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TERTIARY FLORA AND VEGETATION OF THE HLAVAČOV GRAVEL AND SAND AND THE SURROUNDINGS OF HOLEDEČ IN THE MOST BASIN (CZECH REPUBLIC)

VASILIS TEODORIDIS

Charles University, Institute of Geology and Palaeontology, Albertov 6, 128 43 Prague 2, Czech Republic; e-mail: vasilis@natur.cuni.cz

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Abstract. The floras of the Hlavačov gravel and sand are bound to clay lenses irregularly distributed in psammitic - psephitic sediments of the Tertiary river, which drained off areas of Central and West Bohemia and led through Rakovník towards Žatec into the Most Basin. The flora of Holedeč is preserved in clay layers, which genetically belong to the lower part of the Žatec facies of the Most Formation. This locality was discovered in the 19th century. Both areas have yielded 2 ferns, 5 conifers and 51 angiosperms. *Populus zaddachii* HEER var. *brabenecii* var. n. has been described as a new taxon. The plant fossils are preserved as impressions without any chance for taxonomical determination by cuticular analysis. An ecological reconstruction of plant associations connected with the Hlavačov gravel and sand corresponds to the temperate riparian forest with dominant deciduous elements, e. g. *Fagus saxonica* Z. KVAČEK et WALTHER, *Pseudolarix schmidtgenii* KRÄUSEL, *Taxodium dubium* (STERNBERG) HEER, Betulaceae. The locality Holedeč differs in the sedimentary setting. It is possible to infer sedimentation in lake conditions or oxbow lake by a domination of *Salvinia reussii* ETTINGSHAUSEN and occurrences of *Stratiotes kaltennordheimensis* (ZENKER) KEILH. The floras from Holedeč and the Hlavačov belt are correlated with the Upper Oligocene Floristic assemblage Thierbach (in the sense of Mai and Walther 1991) from the uppermost part of the Weisselster Basin and the lower part of the Bitterfeld Basin (Germany).

■ Czech Republic; Most Basin; river; flora; Upper Oligocene; palaeoecology.

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Introduction

This work represents a slightly modified English version of the master's thesis of the author (Teodoridis 2000). The main aim of the present work is a detailed characteristic of the Tertiary floras and vegetation of Hlavačov and Holedeč deposits, which are situated between the towns Rakovník and Holedeč. The Hlavačov gravel and sand and deposits in surroundings of Holedeč, which genetically belong to the Žatec facies of the Most Formation, have been intensively studied since 19th century. During this century, opinions on stratigraphical position and correlation with deposits of the Most Basin have been changed, but have never been favourably solved. The present work revises all original fossil material and tries to show a new way for claryfying this problematic.

History of investigation

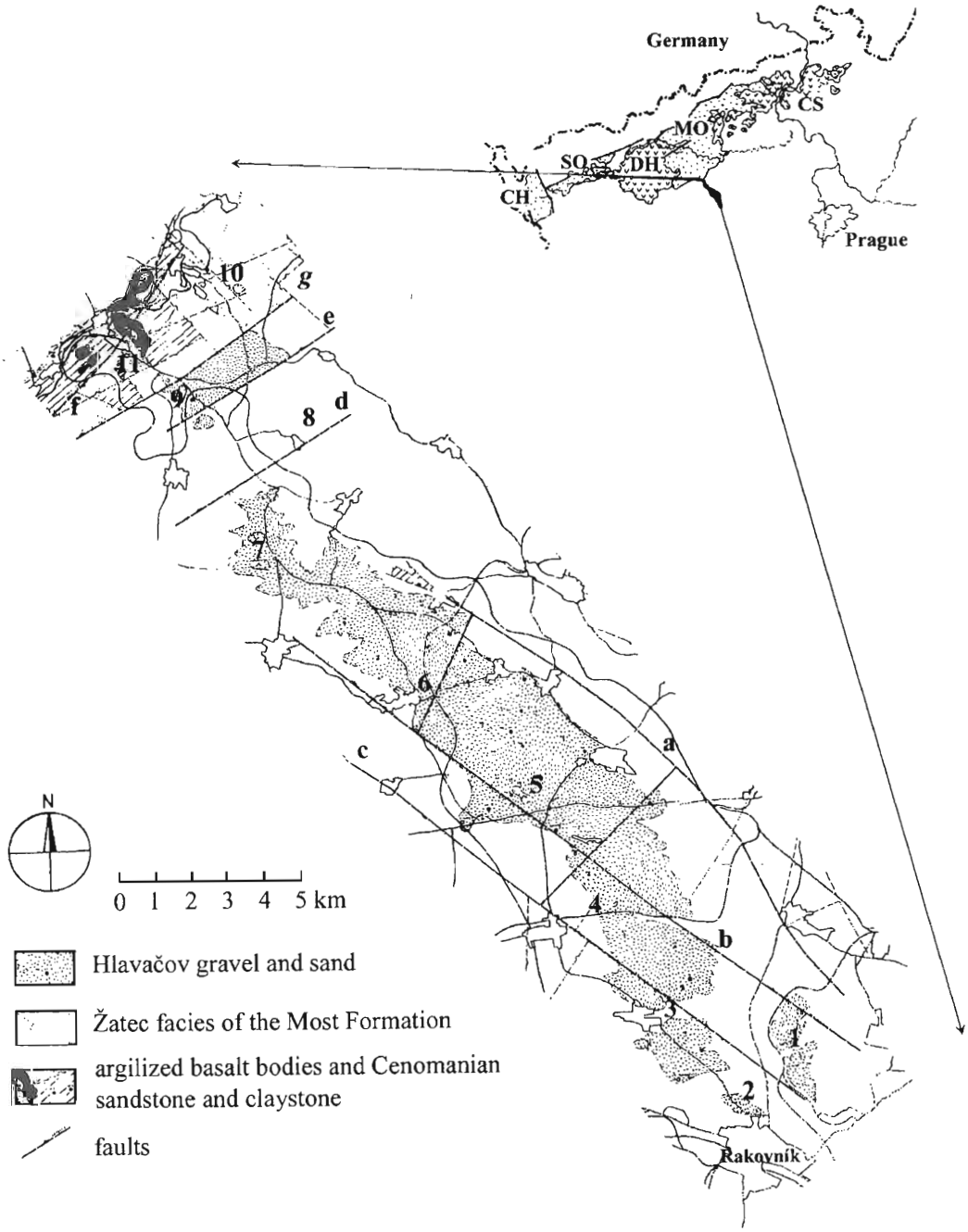
The oldest work, which deals with the Hlavačov gravel and sand as pebble beds at towns Měcholupy, Holedeč and Liběšice, was published by Krejčí (1877). Next reports about the existence of these Tertiary sediments are known from works by Kušta (1879) and K. Feistmantel (1881), who investigated mainly the area around the towns Broumy and Karlova Ves. These deposits and also their equivalents in the Rakovník Basin were considered as residual Carboniferous sediments. The first attempt to decide about the age of the Hlavačov gravel and sand by occurrences of fossil plants from clay lenses at Sádek was made by Kušta (1889). This material was commented by Němejc (1949), although not studied authentically, because the collection of Kušta is not available. The age of the plant impressions was assigned as Miocene, i. e. Tertiary. Next important accounts are works of Brabenec (1904) and Kettner (1912). Brabenec (1904) described an evidently Tertiary flora from clay lenses from the lower zone of the "Žatec beds" in the surrounding of Holedeč. Kettner (1912) provided paleontological evidence of existence of Tertiary deposits in the area of Klínec upon Všenory and Na Sulavě at Černošice. Further occurrences of the flora from the sand pit of Dykast at Nesuchyně on an elevation "Rovina" (Vachtl 1935a) were revised by Němejc (1949). Works by Smetana (1915, 1926), Kunský (1929) and Vachtl (1935b) deal with the geology of the Hlavačov gravel and sand and Neogene "islands" in Central Bohemia and their mutual connection in Tertiary rivers or a lake (Smetana, 1926). A re-appraisal of these previous studies was given by Němejc (1949), who determinated the age of the Hlavačov gravel and sand as Tertiary on the basis of paleobotanical considerations and recognised an older phase (Miocene) of Klínec (localities Nesuchyně, Na Sulavě by Černošice and Klínec upon Všenory) and a younger phase (Upper Pliocene) of Zdiby (locality U sv. Antonína) - see in detail Němejc (1949, 1953a, b). In post-war time many authors came back to the problems of the Hlavačov gravel and sand, e. g., Bretšnajder (1950, 1952), Bůžek (1958), Váně (1953, 1977, 1981, 1985), Malecha (1962), Čadek (1966), Gabriel and Valín (1968), Holý and Bůžek (1966), Pešek (1972), Pešek and Spudil

(1986), Bůžek and Kvaček (1989a, b). Their results are summarised and re-evaluated in this paper.

Geological setting

A relatively continuous belt of the Hlavačov gravel and sand is situated between towns Rakovník on the Southeast, and Holedeč and Měcholupy on the Northwest, mostly within the area of the Rakovník Basin. The basement of this basin is complicated in its morphological and geological structure. Two types of rocks are generally represented there: granites, genetically belonging to the Čistá - Jesenice Pluton, and the Upper Proterozoic greywackes and slates (see in detail Hrdý 1962). Besides these rocks in the area of the Hlavačov gravel and sand there occur deposits of the continental Permo-Carboniferous (sediments of the Kladno, Týnec, Slaný and Líně formations - mainly red and grey mudstones, arkoses, sandstones, rhyolite tuffs and rare coal seams) and deposits of the Cenomanian and Lower Turonian (ferruginous and quartzose sandstones, conglomerates, marls, claystones etc.).

The best known locality of the Hlavačov deposits is a nominal locality Hlavačov situated on the east bank of the Lišany stream between towns Rakovník and Lišany. Southern occurrences were recovered at the north periphery of Rakovník (lo-

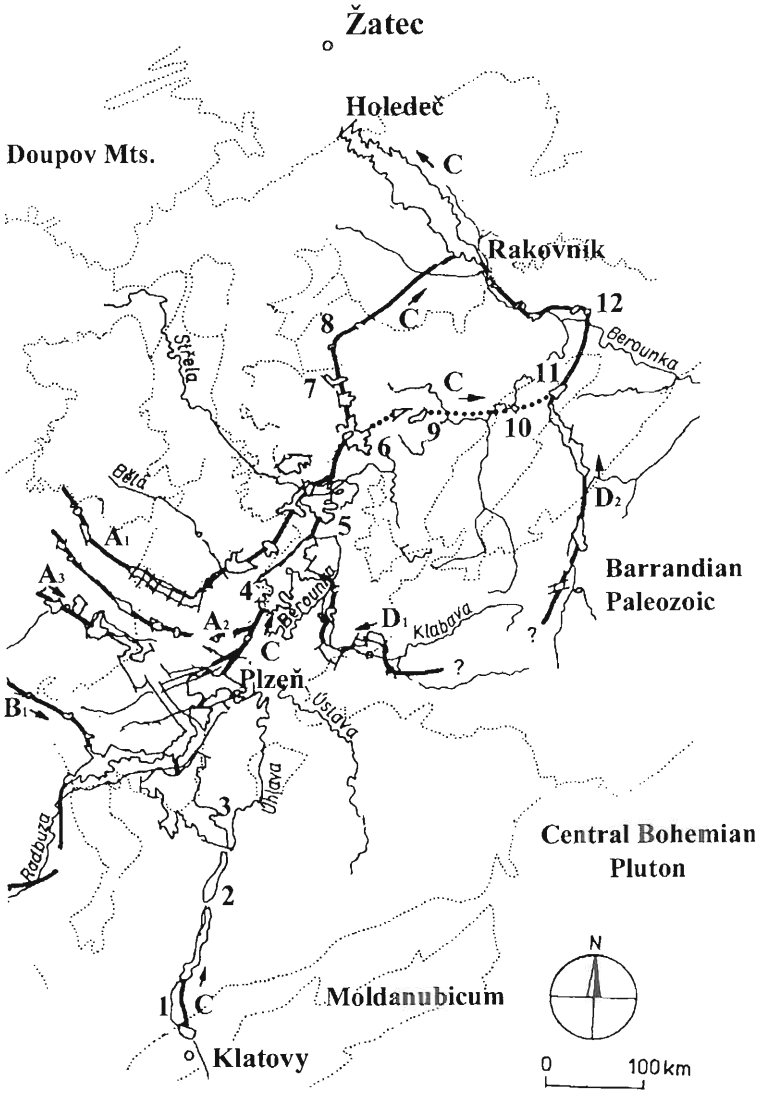


Text-fig. 1. Location and tectonic of the Hlavačov gravel and sand (according to Váně 1981 and Mísař et al. 1982)
Localities: 1. Hlavačov, 2. U sv. Antonína, Na Bendovce, 3. Olešná, 4. Chrášťany, 5. Nesuchyně, 6. Svojetín, 7. Velká Černoc, 8. Sádek, 9. Želeč, 10. Holedeč, 11. Měcholupy. Faults: a - the Milostín fault, b - the Svojetín fault, c - the Chrášťany fault, d - the Sádek fault, e - the Želeč fault, f - the Měcholupy fault, g - the Sířemy fault. Symbols: CH - the Cheb Basin, SO - the Sokolov Basin, MO - the Most Basin, DH - the Doupov Mts., CS - the České Středohoří Mts.

cality U sv. Antonína, Na Bendovce) and around Olešná. The sedimentary belt of Hlavačov continues towards Chrášťany, Nesuchyně, Milostín, Povlčín, Svojetín, Velká Černoc and Janov to the area south of Sádek - see text-fig. 1. Its length is about 21 km and the width varies from 2 to 3.5 km (Váně 1985). The belt of the Hlavačov gravel and sand is broken and denudated in a width of 1.7 km. In this area underlying deposits of the Permo-Carboniferous and Cretaceous occur on the surface. Next relicts of the Hlavačov gravel and sand occur near Želeč and Sádek (railway station). In the surroundings of the towns Holedeč and Měcholupy, the Hlavačov gravel and sand does not appear on the earth surface, but under the Žatec facies, which belongs to the Most Basin.

The litological character of the gravel and sand of Hlavačov is very typical. Boulder material of the gravel facies is very varied and includes mainly white or yellowish quartzs and black lydites. Besides the boulder material, also clastic fragments of unstable rock components occur in the proportion of 30 % in the southern part of the Hlavačov gravel and sand and only 2 % in the northern part (near Holedeč). This fall of percentage is obviously due to abrading of clastic material during transport in the river bed (see more in Smetana 1926, Bretšnajder 1952, Váně 1985). The colour of the Hlavačov gravel and sand is most often brown-yellow or reddish-brown, often orange or light grey. An important feature is the clay content (about 3-8%). In the course of the Hlavačov sedimentary belt, 1 to 3 clay layers (20-50 cm in thickness) can be find, which are of different distribution, thickness and number. They are very often represented as isolated, partly fossiliferous lenses. The colour of the clay is often grey, light grey or light yellow, dark grey with organic admixtures (Bretšnajder 1952, Váně 1985). The important components are heavy minerals: mainly tourmaline, andalusite, sillimanite, rutile, zircone, staurolite etc. (see in detail Čadek 1966, Bylová in Váně, 1981).

