knobloch, E., Kvaček, Z. (1976): Miozäne Blätterfloren vom Westrand der Böhmischen Masse. - Rozpr. Ústř. Úst. geol., 42: 1-130.
Knobloch, E., Kvaček, Z., Bůžek, Č., Mai, D. H., Batten, D. J. (1993): Evolutionary significance of floristic changes in the Northern Hemisphere during the Late Cretaceous and Palaeogene, with particular reference to Central Europe. - Rev. Palaeobot. Palynol., 78: 41-54.
Knobloch, E., Konzalová, M., Kvaček, Z. (in press): Die obereozäne Flora der Staré Sedlo-Schichtenfolge im Westböhmen. - Rozpr. Čes. geol. Úst., 49.
Kopecký, L. (1966): Tertiary volcanics. - In: Svoboda, J. (ed.): Regional geology of Czechoslovakia. Part. I. The Bohemian Massif. Academia, Praha, 554-581 pp.
Krutzsch, W. (1976): Die Mikroflora der Braunkohle des Geiseltales (Teil IV). Die stratigraphische Stellung des Geiseltalprofils im Eozän und die sporenstratigraphische Untergliederung des mittleren Eozäns. - Abh. Zentr. geol. Inst., 26: 47-92.
Krutzsch, W. (1992): Paläobotanische Klimagliederung des Alttertiärs (Mitteleozän bis Oberoligozän) in Mitteldeutschland und das Problem der Verknüpfung mariner und kontinentaler Gliederungen (klassische Biostratigraphie - paläobotanisch-ökologische Klimastratigraphie - Evolution - Stratigraphie der Vertebraten). - N. Jb. Geol. Paläont. Abh., 186(1-2): 137-253.
Kunzmann, L. (1994): Rekonstruktion fluviatiler Systeme. Möglichkeiten und Grenzen der Untersuchung mit feldgeologischen und makropaläobotanischen Methoden am Beispiel des paläogenen Zwickau Altenburger Flussystems im Weisselsterbecken (NW-Sachsen). - Dipl. Thesis, Tech. Univ. Bergakad., Freiberg.
Kvaček, Z. (1970): A new Platanus from the Bohemian Tertiary. - Paläont. Abh., B, 3(3/4): 435-439.
Kvaček, Z. (1984): Tertiary Taxads of NW Bohemia. - Acta Univ. Carol. Geol., (1982)4: 471-491.
Kvaček, Z. (1989): Fosilní Tetraclinis Mast. (Cupressaceae). - Čas. Nár. Muz., Ř. přírodověd., (1986)155: 45-53.
Kvaček, Z. (1993): The fossil history of Craigia (Tiliaceae) - a review. - Abstr. Paläont. Ges. 63. Jahrestag., Praha.
Kvaček Z. (1994): Connecting links between the Arctic Palaeogene and European Tertiary floras. - In: Boulter, M. C., Fisher, H. C. (eds.): Cenozoic plants and climates of the Arctic. Arcto-Tertiary Conf. London. NATO ASI Series I, 27: 251-266.
Kvaček, Z., Bůžek, Č. (1995): Endocarps and foliage of the Icacinaceae from the Tertiary of Central Europe. - Tert. Res., 15(3-4): 121-138.
Kvaček, Z., Walther, H. (1974): Bemerkenswerte und seltene cinnamomoide Blätter aus dem Grenzbereich des Oligo-Miozäns Mitteleuropas. - Abh. Staatl. Mus. Mineral. Geol. Dresden, 21: 197-221.
Kvaček, Z., Walther, H. (1981): Studium über „Quercus" cruciata A. Braun und analoge Blattformen aus dem Tertiär Europas. - Acta Palaeobot., 21(2): 77-100.
Kvaček, Z., Walther, H. (1987): Revision der mitteleuropäischen tertiären Fagaceae nach blattepidermalen Charakteristiken. I. Teil: Lithocarpus Blume. - Feddes Repert., 98: 637-652.
Kvaček, Z., Walther, H. (1988): Revision der mitteleuropäischen tertiären Fagaceen nach blattepidermalen Charakteristiken II. Teil - Castanopsis (D. Don) Spach, Trigonobalanus Forman, Trigonobalanopsis Kvaček et Walther. - Feddes Repert., 99: 395-418.
Kvaček, Z., Walther, H. (1989): Revision der mitteleuropäischen tertiären Fagaceae nach blattepidermalen

Charakteristiken. III. Teil: Dryophyllum Debey et Saporta und Eotrigonobalanus Walther et Kvaček. - Feddes Repert., 100: 576-599.
Kvaček, Z., Walther, H., Bůžek, Č. (1989): Palaeogene floras of W. Bohemia (C. S. S. R.) and the Weisselster Basin (G. D. R.) and their correlation. - Čas. Mineral. Geol., 34: 385-402.
Laube, G. (1880): Pflanzenreste aus dem Diatomaceenschiefer in Sulloditz im böhm. Mittelgebirge. - Verh. k. k. geol. Reichsanst., 1880: 277-278.
Mai, D. H. (1963): Beiträge zur Kenntnis der Tertiärflora von Seifhennersdorf (Sachsen). - Jb. Mus. Mineral. Geol. Dresden, 1963: 39-114.
Mai, D. H. (1964): Die Mastixioideen-Floren im Tertiär der Oberlausitz. - Paläont. Abh., B, 2(1): 1-192.
Mai, D. H. (1971): Über fossile Lauraceae und Theaceae in Mitteleuropa. - Feddes Repert., 82(5): 313-341.
Mai, D. H. (1976): Fossile Früchte und Samen aus dem Mitteleozän des Geiseltales. - Abh. Zentr. geol. Inst., 26: 281-301.
Mai, D. H. (1981): Entwicklung und klimatische Differenzierung der Laubwaldflora Mitteleuropas im Tertiär. - Flora, 171: 525-582.
Mai, D. H. (1985): Beiträge zur Geschichte einiger holziger Saxifragales-Gattungen. - Gleditschia, 13: 75-88.
Mai, D. H. (1988): New Nymphaealean fossils from the Tertiary of central Europe. - Tert. Res., 9(1-4): 87-96.
Mai, D. H., Walther, H. (1978): Die Floren der Haselbacher Serie im Weisselster-Becken (Bezirk Leipzig, DDR). - Abh. Staatl. Mus. Mineral. Geol. Dresden, 28: 1-200.
Mai D. H., Walther, H. (1983): Die fossilen Floren des Weisselster-Beckens und seiner Randgebiete. - Hall. Jb. Geowiss., 8: 59-74.
Mai, D. H., Walther, H. (1985): Die obereozänen Floren des Weisselster-Beckens und seiner Randgebiete. - Abh. Staatl. Mus. Mineral. Geol. Dresden, 33: 1-260.
Mai, D. H., Walther, H. (1988): Die pliozäne Floren von Thüringen, Deutsche Demokratische Republik. Quartärpaläont., 7: 55-297.
Mai, D. H., Walther, H. (1991): Die oligozänen und untermiozänen Floren NW Sachsen und des Bitterfelder Raumes. Abh. Staatl. Mus. Mineral. Geol. Dresden, 38: 1-230.
Manchester, S. R. (1987): The fossil history of the Juglandaceae. - Monogr. Syst. Bot. Missouri Bot. Gard., 21: 1-137.
Menzel, P. (1896/97): Fie Flora des tertiären Polierschiefers von Sulloditz in böhmischen Mittelgebirge. - Sitz.-Ber. Abh. naturwiss. Ges. Isis Bautzen, 1896/97: 1-54.
Menzel, P. (1901): Die Gymmnospermen der nordböhmischen Braunkohlenformation I-II. - Abh. Naturwiss. Ges. Isis Dresden, (1900): 49-69.
Novák, E. (1950): A Kisegedi Oligocén-Flora Fenyöféléi. - Ann. Biol. Univ. Budapest., 1(1): 48-61.
Pöppelreiter, M. (1992): Sedimentologische Untersuchungen in einem Abschnitt des Thierbacher Flusses im Tagebau Bockwitz. - Engineer Thesis, Engineer School, Bergakademie, Freiberg.
Procházka, M. (1951): Zpráva o paleobotanických pracích v terciéru Českého Středohoří. - Věst. Ústř. Úst. geol., 26: 95-101.
Procházka, M., Bůžek, Č. (1975): Maple leaves from the Tertiary of North Bohemia. - Rozpr. Ústř. Úst. geol., 41: 1-88.
Reid, E. M., Chandler, M. E. J. (1926): Catalogue of Cainozoic plants in the department of geology. I. The Bembridge flora. - Oxford Univ. Press, London, 206 pp.
Rüffle, L., Müller-Stoll, W. R., Litke, R. (1976): Weitere Ranales, Fagaceae, Loranthaceae, Apocynaceae. - Abh. Zentr. geol. Inst., 26: 199-282.
Spicer, R. (1989): The formation and interpretation of plant fossil assemblages. - Advances in Botanical Research, 16: 95-191.
Sveshnikova, I. N. (1980): Novyj vymershij rod semejstva Cupressaceae - Tambovskia Sveshn. gen. nov. - In: Zhilin, S. G. et al. (eds.): Sistematika i evoljucija vysshikh rastenij. Nauka, Leningrad, 42-45 pp.
Walther, H. (1964): Paläobotanische Untersuchungen im Tertiär von Seifhennersdorf. - Jb. Staatl. Mus. Mineral. Geol. Dresden, 1964: 1-131.
Walther, H. (1967): Ergänzungen zur Flora von Seifhennersdorf (Sachsen) I. Teil. - Abh. Staatl. Mus. Mineral. Geol. Dresden, 12: 259-277.
Walther, H. (1972): Studien über tertiäre Acer Mitteleuropas. - Abh. Staatl. Mus. Mineral. Geol. Dresden, 19: 1-309.
Walther, H. (1974): Ergänzungen zur Flora von Seifhennersdorf/Sachsen, II. Teil. - Abh. Staatl. Mus. Mineral. Geol. Dresden, 21: 143-158.
Walther, H. (1975): Versuch der Rekonstruktion einer tertiären Lokalflora am Beispiel von Seifhennersdorf. - Abh. Ber. Naturkdemus. Görlitz, 51(2): 23-36.
Walther, H. (1980): Matudaea menzelii Walther, ein neues neotropisches Geoelement in der Tertiärflora Mitteleuropas. - Flora, 170: 498-516.
Walther, H. (1985): Das Vorkommen der Gattung Platanus L. im Tertiär des Weisselster Beckens (Bezirk Leipzig, DDR). - Hall. Jb. Geowiss., 10: 9-19.