The Hlavačov gravel and sand appears to be a typical fluvial sedimentary body with changing layers of different grain size and clay content, with a diagonal stratification, erosive boundaries inside the formation etc. (in detail Gabriel and Valín, 1968). According to Pešek and Spudil (1986), the Hlavačov gravel and sand is a terminal rest of the river "C" (Central River), which is the longest Tertiary river of the West and Central Bohemia (about 130 - 150 km), deposits of which can



Text-fig. 2. Reconstruction of the Tertiary river net in Central and West Bohemia (according to Pešek and Spudil 1986) The river "C": 1 - Klatovy, 2 - Švihov, 3 - Přeštice, Plzeň, 4 - Česká Bříza, 5 - Třemošná, 6 - Kozojedy, - variant I: 7 - Kožlany, 8 - Nová Ves by Čistá, Rakovník - variant II: 9 - Studená, 10 - Skryje, 11 Karlova Ves, 12 - Zbečno, Rakovník; A_1, A_2, A_3, B_1, D_1, D_2 - sedimentary rests of the Central river affluents

be followed practically from its spring to its estuary into the Most Basin in the Žatec area. According to Pešek (1972) and Pešek and Spudil (1986), the Central River sprang probably in the watershed, which was a morphological elevation of the southwest part of the Central Bohemian Pluton in the surroundings of Klatovy. The river "C" flew through Švihov, Přeštice, Plzeň, along the Berounka River towards Česká Bříza and Bohy to Kozojedy, where the continuation of the Central River is equivocal. The river "C" continued either from Kozojedy northwards thyrough Kožlany to Nová Ves at Čistá and then flew northeast wards to Rakovník (Variant I) or the second variant (Variant II), it curved between towns Kozojedy and Kožlany eastwards through Skryje, Karlova Ves to Zbečno, where the Central river continued northwestwards to Rakovník. The river "C"was connected with the belt of the Hlavačov gravel and sand in Rakovník. Important rivers of the Czech Tertiary are, e. g., rivers A_1, A_2, D_1, D_2, D_3, E a F, rests of which are found in West and Central Bohemian sedimentary islands (see in detail Pešek and Spudil 1986), as, e. g., minute occurrences of the Tertiary gravel and sand along the Rakovník stream between towns Rakovník and Křivoklát (see Vachtl 1935b) or occurrences between Klínec upon Všenory and Na Sulavě by Černošice (see Kettner 1911, Němejc 1949) - see text-fig. 2. Another interpretation of the Tertiary river system was published by Malkovský (1995).

An interesting fact is the occurrence of an analogous standard spectrum of heavy minerals (including sillimanite) in the Thierbach beds of the Weisselster Basin and the Hlavačov gravel and sand (Lotsch et al. 1994). These authors presume a possibility of connection and a common genesis of these sediments, basing on the mentioned occurrence of heavy minerals and a similarity of the Thierbach and the Hlavačov gravel and sand floras. According to Lotsch et al. (1994), it is possible to connect the Central river (in sense of Pešek and Spudil, 1986) and the Thierbach river in a common river system of the same age, length of which was over 300 km and its estuary was situated in Saxony.

According to Váně (1985), the Hlavačov deposit is divided into 3 parts due to tectonic processes. However, it is possible to simply divide it into two parts only. The first, southern section of the Hlavačov sediments is typical of tectonic faults in the NW to SE direction, which is characteristic of Paleozoic basins: the Milostín fault (from Janov to Lišany), the Svojetín fault (from Velká Černoc to Lužná) and the Chrášťany fault (from Veclov to the NE periphery of Rakovník). The second, northern section differs in prevailing orientation of tectonic faults in the NE to SW direction in this part of the Hlavačov deposits: the southeastern Sádek fault (at Sádek), the Želeč fault (at Želeč), the Sířemy fault and the Měcholupy fault (at Holedeč and Měcholupy) - see text-fig. 1. These faults throw down the lithological base of the Hlavačov gravel and sand from 411 meters alt. (borehole HV-9) to 120 meters alt. (borehole HV-10) - see in detail Váně (1985).

An exact connection of the Hlavačov deposits with the sediments of the Most Basin is problematic and has not been so far favourably solved. A main problem is in searching supposed sedimentary eqvivalents within the Most Formation of the Most Basin sediments. One interpretation for the connection of the Hlavačov gravel and sand with the already denuded sediments overlying the Most Formation has been suggested by Malecha (1962) and Pešek and Spudil (1986). On the other hand, the second interpretation suggested by Váně (1981, 1985), Kvaček and Bůžek (1989a) and indirectly Lotsch at al. (1994), connects the Hlavačov gravel and sand with the underlying or the lower part of the Most Formation. The latter interpretation is corroborated in this study.

Systematic descriptions

All individual leaf impressions from the Hlavačov deposits and deposits of the surroundings of Holedeč are determined only on the basis of morphological features due to poor preservation as mere impressions, which does not permit using cuticular analysis. Plant impressions from the Hlavačov gravel and sand are typical of their small contrast compared with the sediment, which makes it difficult to determine individual taxa and produce photographical documentation.

The material described below comes from the collections of B. Brabenec, A. Frič, Č. Bůžek, M. Gabriel, Z. Kvaček and J. Sakala. Most of them are deposited in the collections of the National Museum in Prague (numbers prefixed G) and the Institute of Geology and Palaeontology of the Charles University, Prague (abbreviations Nn, VČ).

In this chapter, all the plant material is systematically dealt with from individual localities Na Bendovce, Hlavačov, Nesuchyně, Velká Černoc and Želeč, which are situated in the Hlavačov gravel and sand and the locality Holedeč, which genetically belongs to the Žatec facies of the Most Basin.

Blechnaceae

Woodwardia SMITH

Woodwardia muensteriana (C. PRESL in STERNBERG 1838) KRÄUSEL 1921

Pl. 1, fig. 7, text - fig. 3.47

1838 *Pecopteris münsteriana* C. PRESL in STERNBERG, p. 154, pl. 36, fig. 2.
1855 *Woodwardia roessneriana* HEER, p. 29, pl. 5, figs 1-4, pl. 6, fig. 1.
1866 *Pteris bilinica* ETTINGSHAUSEN, p. 14, pl. 3, figs 14, 15.
1881 *Pteris bilinica* ETT.; Engelhardt, p. 77, pl. 1, fig. 1 (left).
1881 *Woodwardia roessneriana* HEER; Velenovský, p. 11, pl. 1, figs 1-8.
1921 *Woodwardia münsteriana* (C. PRESL in STERNBERG) KRÄUSEL, p. 366, pl. 11, figs 2, 6-8, pl. 12, fig. 4.

Material. One frond fragment (impression and counterpart) Nn - 65, Nesuchyně.

Description. Part of pinnate frond (midrib 70 mm long), sterile leaflets alternate and interconnected on bases, 9 to 15 mm long and 4 to 6 mm broad, oblong to elliptic, apex obtuse; margin very fine crenate, sinuses between leaflets rounded; venation cladodromous, abaxial secondary veins originating at 32 to 43° from marked primary veins, usually twice forked, innervating individual teeth, and often joined by anastomoses and creating polygonal areoles along the border primary vein.

Remarks. The frond fragment is assigned to *Woodwardia muensteriana* (C. PRESL in STERNBERG) KRÄUSEL on the

basis of the whole form, mutual connection of leaflet bases and the presence of characteristic polygonal areolae along the primary veins. Fertile fronds of this species have been described from the area of the Most Basin (see Bůžek 1971, Hurník 1978).

Woodwardia muensteriana is compared with the recent species *Woodwardia virginica* (L.) SM., which is distributed in the Atlantic part of North America (Luft 1956). Kvaček and Bůžek (1982) ecologically interpret this fossil species as a robust swampy fern, which was taller than its recent relative.

Salviniaceae

Salvinia ADANSON

Salvinia reussii ETTINGSHAUSEN 1866

Pl. 1, figs 1, 2

1866 *Salvinia mildeana* GOEPPERT; Ettingshausen, p. 18, pl. 2, fig. 23.
1866 *Salvinia cordata* ETTINGSHAUSEN, p. 18, pl. 2, figs 19, 20.
1866 *Salvinia reussii* ETTINGSHAUSEN, p. 18, pl. 2, figs 21, 22.
1881 *Salvinia formosa* HEER; Velenovský, p. 12, pl. 1, figs 14-17.
1891 *Salvinia mildeana* GOEPPERT; Engelhardt, p. 16 (144), pl. 1 (4), figs 26, 27.
1904 *Salvinia formosa* HEER; Brabenec, p. 12, pl. 1, fig. 2a-d.
1949 *Salvinia reussii* ETTINGSHAUSEN; Němejc, p.27, pl. 2, figs 4-8.
1954 *Salvinia formosa* HEER; Procházka, pp. 170, 172, 173.
1963 *Salvinia mildeana* GOEPPERT; Němejc, p. 462, pl. 56, figs 4-6.
1971 *Salvinia reussii* ETTINGSHAUSEN; Bůžek, Konzalová and Z. Kvaček, p. 202, pls. 1-8, text- figs1-9, 11.

Material. Greater quantity of complete and incomplete impressions of paired or individual leaves, 2 systems of floats, sori, microsporangia, megasporas, Holedeč, Nesuchyně, Velká Černoc, Želeč.

Description. Leaves rounded to elliptical, in average 20 mm long and 17 mm wide, margin entire; venation brochidodromous, secondary and intersecondary veins thin, parallel, creating intermarginal vein and originating at acute angles from the marked primary vein; tertiary venation thin and perpendicular to secondary veins, creating irregular nets of small tetragonal areoles; areoles contain characteristic tubercles, poorly preserved. Floats oval, probably secondarily dorsoventrally flattened, 7 to12 mm long and 2 to 4 mm broad; distinct midrib strong and more or less straight; system of thin branching veins poorly preserved; floats not interconnected, but individually attached to rounded nodus in number of 6 and 8. Description of generative organs - see Bůžek, Konzalová and Kvaček (1971).

Remarks. The material can be safely assigned to *Salvinia reussii* ETT. on the basis of the characteristic leaf morphology, the presence of floats and individual generative organs. Occurrences of the genus *Salvinia* ADANSON from the Most Basin are in detail dealt with by Bůžek, Konzalová and Kvaček (1971). Individual occurrences, which were described by different authors (see synonymics), have been assigned to *Salvinia reussii* in this monography (Bůžek, Konzalová and Kvaček, 1971). These authors, besides descriptions of leaf morphology and anatomy, spores and sporangia (including the material from the surroundings of Holedeč, Brabenec 1904), elucidated problematic floating organs, which do not exist in recent representatives of the genus *Salvinia* (see also Sakala 1997).

Salvinia reussii can be ecologically interpreted as an aquatic natant fern, which probably overgrew water surface of oxbow lakes or other calm waters. According to Bůžek, Konzalová and Kvaček (1971), no recent representative exists within the genus *Salvinia*, which would be a direct descendant of this fossil species.

Pinaceae

Pinus L.

Pinus sp. (folia)

Pl. 1, fig. 3, text - fig. 3.45

? 1953b *Pinus* sp.; Němejc, p. 14, pl. 2, figs 3, 4.

Material. 1 fragment (impression and counterpart) of a fascicle, VČ - 64, Velká Černoc.

Description. Five - needled fascicle, needles incomplete, 31 to 33 mm long and 1 mm broad; fascicle 5 mm long and 3 mm (in apical part) to 2 mm (in basal part) broad, surface structure of needles poorly preserved, rarely with a medial vein and parallel striation.

Remarks. One incomplete impression and its counterpart of needles can be assigned to the genus *Pinus* on the basis of a relatively poorly preserved fascicle. Without the cuticular structure, the determination is equivocal. According to the number of needles per fascicle (5), this material can be compared best with *Pinus pseudostrobus* BRONGN.

The foliage of *Pinus* sp. can be compared with recent five - needled species with the Euroasian and Northamerican distribution (see in detail Klika et al.1953).

Pseudolarix GORDON

Pseudolarix schmidtgenii KRÄUSEL 1938

Pl. 1, figs 5, 6, 9, text - fig. 3.38

1938 *Pseudolarix schmidtgenii* KRÄUSEL, p. 26, pl. 3, fig. 7, text-figs 4 m-p.
1956 *Pseudolarix fossilis* JARMOLENKO in KRIŠTOFOVIČ et al., p. 49, pl. 1, fig. 4 - 14, text-figs 7, g - r.
1991 *Pseudolarix schmidtgenii* KRÄUSEL, Mai and Walther, p. 24, pl. 3, figs 2-12.

Material. 26 isolated seed cone scales and 2 winged seeds Nn - 51 (right), Nn - IV (left), fragments of needles, Hlavačov, Nesuchyně.

Description. Seed cone scale ovate, 18 to 24 mm long and 11 to 20 mm broad (maximum in the first third of base), apex obtuse, rarely acute, base cordate to rounded; midrib strong, straight, on adaxial side, connecting apex and base, narrowing to acute stalk, along with two imprints or even winged seeds; bract in

central part of base on abaxial side. Winged seed oval in outline, 22 mm and 19 mm long, 7 mm and 6 mm broad (including wing); seed oval, 6 mm and 5 mm long, 3 mm and 2, 5 mm broad; wings copy shape of scale; venation similar as that of scale, parallel veins with midrib, which follow shape of margin. Incomplete needles 24 mm to 65 mm long and 1 mm to 3 mm broad, straight or slightly curved, moderate, apex acute, surface structure marked by midrib, which divides needle in two groves, margin entire.

Remarks. Determination of the above described remains as *Pseudolarix schmidtgenii* KRÄUSEL is based on morphological comparison with the seeds, which were described by Kräusel (1938). The same material was also described by Krištofovič et al. (1956, Pl. 1, figs 4 - 14; text-figs 7, g - r), which was named as *Pseudolarix fossilis* JARM. despite of nomenclatorical priority of *P. schmidtgenii*. Determination of associated fragmentary needles is problematic without aid of cuticular analysis. The main argument is the fact that the needles are closely associated with the scales and match in morphology those of the recent species *Pseudolarix kaempferi* (LINDL.) GORD.

The genus *Pseudolarix* GORDON includes the only extant species *P. kaempferi* (LINDL.) GORD. (syn. *P. amabilis* REHDER) (Novák 1972). This deciduous East Asian element is distributed in southeast China in associations of the Mixed Mesophytic and Evergreen Broad Leaved forests (Mai 1995).

Taxodiaceae

Taxodium RICH.

Taxodium dubium (STERNBERG 1823) HEER 1853

Pl. 1, fig. 4, Pl. 4, fig. 7, text - fig. 3.46

1823 *Phyllites dubius* STERNBERG, p. 37, pl. 36, fig. 3.
1825 *Phyllites dubius* STERNB.; Sternberg, p. 4, tent. et index.
1825 *Filicites*; Sternberg, p. 4, pl. 24, fig. 2, tent. et index.
1838 *Taxodites dubius* (STERNB.) PRESL in STERNBERG, p. 204.
1853 *Taxodium dubium* (STERNB.) HEER, p. 136.
1949 *Taxodium distichum miocenicum* HEER; Němejc, p. 27, pl. 2, fig. 9, pl. 3, fig. 2, pl. 5, figs 7-10.
1953b *Taxodium distichum miocenicum* HEER; Němejc, p. 14, pl. 1, figs 1-2.
1953b *Sequoia langsdorfii* HEER; Němejc, p. 14., pl. 2, figs 1-2.

Material. Greater quantity of sterile twigs with needles (microblasts), 2 fragments of macroblasts (perennial twigs), 1 seed cone scale (G 7747), Hlavačov, Holedeč, Nesuchyně, Velká Černoc, Želeč.

Description. Sterile twigs with needles, which are flatted, distichous, alternate at unequal distances, linear to lanceolate, apex acute, base often very shortly petiolate and obtuse; venation with strong and distinct midrib. Macroblasts with spiral imbricate needles. Seed cone scale on its distal side rhombic in outline, 14 mm broad and 12 mm long, with rhombic umbo, which is 5 mm long and 10 mm broad, its sculptation poorly preserved, scale narrowing in 5 mm long acute stalk.

Remarks. Typically flatted, distichous needles and their characteristic cuticle make it possible to reliably assign such a fossil foliage to the genus *Taxodium* RICH. Similar foliage occurs in the genera *Metasequoia* HU et CHENG and *Sequoia* ENDL. The genus *Metasequoia* is reliably distinguishable from the others by opposite needles. Another reason is also the fact, that this genus has never been located in the whole area of the Most Basin. A reliable differentiation of the genus *Sequoia* from similar foliage of the genus *Taxodium* is possible by cuticular analysis (Kvaček 1985). However, the character of preservation of the material at hand is very poor and does not allow using this method. Therefore, I have determined these remains as belonging to the genus *Taxodium* RICH. and the species *Taxodium dubium* (STERNB.) HEER on the basis of the foliage morphology. Main features are above all the whole form of sterile twigs, which are rather lanceloate in outline, leaves are oriented forward (mainly in apical part) and convergent in *Taxodium*. In *Sequoia*, leaves are oriented laterally leading to the uniform width of the macroblast. Contrary to one evident midrib in *Taxodium*, one or several longitudinal groves are present in *Sequoia* (Němejc 1968).

According to Novák (1972), *Taxodium* includes 3 extant species, which are distributed in southeast areas of USA and Mexico. *Taxodium distichum* (L.) RICH. is a typical element of swamp and flooded forests around the Gulf of Mexico. It is often considered a recent analogue of this fossil species. Autecology of the recent species fits well with the supposed ecological conditions, in which *Taxodium dubium* (STERNB.) HEER thrived in the Tertiary of the Most Basin. Němejc (1949) and Bůžek (1971) remarked, that *Taxodium dubium* resembles the recent Mexican species *T. mucronatum* TEN. as well. But this species is confined rather to mountain than swampy forests (Sakala 1997).

Glyptostrobus ENDL.

Glyptostrobus europaeus (BRONGNIART 1833) UNGER 1850

Pl. 1, figs 8, 10, 11

1833 *Taxodium europaeum* BRONGNIART, p. 168.
1845 *Taxodium oeningense* AL. BRAUN, p. 167.
1847 *Taxodites europaeus* (BRONGN.) ENDLICHER, p. 278
1847 *Taxodites oeningensis* (AL. BR.) ENDLICHER, p. 299.
1850b *Glyptostrobus europaeus* (BRONGN.) UNGER, p. 434.

Material. Greater quantity of sterile twigs with needles and with pollen cones, one impression of unripe seed cone Nn -19, 4 impressions of seed cones, Holedeč, Nesuchyně, Velká Černoc, Želeč.

Description. Sterile twigs with spiral imbricate needles or cryptomeroid leaves (typical of young or fertile twigs). Male cones relatively small, terminal, oval to obovate, 2 to 2.5 mm long and 1 to 1.5 mm broad. A spherical compact object (Nn - 19) reminds of an unripe seed cone, which is 11 mm long and 8 mm broad. Identifiable seed cones (VČ - 52) rhomboid in outline, 8 to 13 mm long and 10 to 15 mm broad, apex reatively rounded, base narrowed and rounded, rarely stalked (10 mm long). Surface structure poorly preserved.

Remarks. The genus *Glyptostrobus* ENDL. is well proved by the occurrences of seed cones or individual scales and isolated seeds in the North Bohemian Tertiary (Bůžek and Holý 1964, Sakala 1997). Occurrences of seed cones (Nn -

17, VČ - 52) can be considered as a proof for assigning to *Glyptostrobus europaeus* (BRONGN.) UNGER. Sterile twigs and fertile twigs with pollen cones are morphologically indistinguishable from the species *Quasisequoia couttsiae* (HEER) KUNZMANN. According to Kvaček (1985), these species have analogous also leaf anatomy, therefore seed cones are conclusive for my determination of the genus and the species. Sakala (1997) remarked some differences in the structure of both taxa, but he himself critically admitted that he had not sufficient comparative material at his disposal. Nevertheless, this could be, after verification, one way to the differentiation of *Glyptostrobus europaeus* and *Quasisequoia couttsiae* on the basis of the cuticle structures.

According to Novák (1972) *Glyptostrobus europaeus* can be matched with the only extant species *Glyptostrobus pensilis* (STAUTON ex D. DON) K. KOCH, which is distributed in southeast China (Novák 1972). The fossil species is more or less identical in its epidermal structure with its recent analogue (Kvaček 1960, 1966). However, according to Kvaček (1985), it will be probably a cumulative taxon. *Glyptostrobus europaeus* is a characteristic element of coal - forming swamps. It is one of typical cases with changed autecology in comparison to the recent species. *G. pensilis* occupies moist habitats on river banks and on sea coast, but never grows far from the coast on upland slopes (Svešnikova 1963, Sakala 1997).

Cupressaceae

Tetraclinis MASTERS

Tetraclinis salicornioides (UNGER 1841) Z. KVAČEK 1989

Pl. 2, fig. 12, text - fig. 3.42

1841 *Thuites salicornioides* UNGER, p. 11, pl. 2, figs 1-4.
1847 *Libocedrites salicornioides* (UNG.) ENDLICHER, p. 275.
1855 *Libocedrus salicornioides* (UNG.) HEER, p. 47, pl. 21, fig. 2.
1989 *Tetraclinis salicornioides* (UNG.) Z. KVAČEK, p. 48, pl. 1, fig. 11, pl. 2, figs 2-14, pl. 3, figs 3-4, text-fig. 1.

Material. An isolated fragment of foliage twig, Nn - 39, Nesuchyně.

Description. Foliage twig flattened, truncate at base, 11 mm long, towards apex gradually broaden, at base 2 mm and at apex 4 mm broad, individual needles imbricate, markedly flatted, 4 fused in whorl, forming a cladode - like segment (cladodium), apical part of the segment obtuse with one terminal incision and two lateral incisions, innervated with evident midrib and two lateral thin veins, base round.

Remarks. The fragment of this sterile twig can be assign to *Tetraclinis salicornioides* (UNG.) Z. KVAČEK on the basis of morphology. The feature, which is significant for a sure differentiation of sterile twigs of this species from another species, *T. brachyodon* (BRONGN.) MAI et WALTHER, is a more robust foliage segment, which is fused completely into a whorl (see in detail, e. g., Kvaček 1989, Mai and Walther 1991, Kvaček, Manchester and Schorn 2000). *Tetraclinis salicornioides* is typified by sterile twigs from the Miocene sediments of Radoboj (Unger 1841), where individual impressions were described as *Thuites salicornioides* UNG. This species was regarded by Endlicher (1847) as a species of *Libocedrites* (*L. salicornioides* (UNG.) ENDL.), similarly by Heer (1855) as *Libocedrus salicornioides* (UNG.) HEER. Fossil representatives of the genus *Tetraclinis* are known from the Tertiary of Europe and USA. *Tetraclinis brachyodon* is bound to coastal xeric vegetation. Its stratigraphical range is from Eocene to Pliocene and its recent analogue is *T. articulata* MAST. distributed as a relict in the area of western Mediterranean. The species *T. salicornioides* was separated at the end of the Eocene and was adapted to forest conditions in the subtropical humid zone as a woody shrub. This species became extinct in Late Pliocene.

Lauraceae

Daphnogene UNGER

Daphnogene cinnamomifolia UNGER 1850 f. *cinnamomifolia*

Pl. 1, fig. 15, text - fig. 3.1

1850 *Daphnogene cinnamomifolia* UNGER, p. 424.
1898 *Cinnamomum buchii* HEER; Engelhardt, p. 19.
1898 *Cinnamomum scheuchzeri* HEER; Engelhardt, p. 19.
1949 *Cinnamomum scheuchzeri* HEER; Němejc, p. 74, 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. 11 fragments of leaves (impressions), Holedeč, Nesuchyně, Želeč.

Description. Leaves elliptic to ovate triveined, 51 to 57 mm long, 21 to 28 mm broad, base cuneate, apex attenuate to acute, margin entire; venation suprabasal acrodromous, medial vein strong, moderate, straight, innervating apex, lateral veins thinner, alternate, running along margin and ending 2/3 of the leaf length; long secondary veins often looping, alternate, poorly preserved as venation of higher order.

Remarks. This material is assigned to *Daphnogene cinnamomifolia* UNGER f. *cinnamomifolia*. The main diagnostic character is a more or less broader form, that differentiates it from another elongate form (*D. cinnamomifolia* f. *lanceolata*) of the same species (see in detail Kvaček and Walther 1995). Both forms were newly described by Kvaček and Walther (1995) from the Oligocene locality Suletice - Berand. Minute variation in size and outline of this form can be interpreted as shade leaves and sun leaves of one plant (in sense of, e. g., Kvaček and Walther 1976). Occurrences of this species are known from other localities, like Bechlejovice, Valeč and Hammerunterwiesenthal. According to Kvaček and Walther (1995), *Daphnogene cinnamomifolia* UNGER is a "pioneer" plant, which occupied, e. g., tuffite deposits (substrates). Generally, it can be said, that representatives of the genus *Daphnogene* are typical evergreen elements of subtropical oak - laurel forests of the European Tertiary.

Berberidaceae

Mahonia NUTT.

Mahonia bilinica (UNGER 1845) Z. KVAČEK et BŮŽEK 1994

Pl. 2, fig. 3, text - fig. 3.8

1845 *Quercus bilinica* UNGER, pl. 29, fig. 3.
1847 *Quercus bilinica* UNGER; Unger, p. 107.
1866 *Quercus bilinica* UNGER; Ettingshausen, p. 137, pl. 17, fig. 7.
1938 *Ilex bilinica* (UNGER) KRÄUSEL, p. 70, pl 11, figs 3-4.
1971 cf. *Mahonia* sp.; Bůžek, p. 39, pl. 52, figs 11-12.
1994 *Mahonia bilinica* (UNGER) Z. KVAČEK et BŮŽEK, p. 59-61, pl. 1, figs 1-9.

Material. 1 complete (G7162a) leaflet and its counter impression (G7162b), Nesuchyně.

Description. Leaflet asymmetric, ovate in outline, 4 lobed (dentate), lobes long, broadly to narrowly triangular, 57 mm long, 44 mm broad, base asymmetric, broadly cordate, apices acute to attenuate, sinuses round, margin entire; venation palmate, semicraspedodromous, midrib strong, often straight, innervating apex of main lobe, lateral primary veins thinner; secondary and intersecondary veins creating oblong, broad polygonal loops along primary veins, thinner veins innervating apices of lateral lobes start from loops, venation of higher orders poorly preserved.

Remarks. This species was revised by Kvaček and Bůžek (1994) including the material from Nesuchyně. Determination of this species is based on morphological characters, e. g., asymmetric base, palmate venation, deeply lobed leaflets, which rule out at the same time an affinity to the genera *Quercus* L. or *Ilex* L., leaves of which are not compound. Leaves and leaflets of *Mahonia* from the Late Oligocene locality of the North Bohemian area (Bůžek et al. 1990), France (Saporta 1865) and the Upper Miocene of Moldavian and Abchasian (Tachtadžan 1974) have, in contrast to *M. bilinica*, more obtuse and more shallow dentate leaflets. Morphologically similar species of *Mahonia* were described from the Tertiary and even from the Late Cretaceous, e. g. *Mahonia simplex* (NEWBERRY) ARNOLD from the Lower Oligocene locality Bridge Creek and from the area of the western USA (Arnold 1936, Axelrod 1964, 1985, Manchester and Meyer 1987).

With regard to relatively broader individual leaflets, *Mahonia bilinica* can be compared with the recent South Asian representatives of section *Longibracteatae* FEDDE, as e. g. *Mahonia japonica* (THUNB.) DC., which are distributed in conditions of humid climate. *M. bilinica* probably belongs to an undergrowth shrub of mesophytic forests.

Hamamelidaceae

Liquidambar L.

Liquidambar europaea AL. BRAUN in BUCKLAND 1836

Pl. 2, figs 1, 11, text - fig. 3.7

1836 *Liquidambar europaeum* AL. BRAUN in BUCKLAND, p. 513.
1845 *Liquidambar europaeum* AL. BR.; Unger, pl 35, figs 1-5.
1856 *Liquidambar europaeum* AL. BR.; Heer, p. 6, pl. 51, figs 2-12; pl. 52, figs 1-9.
1869 *Acer rüminianum* HEER; Ettingshausen partim, p. 23, pl. 48, fig. 8, non fig. 9.
1887 *Liquidambar pliocenica* GEYLARD et KINKELIN, p. 246, pl. 32, fig. 17.
1904 *Liquidambar europaeum* AL. BR.; Brabenec, p. 15, pl. 1, fig. 4.
1949 *Liquidambar europaea* AL. BR.; Němejc, p. 73, pl. 5, figs 1-6, pl. 9, figs 7-9, pl. 10, figs 1-5, pl. 11, figs 1a, 1b.
1953b *Liquidambar europaea* AL. BR.; Němejc, p. 14, pl. 2, figs 7, 8.

Material. About 80 fragments of leaves, 1 poorly preserved infructescence 216/61-21, Hlavačov, Holedeč, Nesuchyně, Želeč.

Description. Leaves palmately 3 to 5- lobed, 45 to 95 mm long, 44 to 120 mm broad, lobes oblong to triangular, base shallowly cordate to cordate, rarely with fragmentary petiole (13 mm long), apices acute, sinuses round, opening, margin regularly crenulate; venation basal actinodromous, 3 to 5 primary veins strong, abmedially curved in 1/3 with lateral veins, originating at 36 to 52°; secondary veins looping, tertiary veins forked, creating polygonal net of areoles. Infructescence oval in outline, echinate (by styles of individual fruitlets), 30 mm long and 19 mm broad, distinctly secondarily flattened with a fragment of stalk (9 mm long), poorly preserved; individual styles radial from the centre of the head.

Remarks. The determination and assignment of the material to *Liquidambar europaea* AL. BR. is based on the morphology of leaves. Main features are above all the whole form of leaf, venation and the crenulate margin. It is possible to compare it with the leaf impression from the locality Břežánky (Ettingshausen 1866, pl. 29, fig. 1). Another occurrence from Zabrušany (see Ettingshausen 1869) was described as *Acer rüminianum* HEER (BŮŽEK 1971). A problem of earlier wrong determinations is above all in underestimating of leaf morphological variability of leaves. During the Tertiary, leaf morphological character has markedly changed. In the Lower Miocene, 3-lobed leaf form was dominating over 5-lobed, during the Miocene the abundance of 5-lobed leaves increased, which continued to almost total domination of 5-lobed leaves in the Pliocene (Bůžek 1971).

Leaves of *Liquidambar europaea* can be compared with leaves of analogue recent *L. styraciflua* L. var. *mexicana* (east coast of USA to Mexico), but infructescences are rather similar with the recent species *L. orientalis* MILL., which is distributed in the area of Cyprus, north Syria and in southwestern Asia Minor. Both these species occupy moist habitats in alluvial soils along the rivers and at the seacoasts.

Fagaceae

Fagus L.

Fagus saxonica Z. KVAČEK et WALTHER 1991

Pl. 2, fig. 4, Pl. 3, fig. 6, Pl. 4, fig. 8, text - fig. 3.2

1847 *Fagus deucalionis* UNGER, p. 101, pro parte, pl. 72, figs 5, 6.
?1949 *Fagus silvatica* L.; Němejc, p. 58, pl. 1, figs 1-4.
1971b *Fagus attenuata* GOEPPERT ssp. *seussensis* KNOBLOCH, p. 8, pl. 1, fig.11-13 ; pl. 3, figs 1-3, 7, 8, 14.

1982 *Fagus attenuata* GOEPPERT; Kovar, p. 58, pl 7, figs 1-4, pl. 27, figs 11-13.
1982 *Quercus* vel *Castanea* sp.; Kovar, p. 64 ; pl. 7, figs 10, 11, pl. 27, figs 14, 15.
1989 *Fagus attenuata* GOEPPERT; Kvaček and Walther, p. 214, pro parte, textfigs 1 a, 1 e, 1 g.
1989a *Fagus attenuata* GOEPPERT ssp. *seussensis* KNOBLOCH; Bůžek and Kvaček, pp. 22-24.
1989b *Fagus attenuata* GOEPPERT ssp. *seussensis* KNOBLOCH; Bůžek and Kvaček, pp. 17-18.
1991 *Fagus saxonica* Z. KVAČEK et WALTHER; Kvaček and Walther, p. 56, pl. 30, figs 1-8, text-figs 3/1-10.

Material. About 30 almost complete leaves and about 40 fragments of leaves (impressions), Holedeč, Nesuchyně, Velká Černoc, Želeč, Na Bendovce.

Description. Leaves narrow elliptic to ovate, 62 to 90 mm long, 20 to 60 mm broad (maximum in lower part), apex acute, base symmetric, widely cuneate to rounded, rarely with a fragmentary petiole (3 to 9 mm long), margin regularly simple - serrate with acute, triangular teeth; venation simple craspedodromous, midrib strong, straight or zik - zak, often slightly curved in upper third; secondary veins straight, curved to apex and margin, innervating teeth apices, alternate, in 9 to 15 pairs, originating at 42 to 54°; tertiary veins forked (2 to 3 times), creating polygonal net of areoles, density 7 to 11 per cm; venation of higher order poorly preserved.