Walther, H. (1988): Museum Seifhennersdorf, Geologie, Paläontologie, Bergbau. 2. überarb. Aufl. - Werk V, Druckerei, Neugersdorf, 43 pp.
Walther, H. (in press): Das Tertiär-Vorkommen von Seifhennersdorf (Oberlausitz, Deutschland). - Neu. Jb. Geol. Paläont. Abh.
Wentzel, J. (1881): Die Flora der tertiären Diatomaceenschichten von Sulloditz im böhmischen Mittelgebirge. - Sitz.-Ber. Akad. Wiss. Wien, math.-nat. Cl., I, 83(3): 241-265.
Zhilin, S. G. (1989): History of the development of the temperate forest flora in Kazakhstan, U. S. S. R. from the Oligocene to the Early Miocene. - Bot. Rev., 55(4): 205-330.

EXPLANATIONS OF THE PLATES

(abbreviations of collections: MMG - Staatliches Museum f. Mineralogie und Geologie, Dresden; PR - Palaeontological Department, National Museum, Praha)

PLATE 1.

1. *Pronephrium stiriacum* (Ung.) Knobloch et Kvaček, No. MMG SuBe 189:1a, × 1.
2. cf. *Osmunda* sp., No. MMG SuBe 733:2, × 2.
3. Bryophyta gen. et sp. indet., Holotype of *Hypnum parvifolium* Engelhardt 1898, pl. 1, fig. 12, No. MMG SuBe 105:2a, × 1.
4. cf. *Cephalotaxus* sp., No. MMG SuBe 798a, × 2.
5. *Tetraclinis salicornioides* (Ung.) Kvaček, a seed, No. MMG SuBe 769a, × 2.
6. „*Libocedrus*“ *suleticensis* Brabenec, No. MMG SuBe 762a, × 1.
7. „*Libocedrus*“ *suleticensis* Brabenec, Holotype, No. PR G 4211, × 2.5.
8. *Tetraclinis salicornioides* (Ung.) Kvaček, a twig with two cones, No. PR G 7535a, × 2.5.
9. *Tetraclinis salicornioides* (Ung.) Kvaček, No. MMG SuBe 375a, × 1.
10. *Tetraclinis salicornioides* (Ung.) Kvaček, No. PR G 3727, × 4.

PLATE 2.

1. *Magnolia* sp., No. MMG SuBe 119:1c, × 1.
2. *Daphnogene cinnamomifolia* (Brongn.) Ung. (forma „*cinnamomifolia*“), No. MMG SuBe 76, × 1.
3. *Laurophyllum* cf. *acutimontanum* Mai, No. MMG SuBe 133b, × 1.
4. *Laurophyllum* cf. *pseudoprinceps* Weyland et Kilpper, No. MMG SuBe 588, × 1.
5. *Laurophyllum* cf. *medimontanum* Bůžek, Holý et Kvaček, Holotype of *Euonymus tenuifolius* Engelhardt 1898, pl. 2, fig. 34, No. MMG SuBe 201c, × 1.
6. *Laurocarpum* sp., Orig. of *Aristolochia aesculapi* Heer - Kafka 1908, textfig. 21, No. PR G 5660, × 1.
7. cf. *Dusambaya* sp., a seed, No. MMG SuBe 765b, × 1.
8. *Laurocarpum* sp., No. MMG SuBe 714, × 2.
9. *Liriondendron haueri* Ettingshausen, a fruit, Orig. of *Fraxinus juglandina* Saporta - Engelhardt 1898, pl. 1, fig. 52, No. MMG SuBe 176 × 1.
10. *Liriodendron haueri* Ettingshausen, No. MMG SuBe 576d, × 1.

PLATE 3.

1. cf. *Matudaea* sp., No. PR G 7538, × 1.5.
2. *Mahonia* sp., No. PR G 7528, × 1.
3. *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček, No. MMG SuBe 3a, × 1.8.
4. *Zelkova zelkovifolia* (Ung.) Bůžek et Kotlaba, No. MMG SuBe 20a, × 1.
5. *Zelkova zelkovifolia* (Ung.) Bůžek et Kotlaba, a twig, No. MMG SuBe 511a, × 1.
6. *Celtis* sp., Holotype of *Celtis bohemica* Engelhardt, 1898, pl. 1, fig. 55, No. MMG SuBe 273:1a, × 1.
7. cf. *Betula* vel *Alnus* sp., No. PR G 7537a, × 1.
8. *Zelkova zelkovifolia* (Ung.) Bůžek et Kotlaba, No. MMG SuBe 491a, × 1.

PLATE 4.

1. *Carpinus grandis* Ung., No. MMG SuBe 253, × 1.8.
2. *Ostrya atlantidis* Ung., No. MMG SuBe 433a, × 1.
3. *Carya serrifolia* (Goepp.) Kräusel, No. MMG SuBe 87a, × 1.
4. *Carpinus mediomontana* Mai, an involucre, Orig. of *Carpinus neilreichii* Kováts - Engelhardt 1898, pl. 1, fig. 13, No. MMG SuBe 778:1a, × 2.
5. *Populus zaddachii* Heer, No. PR G 7523, × 1.

PLATE 5.

1. *Engelhardia orsbergensis* (Wessel et Weber) Jächnichen, Mai et Walther, disintegrated leaves, No. MMG SuBe 723, × 1.
2. *Engelhardia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther, No. MMG SuBe 3e, × 1.5.
3. Juglandaceae gen. et sp. indet., an ament, No. PR G 7536, × 2.
4. Pollen sack with pollen in situ from the ament on fig. 3, × 500.
5. Isolated pollen in situ from the ament on fig. 3, *Engelhardtioidites microcoryphaeus* (R. Pot.) R. Pot., × 500.
6. *Engelhardia macroptera* (Brongn.) Ung., an incomplete fruit, No. MMG SuBe 201b, × 1.
7. *Engelhardia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther, Orig. of *Banksia haeringiana* Ettingsh. - Engelhardt 1898, pl. 1, fig. 39, No. MMG SuBe 85b, × 1.

PLATE 6.

1. *Carpolithes* sp. (cf. *Carya* sp.), No. PR G 7533, × 1.5.
2. *Carya serrifolia* (Goepp.) Kräusel, No. MMG SuBe 102a, b, × 1.
3. *Carya serrifolia* (Goepp.) Kräusel, No. MMG SuBe 101, × 1.
4. cf. *Cyclocarya cyclocarpa* (Schlecht.) Knobloch, No. MMG SuBe 767b, × 1.
5. Juglandaceae gen. et sp. indet., an ament, No. MMG SuBe 389a, × 1.
6. *Craigia bronnii* (Ung.) Kvaček, Bůžek et Manchester, a fruit valve, No. MMG SuBe 505, × 1.
7. *Ampelopsis hibschii* Bůžek, Kvaček et Walther, No. PR G 7541, × 1.
8. *Ampelopsis hibschii* Bůžek, Kvaček et Walther, No. MMG SuBe 156, × 1.

PLATE 7.

1. *Icaciniphyllum artocarpites* (Ettingsh.) Kvaček et Bůžek, Holotype of *Elaeodendron grandifolium* Engelhardt 1898, pl. 2, fig. 30, No. MMG SuBe 216c, × 1.
2. *Icaciniphyllum artocarpites* (Ettingsh.) Kvaček et Bůžek, Syntype of *Ampelopsis bohemica* Engelhardt 1898, pl. 2, fig. 24, No. MMG SuBe 21, × 1.
3. Leguminosae gen. et sp. indet. (forma 1), No. PR G 7540, × 2.5.
4. Leguminosae gen. et sp. indet. (forma 1), Orig. of *Leguminosites rotundatus* Heer - Engelhardt 1898, pl. 3, fig. 22, No. MMG SuBe 146, × 3.
5. *Hydrangea microcalyx* Sieber, Orig. of *Porana oeningensis* Heer - Kafka 1908, text-fig. 20, No. PR G 5418, × 1.
6. Leguminosae gen. et sp. indet. 4, No. MMG SuBe 328, × 2.
7. Leguminosae gen. et sp. indet., a fruit, No. MMG SuBe 25d, × 3.
8. Leguminosae gen. et sp. indet. 2, Orig. of *Leguminosites proserpinae* Heer - Engelhardt 1898, pl. 3, fig. 20, No. MMG SuBe 133a, × 1.
9. *Rosa lignitum* Heer, No. MMG SuBe 539c, × 2.

PLATE 8.

1. *Acer tricuspidatum* Bronn, No. MMG SuBe 788a, × 1.
2. *Ailanthus* sp., No. MMG SuBe 484e, × 1.
3. *Acer palaeosaccharinum* Stur, No. MMG SuBe 765c, × 1.
4. „*Elaeodendron*“ sp., Orig. of *Euonymus latoniae* Ung. - Engelhardt 1898, pl. 2, fig. 22, No. MMG SuBe 171a, × 1.
5. *Acer* sp., a fruit, No. MMG SuBe 319a, × 2.
6. „*Quercus*“ *cruciata* A. Br., Orig. Engelhardt 1898, pl. 1, fig. 27, Kvaček et Walther 1981, pl. 7, fig. 2, 4, No. MMG SuBe 26:1, × 1.
7. *Cornus studeri* Heer, No. MMG SuBe 119:1b, × 1.

PLATE 9.

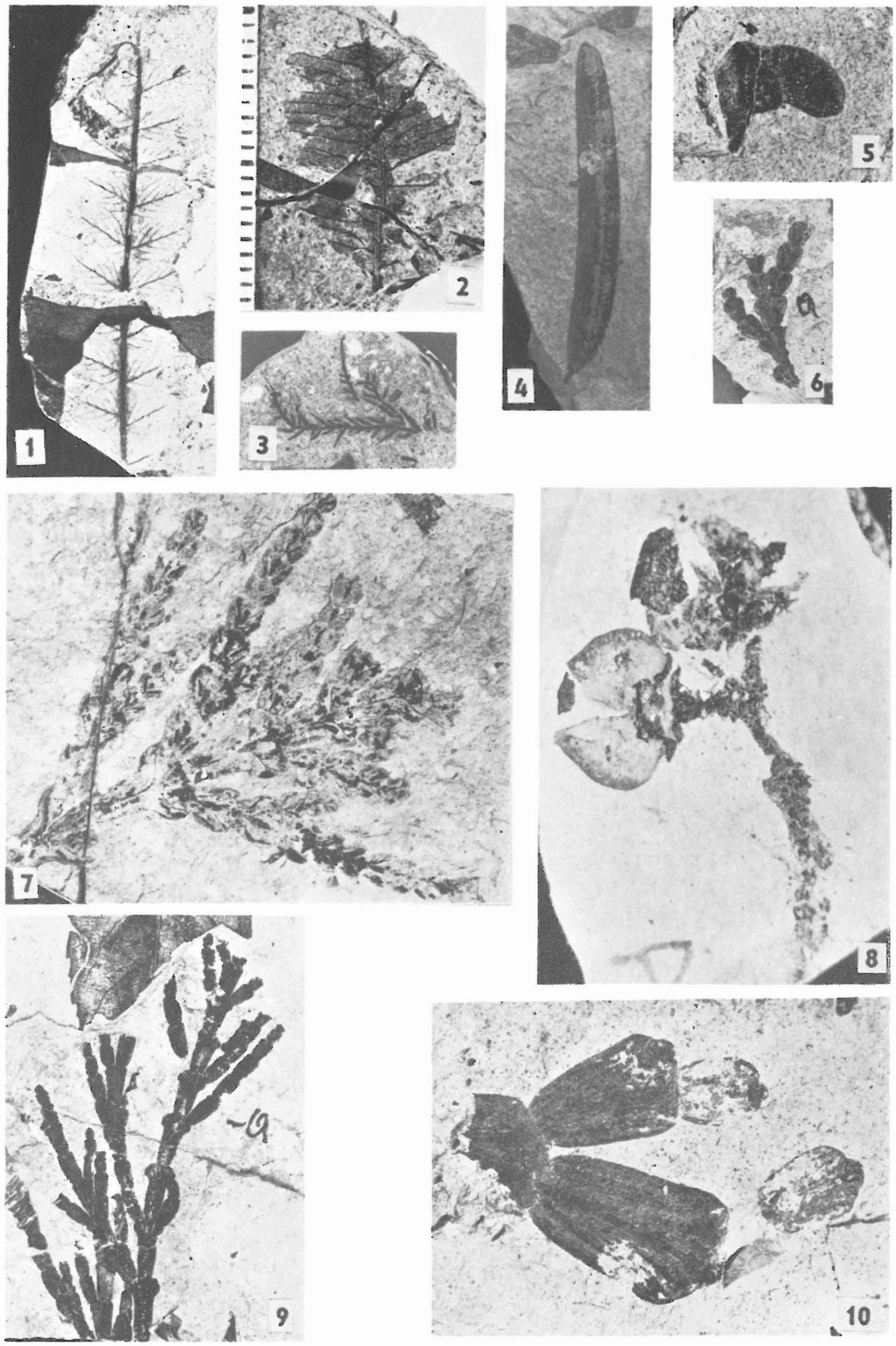
1. *Dombeyopsis* sp., No. MMG SuBe 657a, × 1.
2. *Apocynospermum striatum* Reid et Chandler, a seed, No. PR G 7527, × 3.
3. Monocotyledonae gen. et sp., Holotype of *Pinus laricioides* Menzel 1901, pl. 3, fig. 16, No. MMG SuBe 817:1, × 1.
4. *Smilax* sp., No. MMG SuBe 141e, × 1.
5. „*Palaeolobium*“ sp., No. PR G 7531, × 1.
6. *Dicotylophyllum* sp., No. MMG SuBe 617b, × 1.
7. *Dicotylophyllum maii* Bůžek, Holý et Kvaček, MMG SuBe 174b, × 1.