Remarks. The material is assigned to *Fagus saxonica* Z. KVAČEK et WALTHER on the basis of leaf morphology. Main features for determination are above all biometrical parameters of leaves (width, length and number of secondary vein pairs). Similar large and narrow leaves were described by Knobloch (1971b) as *Fagus attenuata* GOEPP. ssp. *seussensis* KNOBLOCH. This population is also determined on morphological features of leaves due to bad preservation of cuticles like the whole material from the Hlavačov and Holedeč deposits. Likewise similar leaves were described by Kovar (1982) as *Quercus* vel *Castanea* sp. Kvaček and Walther (1991) defined a new species *Fagus saxonica* Z. KVAČEK et WALTHER. The determination of this species is based on leaf morphology and epidermal structure. Leaves similar to *F. saxonica* were described as *Fagus pristina* SAPORTA (see, e. g., Saporta 1892, Barrón and Diéguez 1994). However, the latter species has different (higher) number of secondary vein pairs (16 to 20 pairs). A similar situation is in *Fagus antipofii* HEER (see Žilin 1974), where the number of secondary vein pairs ranges from 14 to 20 and the type of secondary venation is semicraspedodromous. This species is typical of the Oligocene and Miocene of East Europe and Kazachstan.

Fagus saxonica is the earliest representative of *Fagus* L. in Central Europe. It appeared in the Upper Oligocene in rich floristic associations of riparian and mesophytic elements, which are referred to the Floristic assemblage Rott - Thierbach (see e. g. Mai and Walther 1991, Mai 1995). In the area of the Sokolov Basin, this species is known from the Volcanic Formation from the localities Počerny and Podlesí (see Holý 1984, Kvaček et. al. 1989). *Fagus grandifolia* EHRH., which is distributed in south to southeast areas of USA can be designated as a recent analogue of *Fagus saxonica* (Kvaček and Walther 1991).

Fagus deucalionis UNGER 1847

Pl. 2, fig. 9, Pl. 6, fig. 5

1847 *Fagus deucalionis* UNGER, p. 101, pl. 27, figs 1-4 (non figs 5-6 = fol.).
1858 *Fagus horrida* LUDWIG, p. 144, pl. 29, figs 2, 5.
1887 *Fagus pliocenica* GEYLER et KINKELIN, p. 23 ; pl. 2, figs 9-10.

Material. 3 almost complete cupules Nn - 121, G 2736 and G 7755, Holedeč, Nesuchyně, Želeč.

Description. Compressed cupules regularly ovate, 10 to 11 mm broad, 11 to 18 mm long, base cuneate, narrowed abruptly into fragmentary stalk (24 mm long), apical part incomplete, bordered by forward and laterally oriented triangular appendices, probably narrowed into fine spines.

Remarks. Cupules of this type have been assigned to *Fagus deucalionis* UNGER, which occurs in association with fossil leaves of *F. saxonica* Z. KVAČEK et WALTHER (see Kvaček and Walther 1991). The leaves and fruits have never been found attached. Therefore, this species deserves still its own name. In Unger (1847) as well as Mai and Walther (1991) cupules are figured with short stalks. However, in the collections from the type horizon from surroundings of Karlovy Vary cupules have long stalks (see Kvaček and Walther 1989). Leaves from the type horizon are morphologically comparable with the holotype of *Fagus saxonica*. The epidermal structure is not preserved there. Ludwig (1858) described similar cupules as *Fagus horrida* LUDWIG from the Miocene deposits of surroundings of Frankfurt u. Mohan. From the Pliocene deposits of same area another species *Fagus pliocenica* GEYLER et KINKELIN was described (see Geyler and Kinkelin 1887), which was directly designated as a homonym of *Fagus pliocenica* SAPORTA (see Saporta 1873). Kvaček and Walther (1991) noticed that, in the morphology of cupules, the degree of dehiscence depends on fruit maturity. According to this logical hypothesis and the characteristic morphology of the material from the localities Nesuchyně and Holedeč I suppose that the specimens at hand represent unripe fruits.

Mai and Walther (1991) matched cupules of *Fagus deucalionis* to the recent species *F. grandifolia* EHRH. Distribution of this species is from Texas to New Brunswick in the Atlantic part of North America. However, cupule stalks of *F. grandifolia* EHRH. are short, ranging from 5 to 10 mm only (see Kvaček and Walther 1991). The stalk of the cupule (Nn - 121) from the locality Nesuchyně is 24 mm long, which is near to the recent species *Fagus orientalis* LIPSKY or *Fagus sylvatica* L. However, the leaves of this recent species are not identical in morphology with *F. saxonica*.

Castanea MILL.

cf. ***Castanea atavia*** UNGER 1850 sensu KRÄUSEL 1938

1850c *Castanea atavia* UNGER, p. 34 (164), pl. 10 (31), fig. 5, 7.
1852 *Castanea atavia* UNGER; Goppert, p. 274, pl. 34, fig. 4.
1938 *Castanea atavia* UNGER; Kräusel, p. 45, pl. 5, fig. 12, pl 6. fig. 1, text-figs 12a, b.
1969 *Castanea atavia* UNGER, Knobloch, p. 94, pl. 41, fig. 5, pl. 42, fig. 9, text-figs 217.

Material. Only 1 fragment of leaf Nn - 158, Nesuchyně. Description and determination see Sakala and Teodoridis (2001).

Trigonobalanopsis Z. KVAČEK et WALTHER

cf. *Trigonobalanopsis rhamnoides* (ROSSMÄSSLER 1840) Z. KVAČEK et WALTHER 1988

Pl. 4, fig. 11, text - fig. 3.4

1840 *Phyllites rhamnoides* ROSSMÄSSLER, p. 35, pl. 8, figs 30, 31.
1931 *Tristania toscana* BANDULSKA, p. 668, pl. 40, figs 9-11, text-fig. 23.
1954 *Castanopsis toscana* (BANDULSKA) KRÄUSEL et WEYLAND, p. 135, pl. 29, figs 3-9, text-pl. 14.
1976 *Castanopsis toscana* (BANDULSKA) KRÄUSEL et WEYLAND; Knobloch and Kvaček, p. 39, pl. 4, fig. 1, pl. 16, figs 10, 11, pl. 17, fig. 16, pl. 20, figs 11, 15.
1988 *Trigonobalanopsis rhamnoides* (ROSSM.) Z. KVAČEK et WALTHER, p. 405, pl. 49, figs 1-8, pl. 50, figs 1-4, pl. 51 figs 1-6, pl. 52, figs 1-12, pl. 53, figs 1-12, pl. 54, figs 1-4, pl. 56, figs 1-4.

Material. Only 1 fragment of a leaf Nn - 135, Nesuchyně.

Description. Leaf fragment of apical part, obviously elliptic to obovate, 29 mm long and 21 mm broad, apex not preserved, probably acute or attenuate, margin entire; venation brochidodromous, midrib strong, straight; secondary veins thin, alternate, originating at acute angles, regularly spaced, 4 to 6 mm apart; tertiary veins straight or forked, originating at right or often at acute angles; veins of higher order not preserved.

Remarks. Taxonomical assignment of this specimen is relatively complicated for its incompleteness and poor preservation without any chance of using cuticular analysis. Determination is based on its leaf morphology, where main features are entire margin, brochidodromous type of venation and relatively regularly disposed secondary veins, matching the material from other localities (see, e. g., Knobloch and Kvaček 1976, Kvaček and Walther 1988). Hence, the material from the locality Nesuchyně can be a similar morphotype. Therefore, I determine it as cf. *Trigonobalanopsis rhamnoides* (ROSSM.) Z. KVAČEK et WALTHER. A combination of the leaves of *T. rhamnoides* with the fruits of *Trigonobalanopsis exacantha* (MAI) Z. KVAČEK et WALTHER (see Kvaček and Walther 1988) are based on common occurrences at many localities and the identical epidermal structure of the cupule stalk and the leaf petiole. The cuticular structure of leaves is the same as that of some recent representatives of *Castanopsis* (D. DON) SPACH (see Kvaček and Walther 1988).

T. rhamnoides (ROSSM.) Z. KVAČEK et WALTHER is an extinct evergreen mesophytic element, which is known from associations with other representatives of Fagaceae starting with the Upper Eocene of the Staré Sedlo Formation (see Knobloch, Konzalová and Kvaček 1996). The flora of this formation is markedly thermophilous and is referred to the Floristic assemblage Hordle - Zeitz ("older" mastixioid floras). During the Oligocene, it became an element of temperate forests, and appeared, e. g., in the Floristic assemblage Rott - Thierbach. In the Lower Miocene, this species achieved an optimum of its evolution and distribution in the association of the "young" mastixioid floras, which are typical of the Floristic assemblage Eichelskopf - Wiesa (see Mai 1995). *Trigonobalanus doichangensis* (CAMUS) FORMAN, which is distributed in Thailand and south China, can be interpreted as a recent analogue of *T. rhamnoides* (ROSSM.) Z. KVAČEK et WALTHER. This interpretation is based on morphology of cupules and morphology of pollen (Erdtman 1967).

Betulaceae

Betula L.

Betula sp.

Pl. 2, figs 2, 7, 13, Pl. 3, fig. 8, text - figs 3.3, 3.11

?1851 *Betula prisca* ETTINGSHAUSEN, p. 11, pl. 1, figs 15-17.
?1855 *Betula subpubescens* GOEPPERT, p. 11, pl. 3, fig. 9.
1949 *Betula prisca* ETT.; Němejc, p. 42, pl. 3, figs 3-6, pl. 11, figs 2-12, pl. 12, figs 1-5.
1949 *Betula subpubescens* GOEP.; Němejc, p. 42, pl. 3, fig. 7, pl. 9, figs 3, 3a.
1953b *Betula prisca* ETT.; Němejc, p. 14, pl. 1, figs 3-7.

Material. About 60 identifiable fragments of leaves (impressions), Hlavačov, Holedeč, Nesuchyně, Velká Černoc.

Description. Leaves elliptic to ovate, 50 to 67 mm long and 22 to 48 mm broad, base broadly cuneate, often with a fragmentary petiole (12 to 16 mm long), apex acute, margin entire at leaf base, upwards irregularly double - serrate; primary teeth acute, 1 to 1. 5 mm high and at base 2 to 2. 5 mm broad, secondary teeth 0. 5 to 1, 0 mm high and base 1. 5 to 2. 0 mm broad, 2 - 3 between two secondary veins; sinuses between all teeth acute; venation simple craspedodromous, midrib strong, moderate, often straight or slightly curved in apical part; secondary veins thin, distinct, alternate or opposite, 7 to 8 (10) pairs number in interspaced at distances of 4 to 7 mm, curved towards the apex and margin, originating at 40 to 50°; tertiary veins often straight or forked, innervating apices of secondary teeth; venation of higher orders poorly preserved.

Remarks. The material is assigned to *Betula* L. on the basis of leaf morphology. The determination of this taxon is very problematic because of a large morphological variability of leaves and because of the lacking cuticular structure. Occurrences of leaf impressions from the belt of the Hlavačov gravel and sand and the Holedeč deposits are very similarly to *Betula prisca* ETT. (Ettingshausen 1851), which is no more in use for its misapplied primary diagnosis (see in detail Hummel 1991a). According to Hummel (1991a), the leaves, which were described as *Betula prisca* ETT., are morphologically similar with the leaves, which Goeppert (1855) assigned to *Betula subpubescens* GOEPP. Hummel (1991a) stresses poor preservation of the type material from Arsenal and regards a slight morphological discrepancy in the form and venation as intraspecific variation. Ettingshausen (1866) also described similar leaves as *Betula prisca* ETT. from the locality Bílina, which, after the revision, are regarded as *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ (Hummel 1991a). Likewise, Hummel (1991a) assigned complete relatively small leaves with typical cordate

bases (see, e. g., Menzel 1906) to *Carpinus grandis* UNGER emend. HEER, which were originally described as *Betula prisca* ETT.

Leaves of *Betula* sp. match the extant *B. alnoides* BUCH. - HAM., which grows in China and Himalayas, or with *B. albosinensis* BURKILL. var. *septentrionalis* SCHNEID., which is distributed in western China (Krüssmann 1960). Autecology of this taxon can be characterised as a mesophytic element within riparian forests (Kvaček and Bůžek 1982).

Alnus B. EHRH.

Alnus julianiformis (STERNBERG 1823) Z. KVAČEK et HOLÝ 1974

Pl. 3, figs 7, 9, text - fig. 3.6

1823 *Phyllites julianaeformis* STERNBERG, p. 37, 39, pl. 36, fig. 2.
1845 *Fagus feroniae* UNGER, p. 106, pl. 28, figs 3, 4.
1855 *Quercus attenuata* GOEPPERT, p. 17, pl. 8, figs 4, 5.
1866 *Fagus feroniae* UNGER; Ettingshausen, p. 126, pl. 1, fig. 18, pl. 2, figs 7, 8, pl. 15, figs 12-20, 22, p.16, fig. 1.
1866 *Quercus furcinervis* ROSSM.; Ettingshausen, p. 58, pl. 16, figs 11, 12.
1881 *Fagus feroniae* UNGER; Velenovský, p. 23, pl 3, figs 7, 8.
1891 *Fagus feroniae* UNGER; Engelhardt, p. 158, pl. 7, figs 32-34, pl. 8, figs 4-8, 10.
1934 *Alnus feroniae* UNGER; Czeczott, p. 109, text-figs 29, 30.
1949 *Alnus feroniae* UNGER; Němejc, p. 49, pl. 1, figs 6-11, pl. 2, fig. 11, pl. 3, fig. 1, pl. 7, figs 1, 2.
1954 *Fagus attenuata* (GOEPP.) KRÄUSEL et WEYLAND, p. 132, pl. 28, figs 5, 6, pl. 29, figs 1, 2, textfigs 1, 13.
1968 *Alnus feroniae* (UNGER) CZECZOTT; Iljinskaja, p. 55, pl. 2, figs 1, 2, pl 13, fig. 4, pl. 38, fig. 2, pl. 39, figs 4-7, pl. 44, fig. 7.
1971a *Alnus attenuata* (GOEPP.) KNOBLOCH, p. 264.
1974 *Alnus julianaeformis* (STERNB.) Z. KVAČEK et HOLÝ, p. 367, pl 1, 2, 3, pl. 4, fig. 1, text-fig. 1.

Material. 6 relatively complete leaves and about 20 identifiable leaf fragments (impressions), Holedeč, Nesuchyně, Velká Černoc, Želeč, Na Bendovce.

Description. Leaves elliptic, about 50 mm long and 23 to 38 mm broad (maximum width in the middle), apex shortly acute, base cuneate with fragmentary petiole (5 mm long); margin entire in basal part, upwards simple - serrate; teeth acute, about 0. 6 mm high and at base 1. 0 to 1. 5 (2. 0) mm broad, 0 to 3 (5) between two secondary veins; sinuses between all teeth acute; venation simple craspedodromous, midrib strong, moderate; secondary veins often semicraspedodromous in basal part, thin, distinct, alternate or opposite (often by base), in number of 7 to 8 pairs, interspaced at distances of 7 to 9 mm, curved towards to apex and margin, originating at 35 to 45° (55°); tertiary veins often straight or forked, originating at right and acute angles (frequency 6 to 8 veins/cm), innervating apices of teeth with secondary veins; venation of higher orders poorly preserved.

Remarks. The material is assigned to *Alnus julianiformis* (STERNBERG) Z. KVAČEK et HOLÝ on the basis of leaf morphology. Main determinant features are whole leaf form, type of margin, number and spacing of secondary vein pairs. These morphological criteria safely rule out assigning to *Alnus gaudinii* (HEER) KNOBL. et Z. KVAČEK, to *Alnus* sp. sensu Bůžek or to the genus *Betula* L. Leaves, which are at present described as *Alnus julianiformis*, were assigned to the genus *Fagus* L. in paleobotanical history (see synonymics). Czeczott (1934) regarded this leaf material for the foliage of *Alnus* B. EHRH. on the basis of morphological differences and absence of associated beech fruits (see in detail Czeczott 1934, Sakala, 1997). Kvaček and Holý (1974) confirmed this transfer and created a new combination *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ according to the principle of priority (see also in Knobloch and Kvaček 1996).