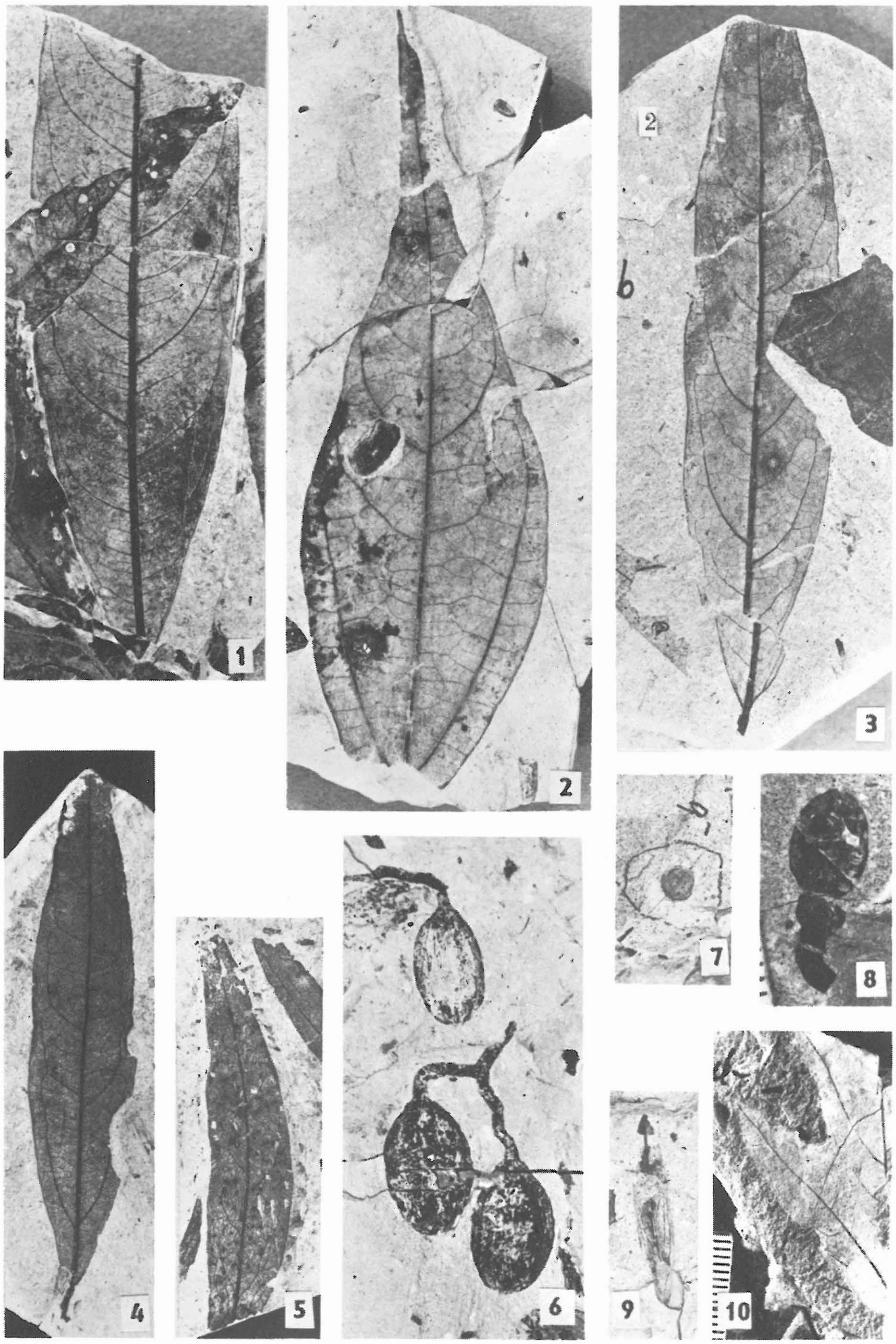
PLATE 10.

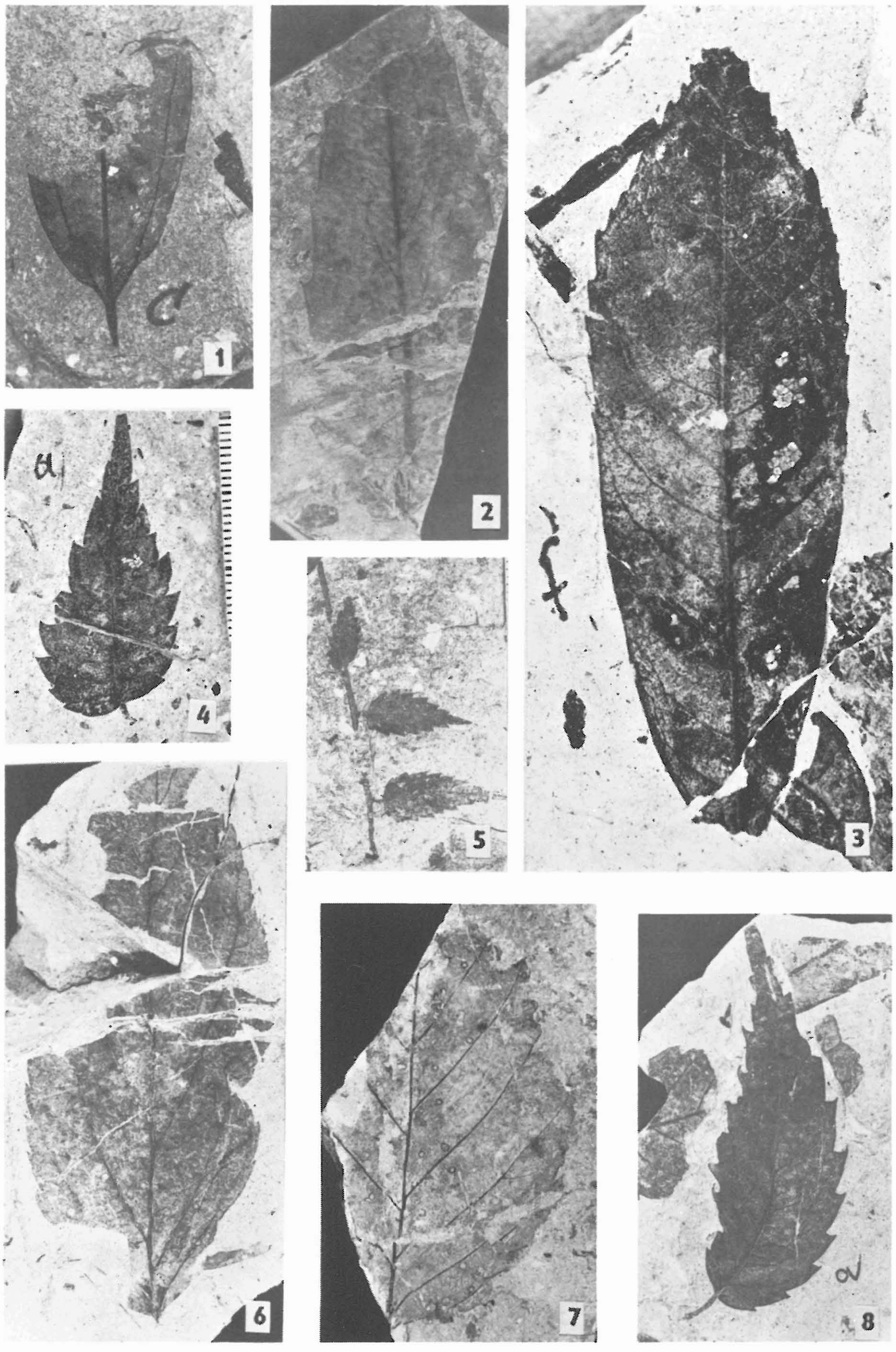
1. *Acer angustilobum* Heer, No. PR G 7534, × 1.
2. *Acer* cf. *decipiens* A. Br., No. MMG SuBe 825:2, × 1.
3. *Carpolithes* sp., Orig. of *Castanea kubinyi* Kováts - Engelhardt 1898, pl. 1, fig. 21, No. MMG SuBe 284:1, × 1.
4. *Dicotylophyllum maii* Bůžek, Holý et Kvaček, No. MMG SuBe 624a, × 1.
5. *Icaciniphyllum artocarpites* (Ettingsh.) Kvaček et Bůžek, No. MMG SuBe 545:1, × 1.
6. *Dicotylophyllum* sp., No. MMG SuBe 666:1c, × 1.

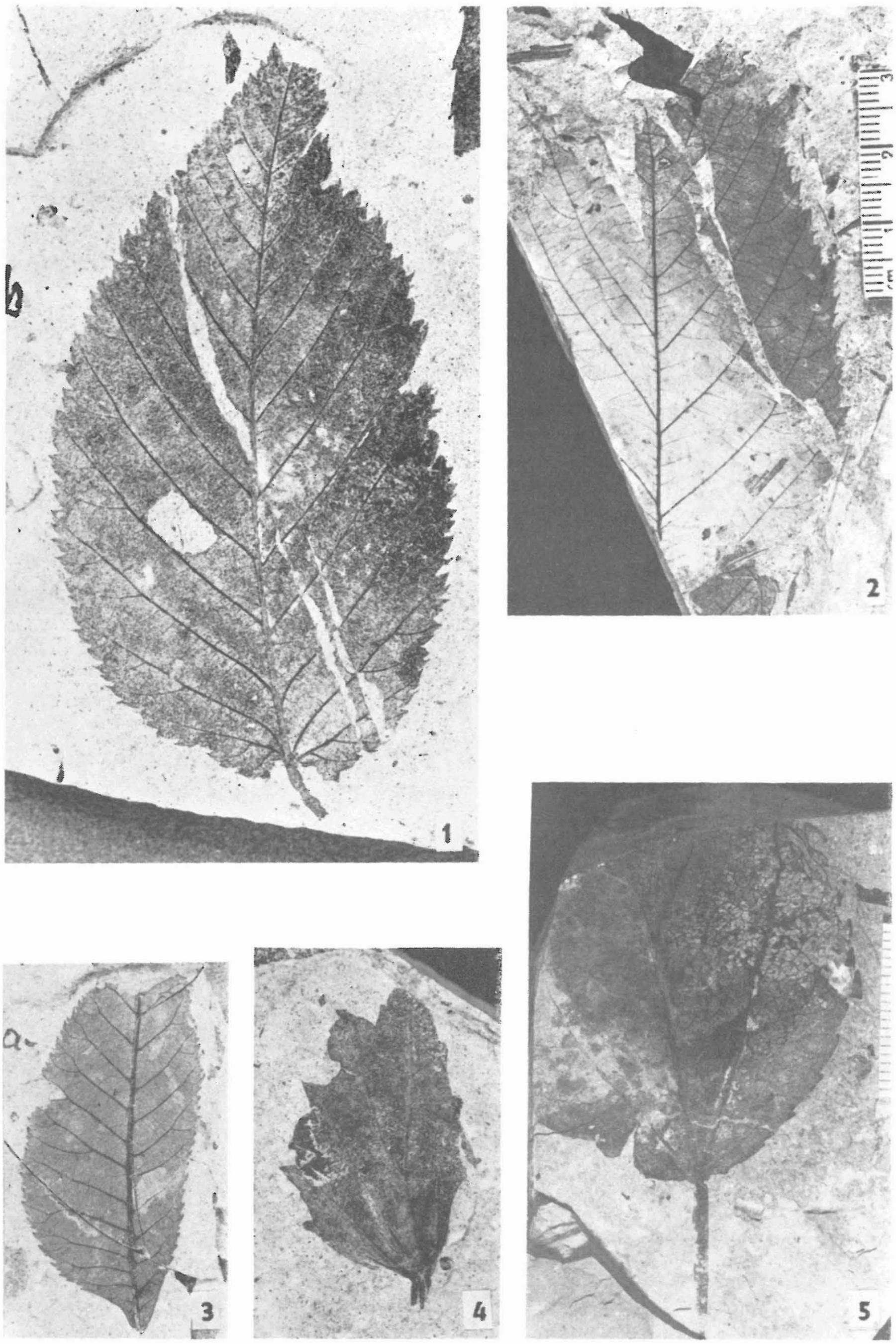
PLATE 11.