The leaves of *Alnus julianiformis* show a close relation to the recent species of subgenus *Alnaster* (SPACH) ENDL. or with the species *Alnus trabeculosa* HAND. et MAZZ. (subgen. *Gymnothyrsus* (SPACH) REGEL.) on the basis of the epidermal structure. This recent species is distributed in central China in the mixed mesophytic forest (Kvaček and Holý 1974). In the area of the Most Basin *Alnus julianiformis* is a typical element of swampy associations with periodical, relatively long-lasting floods.

Alnus sp. sensu Bůžek 1971

Pl. 3, fig. 10, text - fig. 3.10

1845 *Alnus kefersteinii* (GOEPP.) UNGER partim, p. 115, pl. 33, fig. 4.
1866 *Alnus kefersteinii* (GOEPP.) UNG.; Ettingshausen, p. 47, pl. 14, figs 19, 20 (non strobili figs 17, 18).
1866 *Betula grandifolia* ETTINGSHAUSEN, p. 47, pl. 14, figs 23, 24.
1881 *Alnus kefersteinii* (GOEPP.) UNG.; Velenovský, p. 22, pl. 2, fig. 24, pl. 3, figs 13-17 (non fig. 16 left).
1891 *Alnus kefersteinii* (GOEPP.) UNG.; Engelhardt, p. 156, pl. 7, figs 25, 26.
1949 *Alnus rotundata* GOEPP.; Němejc, p. 49, pl. 7, figs 3, 4.
? 1953b *Alnus* sp.; Němejc, p. 14, pl. 1, figs 10-12.
1971 *Alnus* sp.; Bůžek, p. 48, pl. 13, fig. 12, pl. 15, figs 1-6.

Material. About 10 identifiable fragments and relatively complete leaves (impressions), Hlavačov, Holedeč, Nesuchyně, Velká Černoc.

Description. Leaves elliptic to ovate, 50 to 95 mm long and 42 to 58 mm broad, base broadly cuneate or rounded to slightly cordate, petiole not preserved, apex fragmented, probably acute; margin entire in basal leaf part, upwards irregularly double - serrate; form of teeth variable, primary teeth at acute or right angles in apex, at base to 2 mm broad; secondary teeth flat; sinuses between all teeth acute; venation simple craspedodromous, midrib strong, moderate, straight; secondary veins thin, distinct, alternate or opposite (often at basal part), 9 to 11 pairs number in interspaced at distances of 7 to 14 mm, curved towards to apex and margin, originating at 40 to 65°; rare intersecondary veins parallel with secondary veins; tertiary veins often straight or forked, originating at right and acute angles, innervating apices of teeth with secondary veins; venation of higher orders poorly preserved.

Remarks. This taxon is based on characteristic morphological features, which help to distinguish it from other representatives of Betulaceae: broader leaves, markedly rounded to slightly cordate, higher number of secondary vein pairs and larger interspaces. I describe my material as *Alnus* sp. sensu Bůžek on the basis of these parameters and morphological comparison with

the material from the locality Čermníky (Bůžek 1971). Occurrences of leaf impressions from the belt of the Hlavačov gravel and sand and the Holedeč deposits are morphological very similar to the leaves, which have been described as *Alnus menzelii* RANIECKA-BOBROWSKA (Raniecka-Bobrowska 1954, Zastawniak and Walther 1998), or as *Alnus rotundata* GOEPP. (Menzel 1906, Kräusel et al. 1919, Němejc 1949), *Betula macrophylla* (GOEPP.) HEER (Heer 1868), *Betula grandifolia* ETT. (Ettingshausen 1866), *Alnus rostaniana* SAPORTA emend. MAI et WALTHER (Mai and Walther 1991), including *Alnus nostratum* (UNG.) KNOBLOCH (Knobloch 1971b), or *Alnus kefersteinii* (GOEPP.) UNG. (Unger 1845, Ettingshausen 1866, Velenovský 1881, Saporta 1892, Engelhardt 1891). The latter is now only used for female strobile-like infructescences (see e. g. Bůžek 1971, Zastawniak and Walther 1998). Zastawniak and Walther (1998) revised the original Goeppert material and newly assigned it to *Alnus adscendens* (GOEPP.) ZASTAWNIAK et WALTHER. Another alternative morphological analogue could be *Alnus schmal-hausenii* (GRUB.) KRIŠTOFOVIČ et al., which was described first from the Oligocene locality Ašutas in Kazakhstan (Krištofovič et al. 1956). The taxa, which are mentioned above, are morphological very similar, but are not identical in all morphological features, which are typical of the material from the localities of the belt of the Hlavačov gravel and sand, Holedeč and, of course, Čermníky. Besides, I am aware of a large leaf morphological variability of this genus and family. Therefore I cannot determine the material to a species without cuticular analysis. The presence of infructescences is a very interesting fact in the Hlavačov and the Holedeč deposits, which compare in form and size with the material from the Pětipsy area (see Bůžek 1971). I assign these infructescences to *Alnus kefersteinii* (GOEPP.) UNG. (see below).

The leaves of *Alnus* sp. sensu Bůžek are compared with the recent *A. serrulata* WILLD. and *A. subcordata* C. A. MEY.

Alnus kefersteinii (GOEPPERT 1836) UNGER 1847

Pl. 4, fig. 10

1836 *Alnites kefersteinii* GOEPPERT, p. 364, pl. 41, figs 1-19.
1845 *Alnus kefersteinii* (GOEPP.) UNGER, p. 78, pl. 33, figs 1-3.
1847 *Alnus kefersteinii* (GOEPP.) UNG.; Unger, p. 115, pl. 33, figs 1-3.
1881 *Alnus kefersteinii* (GOEPP.) UNG.; Velenovský, p. 33, pl. 3, fig. 17.
1892 *Alnus kefersteinii* (GOEPP.) UNG.; Saporta, p. 47, pl. 12, figs 7-8.

Material. 6 impressions and 1 counterpart of infructescences, Holedeč, Nesuchyně, Velká Černoc, ? Želeč.

Description. Strobile - like infructescences oval, 9 to 13 mm long and 6 to 8 mm broad, fragments of stalk often preserved (4 mm long). Surface structure not or poorly preserved.

Remarks. Assigning of the material to *Alnus kefersteinii* (GOEPP.) UNG. is based on morphological parameters of infructescences. Two types of infructescence similar in form were described from the area of the Most Basin as *Alnus gracilis* UNG. (Unger 1845, Ettingshausen 1866). and *Alnus kefersteinii* (GOEPP.) UNG. (Unger 1845, 1847, Velenovský 1881). According to Bůžek (1971), the type of subtle and smaller infructescences (*Alnus gracilis* UNG.) occurs in association with the leaves, which are now assigned to *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ (see also Knobloch and Kvaček 1996). More robust infructescences of *Alnus kefersteinii* (GOEPP.) UNG. were found by Bůžek (1971) in association with the leaves, which he described as *Alnus* sp. Another type of well morphological distinguishable infructescences are described as *Alnus menzelii* RANIECKA-BOBROWSKA. These oblong catkin - like infructescences can be compared with the same named leaves.

According to Bůžek (1971), a morphologically similar type of infructescences is developed in recent representatives of section *Alnobetula*.

Carpinus L.

Carpinus grandis UNGER 1854 emend. HEER 1856

Pl. 2, fig. 5, Pl. 3, fig. 1, text - fig. 3.5

1845 *Carpinus grandis* UNGER, p. 220 (nomen nudum).
1850a *Carpinus grandis* UNG.; Unger partim, p. 408 (folia).
1852 *Carpinus grandis* UNG.; Unger partim, p. 39, pl. 20, fig. 4 (folia), non figs 2, 3 (fructus).
1855 *Carpinus* sp.; Goeppert, p. 19, pl. 5, figs 4-6.
1855 *Betula prisca* ETT.; Goeppert, p. 11, pl 3, figs 11, 12.
1855 *Betula carpinoides* GOEPPERT, p. 12, pl. 3, fig. 16.
1856 *Carpinus producta* UNG.; Kováts, p. 24, pl. 4, fig. 5.
1856 *Carpinus grandis* UNG.; Heer, p. 40, pl. 72, figs 2-19, 20(?), 22-24, non fig. 21, pl. 73, figs 2-4.
1949 *Carpinus grandis* UNG.; Němejc, p. 53, pl. 8, fig.12, pl. 10, figs 6-9, pl. 11, figs 1a, 1b.

Material. 16 identifiable fragments and relatively complete leaves (impressions), Holedeč, Nesuchyně.

Description. Leaves oval to ovate, 59 to 68 mm long and 36 to 58 mm broad, base cuneate to slightly cordate, apex acute; margin usually double - serrate; apices of individual teeth acute, 1 - 3 teeth between two secondary veins; sinuses between all teeth acute, venation simple craspedodromous, midrib strong, moderate; secondary veins thin, distinct, alternate, 8 to 12 pairs number in interspaced at distances of 6 to 11 mm, curved towards to apex and margin, originating at 35 to 45° (55°); tertiary and venation of higher orders poorly preserved, except parts of margin, where innervate apices of teeth.

Remarks. Leaves are morphologically very similar to leaves described above as *Betula* sp. Diagnostic differences are first in marginal teeth, which are relatively finer in *Carpinus grandis* UNG. emend. HEER, together with a higher number of secondary vein pairs and cordate base. Determination of individual species of *Carpinus* L. in the Tertiary of Europe is based on morphology of fruits and bracts. Leaf impressions are usually assigned to one fossil species *Carpinus grandis* UNG. emend. HEER, which has a character of cumulative taxon (Hummel 1991b). Hummel (1991a) included to this species also all relatively small leaves with cordate bases, which were described previously as *Betula prisca* ETT. (see, e. g., Goeppert 1855, Menzel 1906).

Carpinus grandis belongs to mesophytic elements of the lower tree storey of deciduous broad - leaved forest in the subtropical and temperate zones (Kvaček and Bůžek 1982). This species is usually compared with the recent species *Carpinus betulus* L.

Betulaceae gen. et sp. div. et indet.

Material. Great quantity of leaf fragments, Holedeč, Nesuchyně, Velká Černoc, Želeč.

Remarks. A high number of poorly preserved fragments of leaves cannot be determined to any taxon below the family for incompleteness, absence of leaf margin and poor preservation of venation.

Myricaceae

Myrica L.

Myrica sp.

Pl. 2, fig. 10, Pl 4, fig. 5, text - fig. 3.12

Material. 1 complete leaf and 6 leaf fragments (impressions), Nesuchyně, Želeč.

Description. Leaves oblong to elliptic, 45 to 60 mm long and 12 to 16 mm broad (maximum in the middle part), base narrow cuneate, apex acute; margin entire or rarely simple-serrate; venation brochidodromous (partly eucamptodromous owing to poor preservation), midrib distinct, strong, moderate; secondary veins alternate or opposite, numerous, originating at 52 to 74°; tertiary veins and venation of higher orders irregularly branched in thin veins and anastomoses, which create a reticulate pattern.

Remarks. The material, described above cannot be determined to the species level only on the basis of leaf morphology without epidermal analysis. Therefore, I assign it only to *Myrica* sp. The impressions can belong to some morphologically identical species of the genus *Myrica* L. as, e. g., *Myrica lignitum* (UNG.) SAP., *Myrica integerrima* KRÄUSEL et WEYLAND, which were described from the Most Basin.

Myrica sp. can be ecologically interpreted as a fruticose element of swamps or moist sands and compared with the recent bushes from the southeast USA.

Comptonia L' HÉRIT. in AITON

Comptonia difformis (STERNBERG 1825) BERRY 1906

Pl. 3, fig. 3, Pl. 4, fig. 6, text - fig. 3.9

1821 *Asplenium diforme* STERNBERG, p. 33, pl. 24, fig. 1. nom. illegit.
1825 *Aspleniopteris difformis* STERNB.; Sternberg, p. 33, pl. 24, fig. 1.
1828 *Comptonia acutiloba* BRONGNIART, pp. 141, 143, 209.
1877 *Myrica* (*Comptonia*) *tschernowitziana* ENGELHARDT, p. 375, pl. 4, fig. 14.
1877 *Myrica credneri* ENGELHARDT, p. 376, pl. 4, fig. 13.
1906 *Comptonia diformis* (STERNB.) BERRY, p. 495.

Material. About 20 identifiable fragments and relatively complete leaves (impressions), Holedeč, Nesuchyně.

Description. Leaves of different size, pinnately lobed, oblong to lanceolate in outline, apex acute, base cuneate with short petiole; lobes of different size, ovate or triangular to rhombic, alternate or opposite, smaller towards apex, apex acute; margin entire; venation eucamptodromous, midrib strong, moderate; secondary veins thin, 2 to 4 veins innervating one lobe, originating at 80 to 90°; tertiary veins often straight or forked, creating a reticular pattern; venation of higher orders poorly preserved.

Remarks. This material can be assigned to *Comptonia difformis* (STERNB.) BERRY on the basis of typical pinnately lobed leaves and characteristic venation of lobes. This taxon is based on an impression, which was originally described as *Asplenium diforme* STERNB. by Sternberg (1821). Subsequently Sternberg (1825) described it once more as a member of a new genus *Aspleniopteris* STERNB., *A. difformis* STERNB. (without a reference to his previous *Asplenium diforme*) and he believed that it was a fern (see in detail Kotlaba 1961, 1962). Vassiliev and Žilin (1968) wrongly refused this basionym. These authors referred to the fact, that *Asplenium diforme* STERNB. is a younger homonym of the modern fern *Asplenium difforme* BROWN., and therefore they suggested *Comptonia acutiloba* BRONGNIART (1828) to be the correct name for this taxon. But *Aspleniopteris difformis* STERNB. (1825) is a legitime available basionym and has the priority over *Comptonia acutiloba*. Hence Berry (1906) created a new correct combination *Comptonia difformis* (STERNB.) BERRY with the basionym *Aspleniopteris difformis* STERBN. in his revision of the genus *Comptonia* L' HÉRIT. in AITON. Occurrences from the Most Basin are very numerous mainly from the base of the overlying strata, Břešťan clay and sand-clay facie of the Žatec delta (Kvaček and Bůžek 1982).

Leaves of *Comptonia difformis* are similar to the recent species *Comptonia peregrina* (L.) COULTER (syn. *C. asplenifolia* (L.) AITON), which is distributed as psamophile bushes in the Atlantic part of North America (Kvaček and Bůžek 1982).

Juglandaceae

Juglans L.

Juglans acuminata AL. BRAUN ex UNGER 1850

Pl. 4, fig. 4, text - fig. 3.18

1845 *Juglans* (*Carya*?) *acuminata* AL. BRAUN, p. 170 (nomen nudum).
1845 *Juglans latifolia* AL. BRAUN, p. 170 (nomen nudum).
1850a *Juglans acuminata* AL. BRAUN ex UNGER, p. 468.
1850a *Juglans latifolia* AL. BRAUN ex UNGER, p. 25, pl. 6, fig. 2.
1855 *Juglans pallida* GOEPPERT, p. 36, pl. 25, fig. 3.
1855 *Juglans sieboldiana* GOEPPERT, p. 36, pl. 25, fig. 2.
1855 *Juglans salicifolia* GOEPPERT, p. 36, pl. 25, fig. 4, 5.
1859 *Juglans vetusta* HEER, p. 90, pl. 127, figs 40-44.
1869 *Juglans acuminata* AL. BRAUN ex UNGER; Ettingshausen, p. 45, pl. 51, fig. 12.
1869 *Juglans parschlugiana* UNGER; Ettingshausen, p. 46, pl. 51, figs 7-10.
1881 *Juglans acuminata* AL. BRAUN ex UNGER; Velenovský, p. 44, pl. 8, figs 2, 4, 5, 6.
1891 *Juglans vetusta* HEER; Engelhardt, p. 191, pl. 17, figs 11, 12.
1904 *Juglans acuminata* AL. BRAUN ex UNGER; Brabenec, p. 9
1949 *Juglans acuminata* AL. BRAUN ex UNGER; Němejc, p. 59, pl. 2, fig. 10.