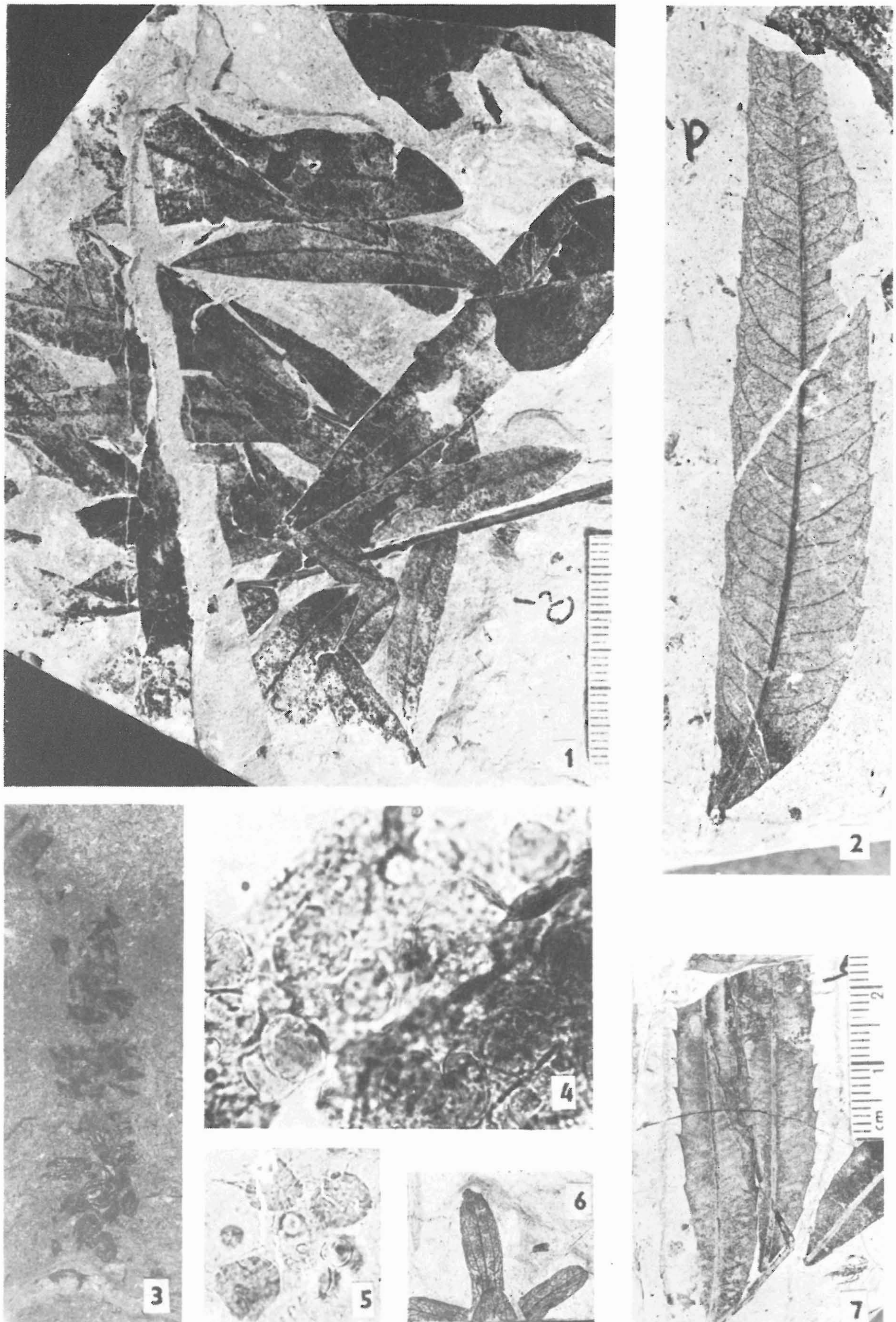
The well at the settlement Berand, which yielded the flora of Suletice-Berand by Engelhardt 1898 (photo by H. Walther 1966).

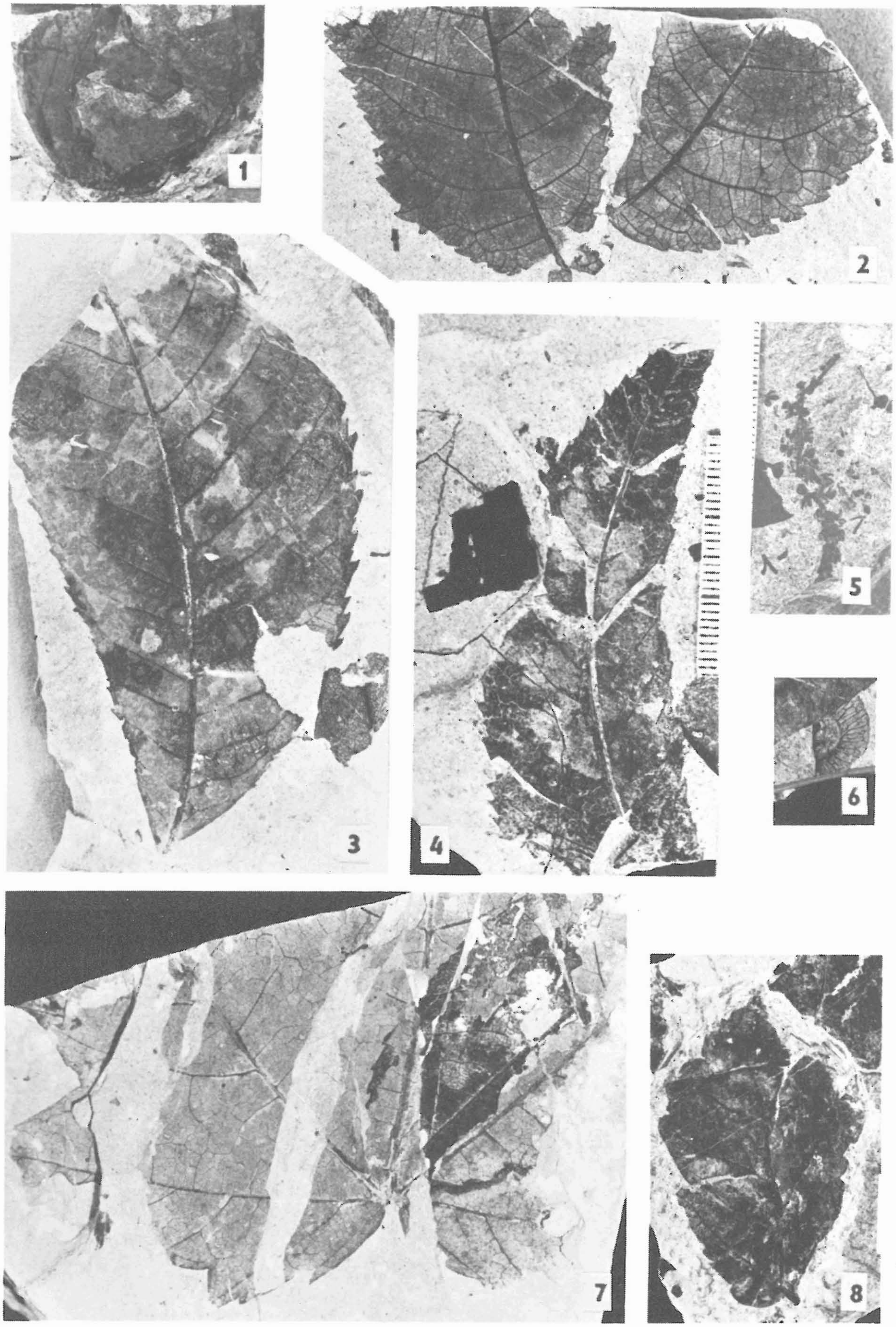


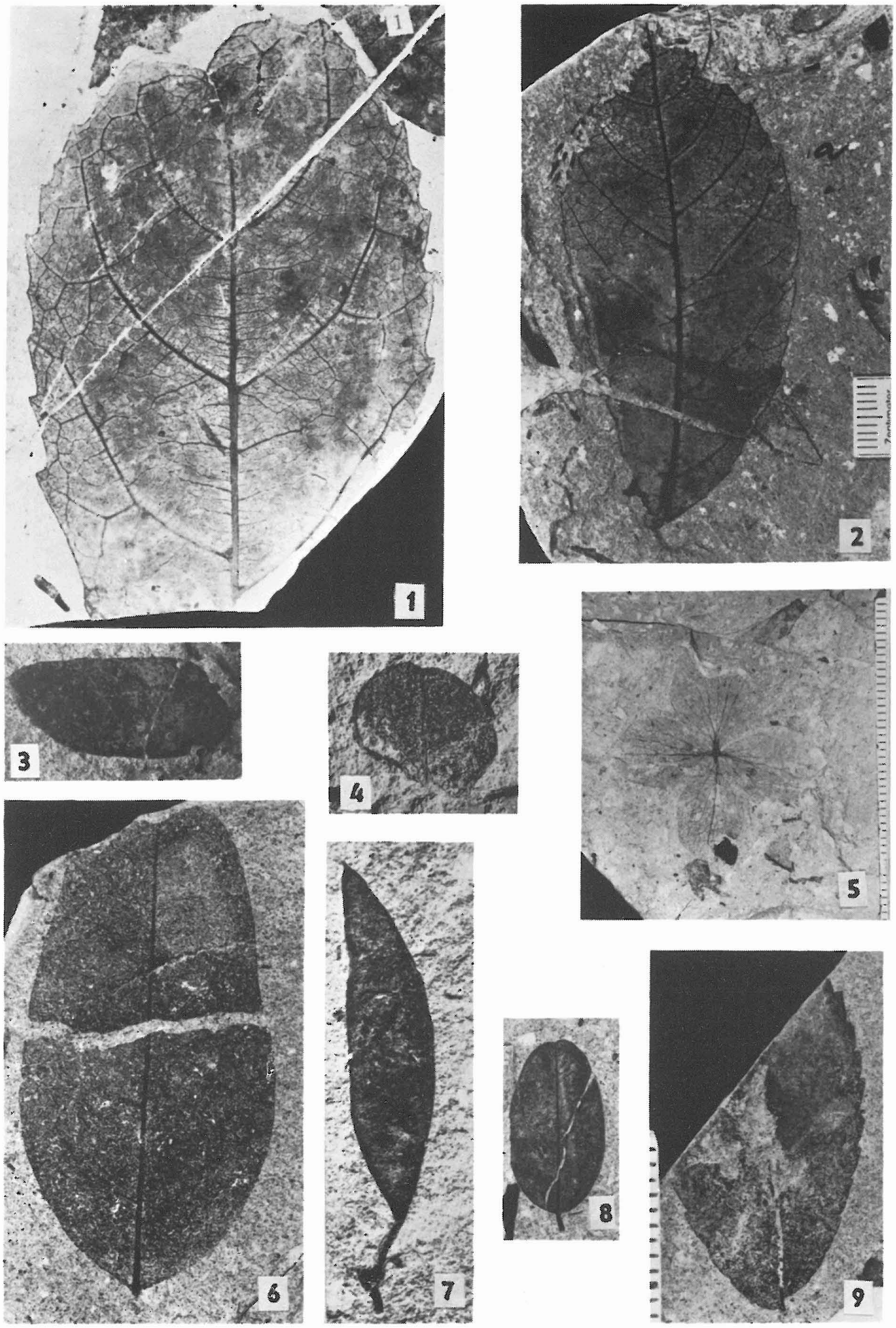

1
2
3
4
5
6
7
8
9
10

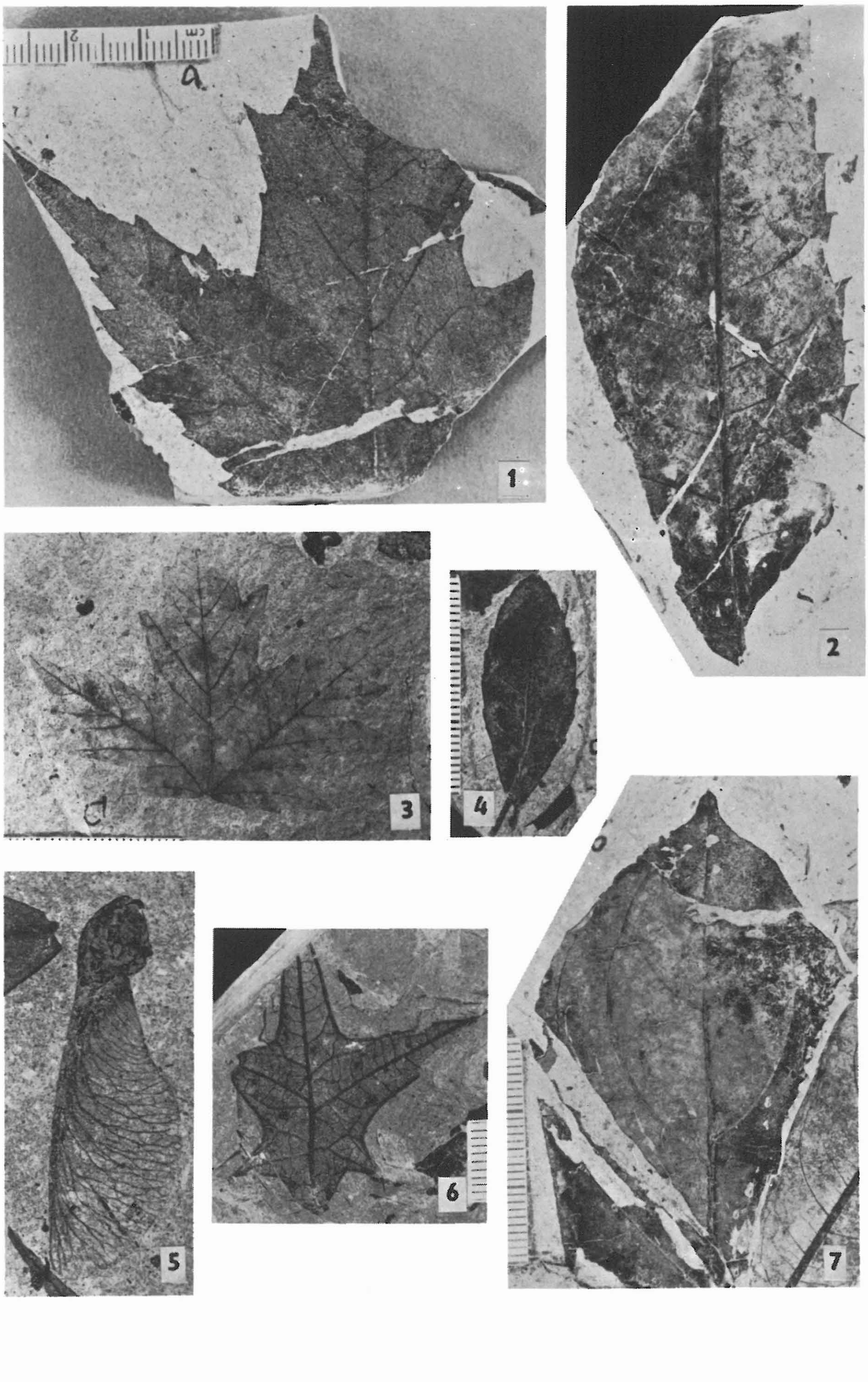

1
2
3
4