Material. Only 1 incomplete leaflet G 2538 - original material (Brabenec, 1904) and 1 fragment of leaflet Nn-100 (impressions), Holedeč, Nesuchyně.

Description. Leaflets oblong to elliptic, 32 to 36 mm long and 24 to 28 mm broad, base slightly asymmetrical, rounded with a fragmentary petiole (3 mm long), apex not preserved, probably acute; margin entire; venation brochidodromous, midrib strong, moderate, straight; secondary veins straight, thin, alternate, rarely opposite, numerous, interspaced at distances of 4 to 11 mm broad (2 mm in basal part), curved towards to apex and margin, originating at 40 to 50° (70° in basal part); tertiary veins and venation of higher orders creating a irregular reticulate pattern.

Remarks. Assigning of the material to *Juglans acuminata* AL. BRAUN ex UNGER is based on the leaflets form, entire margin and characters of venation, but without cuticular analysis the determination is unequivocal. Occurrences were described by many authors under other names of species or genera from the area of the Most Basin, which are identical with *Juglans acuminata* (see synonymics). Interesting occurrences from the Sarmatian, which are closely similar to *Juglans acuminata* (see Hadžiev and Palmarev 1962), were described as *Cedrela* P. BR.

According to Bůžek (1971), *Juglans acuminata* is probably extinct without any direct relation to any recent species.

Carya NUTT.

Carya bohemica BRABENEC 1904

text - fig. 3.13

1904 *Carya bohemica* BRABENEC, p. 9, pl. 1, fig. 10a.

Material. Only 1 (missing) fruit - holotype (Brabenec 1904), Holedeč.

Description. Endocarp round, perpendicularly cracked, lignified, 3 mm thick, 21 mm long and 22 mm broad, base broadly round, apex attenuate (3 mm long), secondarily ragged. Surface structure and sculptation are not commented by Brabenec and not evident from his figure (Brabenec, 1904, pl. 1, fig. 10a).

Remarks. This unique compression of an endocarp was described by Brabenec (1904) as a new species *Carya bohemica* BRABENEC. This species was based on morphology of the endocarp and association with occurrences of leaves from the locality Holedeč, which were assigned to the genus *Carya* NUTT.

According to Brabenec (1904), it is possible to match this species with the recent *Carya alba* NUTT. (see also Mai 1981).

Carya serrifolia (GOEPPERT 1855) KRÄUSEL 1921

Pl. 4, figs 3, 9, text - fig. 3.14

1855 *Quercus serraefolia* GOEPPERT, p. 17, pl. 5, fig. 14.
1866 *Quercus reussii* ETTINGSHAUSEN, p. 56, pl. 16, fig. 8.
1867 *Quercus gaudeti* HEER; Stur, p. 153, pl. 4, fig. 2.
1885 *Quercus reussii* ETT.; Engelhardt, p. 23, pl. 9, fig. 34.
1921 *Carya serraefolia* (GOEPP.) KRÄUSEL p. 389, pl. 5, fig. 2.
1949 *Carya bilinica* (UNG.) ETT.; Němejc, p. 60, pl. 9, figs 4-6a.

Material. 5 incomplete leaflets and fragments (impressions), Holedeč, Nesuchyně.

Description. Leaflets probably oblong, narrow elliptic to ovate, 55 to 65 mm long and 35 to 39 mm broad, base not preserved, apex acute; margin regularly slightly serrate; venation simple craspedodromous, midrib strong, moderate; secondary veins distinct, alternate, numerous, curved towards the apex and margin, originating at 60 to 70°, often branched at margin or midrib; tertiary veins numerous, thin, more or less originating at right angle; venation of higher orders creating a polygonal net.

Remarks. The material is assigned to *Carya serrifolia* (GOEPP.) KRÄUSEL on the basis of leaflet morphology: marginal teeth and venation, which is remarkable by branched secondary veins and more obtuse angle of originating from the midrib (important for differentiation from *Rubus* L. - see thereinafter). In the paleobotanical literature, individual impressions of leaflets were wrongly referred to *Quercus* L. (e. g., Goeppert 1855). Kräusel (1921) revised this material. First impressions of *Carya serrifolia* from the North Bohemian area with a typical branching of the secondary venation were described as *Quercus reussii* ETT. (see, e. g., Ettingshausen 1866, Engelhardt 1885, newly also from the locality Kundratice – see in detail Kvaček and Walther 1998).

This species is usually compared with recent North American representatives of *Carya* NUTT. Kräusel (1921) compared it with *C. olivaeformis* NUTT., Berger (1955) and Jung (1963) with *C. amara* NUTT. and Knobloch (1961) with *C. olivaeformis* NUTT. and *C. tomentosa* NUTT. *Carya serrifolia* can be probably interpreted as a mesophile or hygrophile element (Kvaček and Bůžek 1982).

Carya cf. *serrifolia* (GOEPPERT 1855) KRÄUSEL 1921

Pl. 4, figs 1, 2, text - fig. 3.21

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.

Material. 5 incomplete leaflets and fragments and 1 counterpart (impressions), Holedeč.

Description. Leaflets oblong, elliptic to ovate, 44 to 61 mm long and 13 to 17 mm broad, base cuneate, apex acute; margin regularly finely serrate, teeth triangular, acute; venation semicraspedodromous, midrib strong, moderate, straight; secondary veins straight, distinct, alternate, numerous, originating at 60 to 70°; tertiary veins numerous, thin, more or less originating at right angle; venation of higher orders creating a polygonal net.

Remarks. This material can be assigned to *Carya* cf. *serrifolia* (GOEPP.) KRÄUSEL in sense of Bůžek (1971) also on the basis of their morphology (mainly semicraspedodromous type of venation) and also on the comparison with the material from the locality Čermníky. Individual leaflets and leaves from the Most Basin were described by many authors as *Pterocarya denticulata* (WEB.) HEER (see, e. g., Ettingshausen 1869, Engelhardt 1885, Brabenec 1904). This taxon was initially described as *Juglans denticulata* WEBER (Weber 1852). Weyland

(1941) revised Weber's original material and assigned one part of the specimens to *Juglans bilinica* UNG., and the other part to *Carya serrifolia* (GOEPP.) KRÄUSEL. Some of them are closely similar to *C.* cf. *serrifolia* (see in detail Bůžek 1971). Likewise, it is possible to refer the original Brabenec's material, which was described as *Evonymus proserpinae* ETT. and *Aesculus palaeocastanum* ETT. (Brabenec 1904), to this entity according to a similar venation.

This species is compared also (like *C. serrifolia* (GOEPP.) KRÄUSEL) with the recent North American representatives of the genus *Carya* NUTT.

Salicaceae

Salix L.

Salix varians GOEPPERT 1855

Pl. 6, fig. 6, text - fig. 3.15

1855 *Salix varians* GOEPPERT, p. 26, pl. 19, figs 17, 18, pl. 20, figs 1, 2.
1855 *Salix wimmeriana* GOEPPERT, p. 26, pl. 21, figs 1-3.

Material. About 50 incomplete leaves and fragments (impressions), Hlavačov, Holedeč, Nesuchyně, Velká Černoc, Na Bendovce.

Description. Leaves lanceolate to slightly ovate, 38 to 102 mm long and 19 to 28 mm broad, base cuneate to round, apex acute; margin crenulate to serrate with fine teeth; venation eucamptodromous to semicraspedodromous, midrib strong, moderate, straight; secondary veins alternate, numerous, curved towards the apex and margin, originating at 45 to 65°, rare intersecondary veins very thin, parallel with secondary veins; tertiary veins and venation of higher orders creating a polygonal net, poorly preserved.

Remarks. The material is assigned to *Salix varians* GOEPPERT on account of the leaf morphology: character of margin and form or width of leaves, which is important for differentiation from *Salix haidingeri* ETT. *Salix varians* is based on leaves, female and male catkins from the Upper Miocene locality Sośnica (see Goeppert 1855). The epidermal structure is described, e. g., by Kvaček (1966). According to the character and structure of catkins (5 and more stamens), this species belongs to section *Pleiandrae*.

Salix varians was compared to *S. fragilis* L. or *S. amygdalina* L. (syn. *S. triandra* L.) (see e. g. Goeppert 1855, Meyer in Kräusel et al. 1919), but these modern species are different in the structure of floral diagrams and in the cuticular structure. According to Bůžek (1971), *S. varians* compares best with the recent *S. bonplandiana* H.B.K from section *Pleiandrae* on the basis of epidermal structure. *S. varians* was probably a component of bushes on swamps and its periphery (Kvaček and Bůžek 1982).

Salix macrophylla HEER 1856

Pl. 5, fig. 5, text - fig. 3.16

1856 *Salix macrophylla* HEER, p. 9, pl 67.
1881 *Salix macrophylla* HEER; Velenovský, p. 29, pl. 5, fig. 9-15.
1949 *Salix macrophylla* HEER; Němejc, p. 34, pl. 6, figs 3, 3a.
1971 *Salix macrophylla* HEER; Bůžek, pp. 68-69, pl. 23, fig. 5.

Material. Only 1 leaf fragment G 5159 (impression), Nesuchyně.

Description. Leaf probably long ovate, 58 mm long and 37 mm broad, base and apex not preserved; margin distinctly, fine serrate; venation eucamptodromous to semicraspedodromous, midrib strong, moderate, probably straight; secondary veins numerous, alternate, originating at 61 to 72°; intersecondary veins thin, parallel with secondary veins; tertiary veins distinct, originating at right angle, percurrent or forked; venation of higher orders creating a polygonal net, poorly preserved.

Remarks. The incomplete leaf is assigned to *Salix macrophylla* HEER on the basis of the size of the leaf, the character of the margin and venation and comparisons with the material described by Velenovský (1891) and Bůžek (1971). This species has been so far described from the locality Vršovice (Velenovský 1891). The impressions of smaller leaves, which were described as *S. varians* GOEPP. (pl. 5, figs 16, 17, pl. 6, fig. 8) in this monograph, probably belong to *S. macrophylla* HEER according to only minor differences in the course of tertiary venation.

S. macrophylla can be matched with the recent species *S. fragilis* L. or *S. amygdalina* L., but these recent species do not reach the supposed size of leaves.

Salix haidingeri ETTINGSHAUSEN 1866 emend. BŮŽEK 1971

Pl. 3, fig. 2, Pl. 7, fig. 5, text - fig. 3.20

1850a *Salix angustissima* AL. BR.; Unger, partim, p. 418 (only locality Bílina).
1866 *Salix haidingeri* ETTINGSHAUSEN, partim, p. 88, pl. 29, figs 9-13, 15, 16, non fig. 8.
1866 *Salix angusta* AL. BRAUN; Unger, p. 71, pl. 22, fig. 17 (illustration described as *Salix angustifolia* AL. BR.).
1881 *Salix angusta* AL. BRAUN; Engelhardt, p. 81, pl. 1, fig. 17.
1891 *Salix angusta* AL. BRAUN; Engelhardt, p. 164, pl. 10, figs 15.
1949 *Salix lavateri* HEER; Němejc, p. 35, pl. 4, figs 1-2, pl. 6, figs 4-11.
1949 *Salix bilinica* NĚMEJC, p. 38, pl. 1, fig. 5, pl. 3, figs 8, 9, pl. 6, figs 1, 2.
1971 *Salix haidingeri* ETT. emend. BŮŽEK, p. 66, pl. 35, figs 1-10, pl. 36, figs 1-12, text-fig. 8.

Material. 17 incomplete leaves and fragments (impressions), Holedeč, Nesuchyně.

Description. Leaves narrow elongate to linear, 37 to 63 mm long and 9 to 13 mm broad, base round to cuneate with a fragmentary petiole (7 mm long), apex not preserved; margin entire or rarely fine serrate; venation eucamptodromous, midrib distinct, strong, straight or slightly curved; secondary veins numerous, alternate, originating at 48 to 78°; intersecondary veins thin, parallel with secondary veins; tertiary veins distinct, originating at right angle, straight or forked; venation of higher orders creating a polygonal net, poorly preserved.

Remarks. This material is assigned to *Salix haidingeri* ETT. emend. BŮŽEK. on the basis of the form of leaves, the character of the margin and the course of the venation. Bůžek (1971) has defined a new concept of *Salix haidingeri* ETT. (Ettingshausen 1866) on the basis of the impression material from the

Pětipsy area (Bůžek 1971). He has combined fine serrate forms, which were described as *Salix lavateri* AL. BR. or *Salix haidingeri* ETT., with entire forms, which were designated as *Salix angusta* AL. BR., to one species *Salix haidingeri* ETT. emend. BŮŽEK. This emendation is proved by the existence of transitional forms, same morphological parameters of all leaves and co-occurrence of taxa.

According to Bůžek (1971) *Salix haidingeri* matches the recent species *S. purpurea* L. and *S. caspica* PALL., which are distributed in the area of Caucasus and Iran. The fossil species can be ecologically interpreted as an element of riparian forests (Kvaček and Bůžek 1982).

Populus L.

Populus zaddachii HEER 1859 var. *brabenecii* var. n.

Pl. 1, fig. 13, Pl. 5, figs 2, 3, 10, text - fig. 3.26

1904 *Populus heerii* SAPORTA; Brabenec, p. 6, pl. 1, fig. 3.
1953b *Celtis* sp.; Němejc, p. 14, pl. 2, figs 14, 15.
1971 *Populus* aff. *heeri* SAPORTA; Bůžek, p. 69, pl. 30, figs 1-5.

Material. About 50 incomplete leaves and fragments (impressions), Hlavačov, Holedeč.
Holotype. G 7753, housed in the National Museum, Prague (Pl. 5, fig. 3).
Paratype. G 7756, housed in the National Museum, Prague (Pl. 5, fig. 2).

Description. Leaves ovate, of different sizes, maximally 110 mm long and 52 mm broad, base narrowly round to broad cuneate with fragment of petiole (19 mm long), apex acute; margin irregularly simple-serrate to crenulate, teeth at base 1 to 2 mm broad; venation semicraspedodromous midrib strong, moderate, straight; secondary veins looping, distinct, alternate, partly opposite, curved towards to apex and margin, originating at acute angle, intersecondary veins thin, parallel with secondary veins, both venation creating loops and branched in dense net in marginal part; tertiary veins distinct, originating at right angle, forked and with venation of higher orders creating a polygonal net.

Remarks. The material from the localities of the Hlavačov gravel and sand and Holedeč is described as a new taxon *Populus zaddachii* HEER var. *brabenecii* var. n. This new variety of *Populus zaddachii* HEER (see, e. g., Heer 1859, Saporta 1892, Mai and Walther 1978, 1991) is based on morphological differences of the material from the localities Holedeč (see in detail Brabenec 1904, Bůžek and Kvaček 1989 a, b) and Čermníky (Bůžek 1971) from the Oligocene type material of the Baltic area. The leaf base of the type populations of *Populus zadachii* HEER is usually more or less deeply cordate and very rarely rounded or broad cuneate, while in the rich leaf material from the localities Holedeč and Čermníky the base is distinctly rounded to broad cuneate. The other morphological features are identical. On the basis of this fact and the lack of comparison of both taxa in epidermal structure, I define only a new variety of *Populus zaddachii* HEER, and not a new species. Brabenec (1904) originally described the material from the surroundings of Holedeč as *Populus heerii* SAP. He compared individual impressions with the figure in Saporta's monograph (Saporta 1862, pl. 7, fig. 3), which shows the leaf of the recent species *Populus laurifolia* LEDEB. from section *Balsamacea*, and not with the fossil species *Populus heerii* SAP. (fig. 3A), which is at first sight morphologically different. Therefore, Saporta's name was misapplied by Brabenec (1904).

Ecological interpretations and the recent analogue of *Populus zaddachii* HEER var. *brabenecii* var. n. are the same as with *Populus zaddachii* HEER. According to Mai and Walther (1991) this taxon is interpreted as a mesophytic element, which is compared with the recent *Populus cathayana* REHDER (section *Tacamahaca* SPACH), which is distributed in the Mixed Mesophytic Forest in southeast China.