5
6
7
8

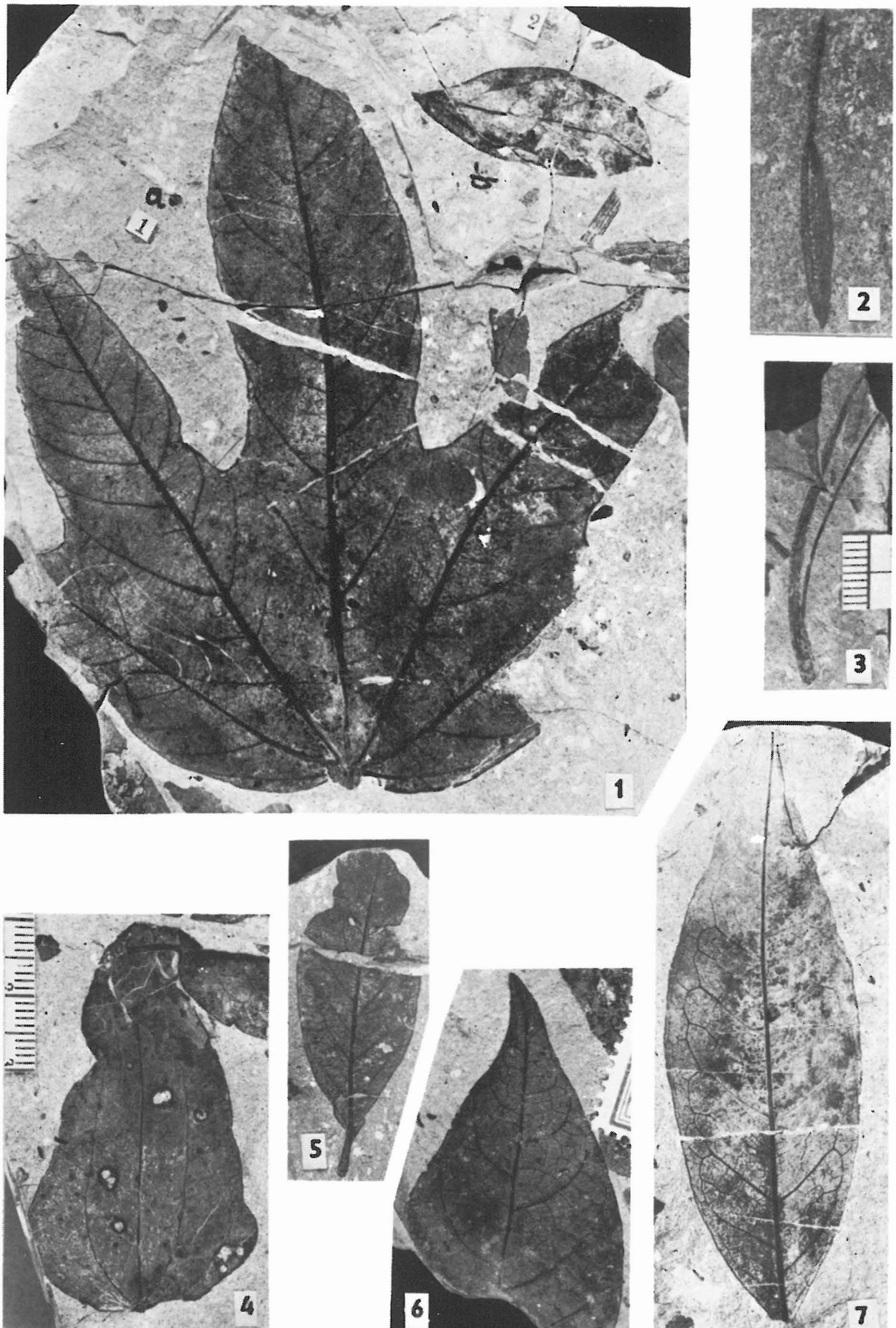


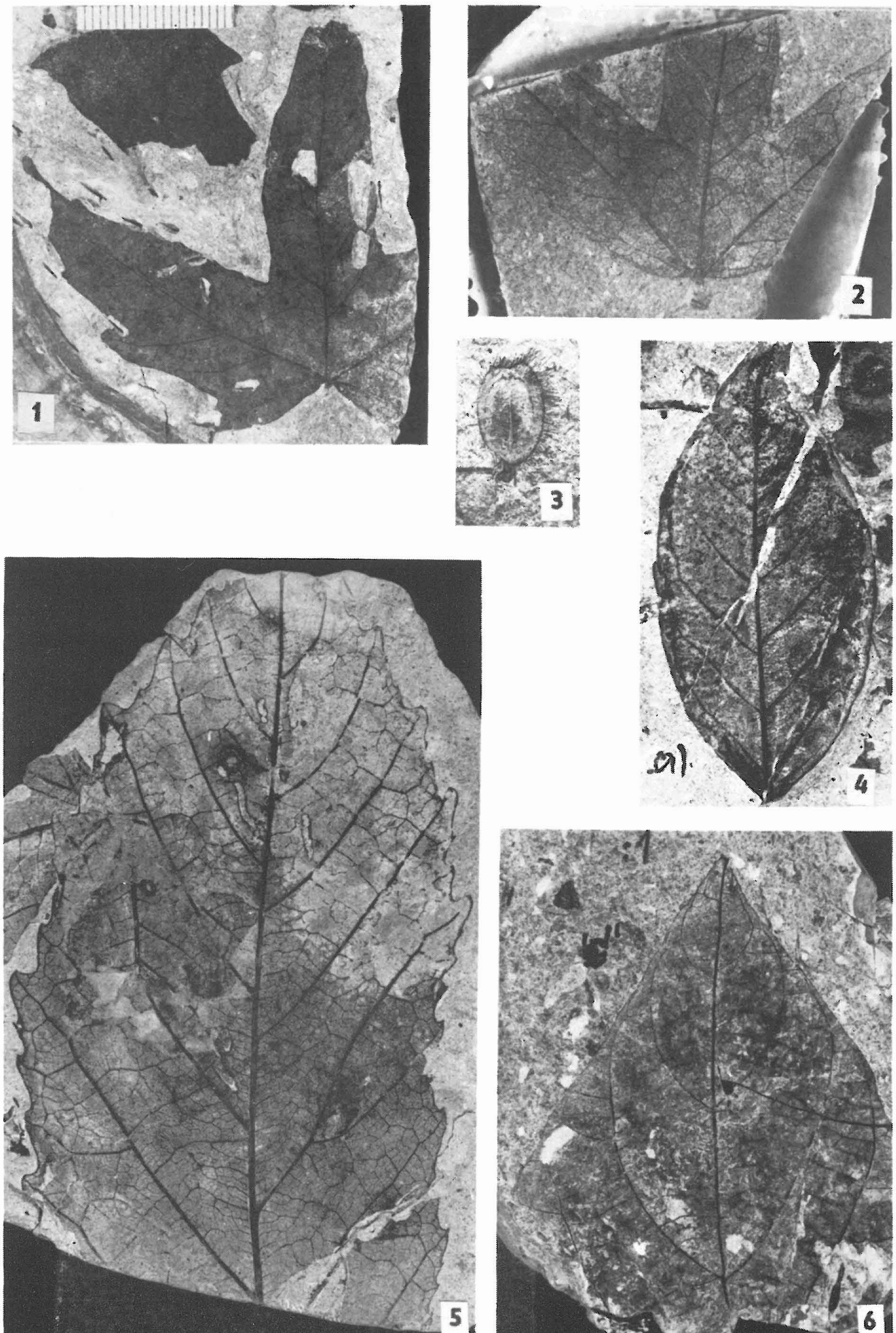

1
2
3
4
5
6
7


1
2
3
4
5
6
7
8






1
2
3
4
5
6
7


1
2
3
4
5
6