Populus populina (BRONGNIART 1822) KNOBLOCH 1964

Pl. 5, fig. 4, text - fig. 3.19

1822 *Phyllites populina* BRONGNIART, p. 237, pl. 14, fig. 4.
1836 *Populus latior* AL. BRAUN in BUCKLAND, p. 512.
1964 *Populus populina* (BRONGN.) KNOBLOCH, p. 601.

Material. Only 1 incomplete leaf impression G -2549, Holedeč.

Description. Leaf rounded, 40 mm long and 45 mm broad, base broad cuneate with fragment of petiole, apex not preserved, probably acute; margin regularly coarse dentate, teeth 2 mm high and by base 3 mm broad; venation semicraspedodromous, midrib strong, moderate, straight; secondary veins looping, thin, distinct, alternate or opposite (first basal pair), originating at acute angle, creating loops and branched in thin veins (tertiary), innervating apices of teeth; tertiary veins and venation of higher orders poorly preserved.

Remarks. The incomplete leaf is assigned to *Populus populina* (BRONGN.) KNOBLOCH on the basis of the leaf form, type and course of venation (branching of the first basal secondary veins pair). In the paleobotanical literature, this taxon is known and often described under the younger synonym *P. latior* AL. BR. Heer (1856) described and figured plentiful material under this name and divided in several morphological varieties. Other leaves, which were described by Heer (1856) as *P. attenuata* AL. BR., can be referred probably to this taxon, which has large morphological variability (see also Braun in Stizenberger 1851, Hantke 1954). Knobloch (1964) determined a new basionym (Brongniart 1822), and created a new correct combination *Populus populina* (BRONGN.) KNOBLOCH, which is based on the principle of nomenclatoric priority.

According to Kvaček and Bůžek (1982), this species can be compared with the recent representants of section *Leuce* (continetal zone of USA, Europe and China). This taxon is ecologically interpreted as an element of riparian forests.

Tiliaceae

Tilia L.

Tilia brabenecii BŮŽEK et Z. KVAČEK 1994

Pl. 6, fig. 1, Pl. 7, fig. 1, text - figs 3.31, 3.34

1888 *Tilia lignitum* ETTINGSHAUSEN sensu KUŠTA (non Ettingshausen 1869); Kušta, p. 461.
1891 *Tilia lignitum* ETT.; Engelhardt, p. 52, pl. 10, fig. 4.
1904 *Tilia lignitum* ETT.; Menzel, p. 18.
1994 *Tilia brabenecii* BŮŽEK et Z. KVAČEK, p. 98, pl. 1, fig. 1-7, pl. 2, figs 1-6.

Material. 6 incomplete fragments of bracts and 1 fragment of leaf G 7122a (impressions), Nesuchyně.

Description. Leaf ovate in outline, 60 mm long and 45 mm broad, base asymmetric, cordate with fragment of petiole (14 mm long), apex not preserved; margin closely simple dentate; venation basal actinodromous, midrib strong, moderate, straight; secondary veins thin, distinct, alternate, in 5 pairs, originating at 32 to 65°; tertiary veins poorly preserved, subparallel or undulating, innervating apices of teeth with secondary venation. Bracts oblong ovate, 25 to 58 mm long, 13 to 18 mm broad, base rounded to cordate with fragment of petiole (max.11 mm long), apex not preserved, probably obtuse, margin entire; midrib strong, moderate, straight; secondary veins looping, thin, distinct, alternate, numerous, originating at angels less than 45°; tertiary veins and venation of higher orders creating a polygonal net, poorly preserved.

Remarks. This species was revised by Bůžek and Kvaček (1994) including the material from Nesuchyně (coll. Bůžek and Kvaček in 1986). The leaf and bracts from Nesuchyně were determined only on the basis of morphological comparison with the holotype and the paratype of *Tilia brabenecii* BŮŽEK et Z. KVAČEK from Břežánky (Lower Miocene). According to Bůžek and Kvaček (1994), the connection of both organs is supported, besides the fact of a common occurrence, also by the same type of hair bases, which occur on the midrib, the petiole and the peduncle. The impressions of isolated bracts were described as *Tilia lignitum* ETT. by Kušta (1888), Engelhardt (1891) and Menzel (1904) from the Most Basin. *Tilia lignitum* was based on a leaf from the Oligocene locality Žichov and a bract from the Middle Miocene locality Parschlung (see Ettingshausen 1869). These occurrences cannot be referred to *Tilia brabenecii* BŮŽEK et Z. KVAČEK without any doubt.

Tilia brabenecii can be matched with the recent species *Tilia croizatii* CHUNG et WANG, which is distributed in a small relict area in southeast China (Bůžek and Kvaček 1994).

Ulmaceae

Ulmus L.

Ulmus pyramidalis GOEPPERT 1855

Pl. 5, fig. 7, text - figs 3.17, 3.25

1845 *Ulmus bronni* UNGER partim, pl. 26, fig. 1, non figs 2-4.
1855 *Ulmus pyramidalis* GOEPPERT, p. 29, pl. 13, figs 10-12.
1866 *Carpinus pyramidalis* GAUDIN; Ettingshausen, p. 49, pl. 15, figs 5-9, 21.
1866 *Ulmus minuta* GOEPP.; Ettingshausen, p. 64, pl. 18, figs 21, 22.
1866 *Planera ungeri* ETT.; Ettingshausen partim, p. 65, pl. 18, figs 14-16, 18(?), 19(?), non figs 17, 20.
1881 *Carpinus grandis* UNG.; Velenovský partim, p. 23, pl. 2, fig. 25(?), pl. 3, figs 1-5, non fig. 6.
1949 *Ulmus longifolia* UNG.; Němejc, p. 69, pl. 1, fig. 12, pl. 4, figs 4-11, pl. 7, figs 3-11a, pl. 9, figs 1-2.
1949 *Ulmus braunii* HEER; Němejc, p. 69, pl 3, figs 10, 11.
1953b *Ulmus longifolia* UNG.; Němejc, p. 14, pl 1, fig. 13, pl 2, figs 5, 6.

Material. About 70 fragments of leaves (impressions), Hlavačov, Holedeč, Nesuchyně, Želeč, Na Bendovce.

Description. Leaves more or less asymmetric, oblong to ovate, 27 to 82 mm long and 16 to 38 mm broad, base rounded to slightly cordate with fragment of petiole (12 mm long), apex attenuate to acute; margin double - dentate to partly tripli - dentate with rectangular primary teeth, secondary teeth usually finer; venation simple craspedodromous, midrib strong, moderate, straight; secondary veins thin, distinct, alternate to opposite, parallel, numerous, originating at 30 to 60°, curved towards to apex and margin, innervating apecis of primary teeth; tertiary veins often straight or forked, innervating apices of secondary teeth, tertiary veins and venation of higher orders creating a dense polygonal net, poorly preserved.

Remarks. The leaf material is referred to *Ulmus pyramidalis* GOEPP. on the basis of the distinctly dentate margin and closely spaced parallel secondaries. The material is variable in size, form and character of margin. This type of leaves was earlier described as *Ulmus longifolia* UNG. (see, e. g., Unger 1845, 1847), but this name is a younger homonym of *Ulmus longifolia* RAFINESQUE. Therefore, the name *Ulnus pyramidalis* GOEPP. must be given priority. Similar impressions of leaves were described as *U. bronni* UNG., *U. braunii* HEER, *U. minuta* GOEPP. or *Carpinus pyramidalis* GAUDIN. These species evidently belong to *U. pyramidalis* and morphological differences can be regarded as intraspecific variability of leaves.

According to Kvaček and Bůžek (1982), *Ulmus pyramidalis* can be compared with the recent species *U. americana* L., which is distributed in east and southeast areas of USA as a characteristic element of riparian forests (Kvaček and Bůžek 1982). This recent elm corresponds not only in morphology but also in autecology with the fossil species *Ulmus pyramidalis*, which is a typical element of riparian forests of the Most Basin, where probably grew on elevated habitats along rivers (aggradate levees).

Ulmus sp.

Pl. 3, fig. 4

Material. 2 incomplete winged samaras Nn - 69, G 3625, Holedeč, Nesuchyně.

Description. Form of wings broad elliptic, 6 mm and 8 mm long, 6 mm and 6, 5 mm broad, base narrowly broad cuneate, verged into long stalk with remains of calyx (G3625), stalk 4 mm long, double - apeces (Nn-69), obtuse; seed area narrowly elliptic, 3 mm and 5 mm long, 2 mm broad; surface poorly preserved.

Remarks. Assigning of the winged samaras to the genus *Ulmus* L. is based on the double - apeces termination of the wing, a fragmentary calyx and the whole form. Bůžek (1971) refers a great quantity of winged samaras to *Ulmus pyramidalis* GOEPPERT, but these occurrences differ from the material of the Hlavačov gravel and sand and Holedeč, namely in the form, the size and the mutual angel of winged samaras and the form of the seed area. Nevertheless, one of the fruits is similar to *Ulmus pyramidalis* in the calyx position (in sense of Bůžek 1971).

Zelkova SPACH

Zelkova zelkovifolia (UNGER 1843) BŮŽEK et KOTLABA 1963

Pl. 6, fig. 10, text - fig. 3.27

1843 *Ulmus zelkovaefolia* UNGER partim, pl. 24, figs 9-13, (non fig. 7 fructus).
1851 *Planera ungeri* ETT.; Anonymus (ref. Ettingshausen), p. 145.
1851 *Zelkova ungeri* (ETT.). KOV.; Anonymus (ref. Kováts), p. 178.
1851 *Planera ungeri* ETT.; Ettingshausen, p. 14, pl. 2, figs 5(?), 6(?), 7-9, 10-12(?), 13, 14, 16 (non figs 15, 17, 18).
1856 *Zelkova ungeri* (ETT.) KOVÁTS, p. 27, pl. 5, figs 1-12, pl. 6, figs 1-6.
1949 *Zelkova ungeri* KOV.; Němejc, p. 71, pl. 8, figs 1, 2.
1963 *Zelkova zelkovaefolia* (UNGER) BŮŽEK et KOTLABA, p. 59, pl. 3, figs 7, 8.

Material. 7 complete leaves, Holedeč, Nesuchyně.

Description. Leaves often asymmetrical, ovate to oblong ovate, 21 to 64 mm long and 21 to 26 mm broad, base round to slightly cordate, apex shortly acute to attenuate; margin coarse simple - serrate; venation simple craspedodromous, midrib strong, moderate, straight; secondary veins distinct, parallel, alternate, originating at 55 to 70°, curved towards to apex and margin, innervating apices of teeth; tertiary veins thin, often straight or forked; venation of higher orders creating a polygonal net.

Remarks. This leaf material is referred to *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA on the basis of the characteristic coarse simple - serrate margin and the whole leaf form. According to Kotlaba (1963) both previously mostly used names *Planera ungeri* ETT. and *Zelkova ungeri* (ETT.) KOV. are illegitimate, because morphologically identical leaves were earlier described as *Ulmus zelkovaefolia* UNG. This species has the nomenclatoric priority. Of course, this species is based on leaves, while the remaining original material of fruits (Unger 1843, pl. 24, fig. 7; 1845, pl. 26, fig. 8) must be excluded.

Zelkova zelkovifolia (UNG.) BŮŽEK et KOTLABA can be compared with the recent species *Zelkova carpinifolia* (PAL.) K. KOCH. from relic deciduous forests of Colchis (Kvaček and Bůžek 1982).

Rosaceae

Rosa L.

Rosa europaea (ETTINGSHAUSEN 1868) Z. KVAČEK et HURNÍK 2000

Pl. 5, fig. 8, Pl. 6, fig. 9, text - fig. 3.22

1868 *Myrsine europaea* ETTINGSHAUSEN, p. 37, pl. 37, fig. 22,
1868 *Rhus prisca* ETTINGSHAUSEN, p. 50, pl. 51, fig. 11
?1869 *Rosa lignitum* HEER, p. 99. pl. 30, fig. 33.
1891 *Planera ungeri* KOV.; Engelhardt, pl. 3, figs 22-24.
1971 *Rosa bohemica* ENGELHARDT; Bůžek, p. 61, pl. 24, figs 1-19.
2000 *Rosa europaea* (ETT.) Z. KVAČEK et HURNÍK, p. 15, pl. 6, figs 1, 9, text-figs 3.3, 4.8, 5.11, 5.14.

Material. Only 2 almost complete leaflets (impressions), Holedeč.

Description. Leaflets ovate, 11 to 18 mm long and 6 to 9 mm broad, base slightly asymmetric, round, apex obtuse; margin simple serrate, entire in basal part, teeth 1 to 1.5 mm broad at base, convex; venation semicraspedodromous, midrib strong, curved in upper third, innervating apex; secondary veins numerous, mostly alternate, originating at 40 to 50°; venation of higher order not preserved.

Remarks. The material can be probably assigned to *Rosa europaea* (ETT.) Z. KVAČEK et HURNÍK on the basis of the size, form of asymmetric base and the character of margin. Validity of this assigning was also corroborated by morphological comparisons with the material of the Pětipsy area (see Bůžek 1971, pl. 24, figs 1-19) and with the material from the localities Želénky, Zábrušany and Vršovice (see Kvaček and Hurník 2000). In the area of the Most Basin leaf impressions of this species were often misinterpreted and described by many authors as *Myrsine europaea* ETT. (Ettingshausen 1868), *Rhus prisca* ETT. (see Ettingshausen 1868), *Rosa lignitum* HEER (Heer 1869) or as *Planera ungeri* KOV. (see Engelhardt 1891). This record has newly been revised by Kvaček and Hurník (2000). These authors selected a new basionym and the type (Ettingshausen 1868) and created a new correct combination (morphotaxon) *Rosa europaea* (ETT.) Z. KVAČEK et HURNÍK (see in detail Kvaček and Hurník 2000).

Rosa europaea was probably a fruticose element of underwood in riparian forests (Kvaček and Bůžek 1982). A recent analogue of this species is not known.

Rubus L.

Rubus merianii (HEER 1859) KOLAKOVSKIJ 1964

Pl. 6, fig. 2, text - fig. 3.24

1859 *Rhus meriani* HEER, p. 82, pl. 126, figs 5-11.
1904 *Rhus meriani* HEER; Brabenec, p.16.
1964 *Rubus meriani* (HEER) KOLAKOVSKIJ, p. 131.

Material. Only 2 almost complete leaflets (impressions), Holedeč.

Description. Leaves originally palmately compound, leaflets oblong to elliptic, 23 mm and 59 mm long, 6 mm and 2.4 mm broad, base broadly cuneate to rounded, apex acute, margin fine simple serrate, teeth 1 mm high and 0.5 mm broad at base; venation semicraspedodromous, midrib strong, straight, moderate; secondary veins relatively numerous, thin, alternate, straight, originating at 35 to 50° at intervals of 6 to 9 mm; tertiary veins straight, often forked, perpendicular; venation of higher order not preserved.

Remarks. The material can be referred to *Rubus merianii* (HEER) KOL. on the basis of morphological features mentioned in the description. The main diagnostic trait for a differentiation from the genus *Carya* NUTT. are steeper secondary veins diverging at more acute angles (35 to 50°) in the case of *Rubus* L. Kolakovskij (1964) has assigned his leaf material to the genus *Rubus* L, which was originally described by Heer (1859) as a representative of *Rhus* L. The former author argued by the morphology of leaves and leaflets, character of venation and presence of spines on the petiole. These features conform with the family Rosaceae (see e. g. Kolakovskij 1964, Sakala 1997). Kvaček and Hurník (2000) newly revised occurences from the Most Basin. The authors suggested a new taxon

Rubus vrsovicensis Z. KVAČEK et HURNÍK, which is based on the original material from Vršovice (Velenovský 1881). This new taxon is morphologically very similar in its venation with the leaf material of *Rubus merianii* (HEER) KOL., but the leaflets are broader and the margin is mostly revolute. Kvaček and Hurník also noted a similarity of leaves, which were described by Bůžek (1971) as cf. *Corylus insignis* HEER from the Pětipesy area, with *Rubus vrsovicensis* (Kvaček and Hurník 2000).

According to Kolakovskij (1964), potential recent analogons of *Rubus merianii* (HEER) KOL. are among representatives of East Asian species of *Rubus* L. (Kolakovskij 1964). According to Kvaček and Bůžek (1982), *Rubus merianii* can be interpreted as hygrophilous blackberry, which was an element of fruticose underwoods in swamps (Bůžek and Kvaček 1982).

Leguminosae

Leguminosites BOWERB.

Leguminosites tobischii ENGELHARDT 1891

Pl. 7, fig. 8, text - fig. 3.23

1881 *Dolichites* vel *Acaciae* cuiusdam; Sieber, p. 91, pl. 4, figs 37, 38.
1891 *Leguminosites tobischii* ENGELHARDT, p. 198, pl. 18, figs 19, 20.
1904 *Acacia beneschi* BRABENEC, p. 16, pl. 1, fig. 5.

Material. Only 1 incomplete pod with 4 seeds - original material (Brabenec 1904), 1 complete seed G 2577 (impression and counterpart), Holedeč.

Description. Pod oblong, slightly curved, narrowed into incurvate apex (tip), 40 mm long and 7 to 9 mm broad, regular contracted in 4 links (seed areas), links approximately same in size, lenticular. Seed oblong, broadly obovate, 16 mm long and 9 mm broad, chalase central on adaxial part, oval, 3 mm long and 2 mm broad, base broadly round, apex acute to attenuate jutting in stalk, surface structure of seed and pod not preserved. Pod and seed probably secondarily flatted.

Remarks. The material is possible to refer to the formal species *Leguminosites tobischii* ENGELH. on the basis of the morphology of the pod and the seed and morphological comparison with the material from the Pětipsy area (Bůžek 1971). The original material from surroundings of Holedeč was described and referred by Brabenec (1904) to a new species *Acacia beneschii* BRABENEC, namely for its distinct form, according to Brabenec, distinct from other hitherto known samples of pods from the Most Basin. Different are, e. g., *Acacia parschlungiana* UNG. (non-contracted pods) and *Acacia lomentacia* HEER (differences in form and contraction) - see in detail Brabenec (1904). According to Brabenec (1904) a recent analogue is *Acacia arabica* WILLD. (section *Gummiferae* BEUTH). Bůžek (1971) tried to verify the systematic position and affinity of the material from Holedeče and from the Pětipsy area within recent and fossil representatives of the families Mimosaceae, Caesalpiniaceae and Viciaceae, however, without success. Pods of *Dolichites maximus* UNG. are contracted in a similar style, but they are bigger, broader and with a higher number of seeds. Bůžek (1971) presumed that the number of seeds in one pod of *Leguminosites tobischii* ENGELH. was 4 to 8. Absolutely identical pods were described by Sieber (1881) from Břežánky and by Engelhardt (1891) from Želénky, therefore the new taxonomical entity published by Brabenec (1904) is not acceptable. Occurrences from Želénky were recorded by Kvaček (1960).

Herndeen (1992b) figured similar pods of the recent species *Sophora japonica* L.

Podocarpium AL. BRAUN ex STIZENBERGER

Podocarpium podocarpum (AL. BRAUN in BUCKLAND 1836) HERENDEEN 1992

Pl. 1, fig. 14

1825 *Cabomba oehninngensis* KOENING, pl. 15, fig. 181 (fructus).
1836 *Gleditschia podocarpa* AL. BRAUN in BUCKLAND, p. 513.
1850a *Dalbergia podocarpa* (AL. BR.) UNGER patrim, p. 185, pl. 61, figs 11, 12, 13 (leaflets), 14 (fructus).
1851 *Podocarpium knorri* AL. BRAUN in STIZENBERGER, p. 90.
1854 *Dalbergia retiulata* ETTINGSHAUSEN patrim, p. 813, pl. 6 (fructus).
1856 *Copaifer longestipiata* KOVÁTS, p. 50, pl. 1, figs 3, 4, 4a.
1859 *Podogonium knorri* HEER, p. 114, pl. 134, figs 22-26a, pl. 35, non fig. 19, pl. 136, figs 1-9.
1869 *Podogonium knorri* HEER; Ettingshausen, p. 114, pl. 54, figs 7 (?), 12 (?).
1881 *Podogonium knorri* HEER; Velenovský, p. 48, pl. 10, figs 13 (?), 14(?), 15-17.
1957 *Podogonium oehningense* (KOENING) KIRCHHEIMER, p. 261, pl. 1, fig. 1., pl. 20, figs 90 a-b.
1971 *Podogonium oehningense* (KOENING) KIRCHHEIMER; Bůžek, pp. 98-99, pl. 47, fig. 9, pl. 50, figs 1-27, pl. 51, figs 1-12, text-fig. 16.
1992a *Podogonium knorri* (AL. BR.) HEER; Herendeen, pp. 4- 16.
1992b *Podocarpium podocarpum* (AL. BR.) HERENDEEN, p. 732.

Material. Only 1 isolated complete leaflet G 7744, Holedeč.

Description. Leaflet oval, 24 mm long and 8 mm broad, apex acute, base asymmetric, cuneate with fragment of short petiole, margin entire; midrib strong, straight; secondary veins poorly preserved, only one camptodromous basal vein.

Remarks. This material can be assigned to *Podocarpium podocarpum* (AL. BR.) HERENDEEN (1992b), namely on the basis of morphological parameters of the leaflet (size, form, asymmetry of base) and comparison with the material from the Pětipsy area (Bůžek 1971). Koening (1825) described, but invalidly published an identical fruit as *Cabomba oehningensis* KOENING from the locality Öhningen (see in detail Herendeen 1992a, p. 9). Braun (in Buckland 1836) overlooked this fact and referred occurrences of pods and leaflets from the same locality to *Gleditschia podocarpa* AL. BR. Later Braun (in Stizenberger 1851) transferred all samples to *Podocarpium knorrii* AL. BR. Heer (1859) compared his material, which he referred to the fossil genus *Podogonium* HEER (6 described species), with the genus *Copaifera* L. According to Heer (1859), *Copaifera* L is characteristic of one-seeded pods, which dehisce in two valves. Comparing other legumes, pods their are short-stalked and different in venation of leaflets. Never-

theless, that pods of *Pogodonium*, according to Heer (1859), do not dehisce, and only on the basis of similarity in leaflet bases, Heer (1859) compared the newly described species *Podogonium knorrii* HEER with the genus *Tamarindus* L., which has all typical features of legumes. Kirchheimer (1957) and also Rüffle (1963) disagreed with the affinity to *Tamarindus* L. although they did not doubt the affinity to other genera of legumes. In comparison with this opinion, Gregor and Hantke (1980) pointed to a direct affinity between fruits of the genus *Podogonium* HEER (i. e., *Podocarpium* AL. BRAUN ex STIZENBER.) and stalked fruits of *Gleditsia aquatica* MARSH. and *Gleditsia heterophylla* BUNGE, distributed in swamps in southeast USA. Herendeen (1992a) compares *Podogonium* HEER (i. e., *Podocarpium*) with several genera, which belong to tribus *Detarieae* and tribus *Amherstieae*. Most representatives of these tribes are distributed in tropical to subtropical Africa (e. g., *Gilletiodendron* VEMOESEN, *Cryptosepalum* BENTH., *Tessmannia* HARMS).

Wisteria NUTT.

? ***Wisteria*** aff. ***fallax*** (NATHORST 1883) TANAI et ONOE 1991

Pl. 4, fig. 12, Pl. 5, fig. 9, text - fig. 3.33

1883 *Sophora* (?) *fallax* NATHORST, p. 58, pl. 10, figs 11, 12, pl. 11, fig. 2.
1961 *Wisteria fallax* (NATH.) TANAI et ONOE, p. 45, pl. 10, fig. 6., pl. 14, figs 2-4.
1971 *Wisteria* aff. *fallax* (NATH.) TANAI et ONOE; Bůžek, p. 64, pl. 25, figs 1-15, text-figs 8.

Material. 2 incomplete leaflets G 7758 and G 7746, Holedeč.

Description. Leaflet No. 1801/60-2 broadly ovate, 53 mm long and 45 mm broad, base broadly cordate, apex and petiole not preserved, margin entire; venation brochidodromous, midrib straight and strong; secondary veins relatively straight, almost opposite, originating at 22 to 35° (by base till 55°); tertiary veins thin, perpendicular, with venation of higher order creating a dense polygonal net. Leaflet No. 170/61-9 ovate, 50 mm long and 33 mm broad, base asymmetric, round, apex and petiole not preserved, margin entire; venation brochidodromous, midrib strong, secondary veins numerous, undulate, partly opposite, mostly alternate, originating at 35 to 67° (at base to 78°); tertiary veins thin, perpendicular, with venation of higher order creating a dense polygonal net.

Remarks. The material is with some hesitation assigned to *Wisteria* aff. *fallax* (NATH.) TANAI et ONOE on the basis of leaf morphology and comparison with the material from the Pětipsy area (Bůžek 1971). Main features are size and form of leaflets, the character of margin and the course of venation. Similar leaflets were described from the Miocene of Japan as *Sophora* (?) *fallax* NATH. (see Nathorst 1883). Tanai and Onoe (1961) revised this material and transferred it into the genus *Wisteria* NUTT. including new leaflet material and fruits from different Neogene localities of Japan. They pointed to the specific morphological resemblance of leaflets with representatives of the genus *Cladrastis* RAF. and *Maackia* RUPR., which can be manifestation of a specific form of convergence, which followed probably from the same ecological strategy of liana plants (Baranova 1967). But main features for determination of these lianas are, e. g., the width of inflorescence, the number of leaflets of the compound leaf and the type of climbing and not only morphological similarity of leaflets. A remarkable phenomenon is the rarity of these samples in surroundings of Holedeč (Brabenec, 1904), which are more common only in the Pětipsy area (Bůžek 1971).

According to Tanai and Onoe (1961) and also Baranova (1967) a recent analogue of the fossil species *Wisteria* aff. *fallax* is *Wisteria floribunda* (WILLD.) DC. It is a liana, which is distributed today in association of riparian forests of the southeast and east USA and East Asia (Kvaček and Bůžek 1982).

Sapindaceae

Koelreuteria LAXMANN

Koelreuteria reticulata (EETTINGSHAUSEN 1854) EDWARDS 1927

Pl. 7, fig. 9

1854 *Dalbergia reticulata* ETTINGSHAUSEN, p. 37, pl. 4, fig. 5, non fig. 6.
1859 *Salvinia reticulata* (ETT.) HEER, p. 156, pl. 145, fig. 16.
1894 *Tmesipteris reticulata* (ETT.) HOLLICK, p. 256.
1904 *Salvinia reticulata* (ETT.) HEER; Brabenec, p. 2, pl. 1, fig. 1 a, b.
1919 *Phyllites reticulata* (ETT.) FLORIN, p. 255.
1927 *Koelreuteria* ? *reticulata* (ETT.) EDWARDS, p. 111.
1937 *Abronia bronni* (UNG.) LAUR.; Weyland, partim, p. 88, pl. 11, fig. 2, text-fig. 17.
1948 *Koelreuteria macroptera* (KOV.) EDW.; Weyland, p. 133, pl. 21, fig. 6.
1958 *Koelreuteria reticulata* (ETT.) EDW.; Rásky, p. 185, pl. 17, fig. 9.
1966 *Phyllites* (*Salvinia*) *reticulata* (ETT.) FLORIN; Hurník and Knobloch, p. 94, 95.
1971 *Koelreuteria reticulata* (ETT.) EDWARDS; Bůžek, pp. 84-85, pl. 31, figs 22, 23.

Material. 2 impressions of incomplete valves G 3637-8, original material (Brabenec 1904), Holedeč.

Description. Valves oblong to ovate, 20 mm and 32 mm long, 12 mm and 20 mm broad, base probably round, apex not preserved, margin entire; medial vein distinct, strong, thin veins originating at acute angles, numerous, course towards margin with venation of higher order creating an irregular reticular net of oblong areoles.

Remarks. The original material of Brabenec (1904), described as *Salvinia* is referable to *Koelreuteria reticulata* (ETT.) EDWARDS (Bůžek 1971) on the basis of the character of higher order venation and, contrary to *Salvinia*, the absence of intramarginal veins and tubercles in areoles. According to Bůžek (1971), similar dehiscing valves could be found also in *Urvillela* KUNTH and *Cardiospermum* L.

Representatives of *Koelreuteria* LAXMANN have remarkable inflated capsules, which dehisce from the apex to the base into four separate valves (see Bůžek 1971; in detail Kirchheimer 1957). These eastasian deciduous trees are elements of the Mixed Mesophytic Forest or evergreen forests of the subtropical zone (Kvaček and Bůžek 1982).

Aceraceae

Acer L.

Acer tricuspidatum BRONN 1838 sensu Procházka et Bůžek 1975

Pl. 6, figs 8, 13, text - fig. 3.37

1823 *Phyllites lobatus* STERNBERG, p. 37, pl. 35, fig. 2.
1825 *Phyllites trilobatus* STERNBERG, p. 42, pl. 50, fig. 2.
1838 *Acer tricuspidatum* BRONN, pl. 35, fig. 10a, b.
1845 *Acer trilobatum* AL BRAUN, p. 172.
1869 *Acer bilinicum* ETTINGSHAUSEN, p. 21, pl. 44, figs 13, 14.
1881 *Acer sturi* ENGELHARDT, p. 83, pl. 1, fig. 21.
1881 *Acer magnum* VELENOVSKÝ, p. 38, pl. 7, figs 7-9.
1904 *Acer trilobatum* AL. BR.; Brabenec, p. 19.
1968 *Acer tricuspidatum* BRONN; Walther, pp. 636, 637, pl. 2, figs 1-3 (neotyp).
1975 *Acer tricuspidatum* BRONN sensu Procházka et Bůžek, p. 24, pls. 22-24, text-figs 2, 3, 4d, 5-13.

Material. About 20 fragments of leaves (impressions), Holedeč, Velká Černoc.

Description. Leaves palmately 3-lobed, 35 to 53 mm long, 40 to 75 mm broad, lobe triangular or pentagonal, base round to slightly cordate, petiole not preserved, apices mostly acute, sinuses round and widely open, margin serrate to crenuate; venation basal actinodromous, 3 primary veins, rare 5 (VČ - 53), strong, slightly curved, originating at 43 to 62°; secondary veins straight or slightly curved, alternate to almost opposite, originating at 40 to 50°; venation of higher order percurrent to forked.

Remarks. Procházka (1952) deals with fossil maples from the North Bohemian Tertiary in detail. The monograph by Procházka and Bůžek (1975) is only a shortened and revised version of the dissertation of in this time already deceased M. Procházka (Sakala 1997). The material at hand is possible to assign to *Acer tricuspidatum* BRONN sensu Procházka et Bůžek on the basis of morphological features of leaves (see description). Of forms, which Procházka and Bůžek (1975) defined, the primitive evolutionary form *A. tricuspidatum* BRONN f. *tricuspidatum* with 3-lobed leaves, showing the rounded base and a triangular form of individual lobes occur at Velká Černoc and Holedeč. The fossil species *Acer tricuspidatum* BRONN sensu Procházka et Bůžek was first described by Sternberg as *Phyllites lobatus* STERNB. (Sternberg 1823). This name is not available for the designation of this maple species (Kvaček 1965). The stratigraphical range of this taxon is from the Lower Oligocene to the Upper Pliocene of Europe. Outside Europe, samples are known only from the Paleogene of Greenland (Procházka 1952).

A. tricuspidatum is most often matched with the recent species *A. rubrum* L., which is distributed in the Atlantic area of North America. This match is supported not only by morphological similarity of leaves, but also by the same autecology of the recent species *A. rubrum* L., which is an important element of swamps of the southeast area of USA, and *A. tricuspidatum*, which is a typical swampy maple of the European Tertiary (Procházka 1952). On the basis of epidermal structure, *Acer tricuspidatum* is near to the recent species *A. saccharinum* L. (see, e. g., Walther 1972, Kvaček 1985, Sakala 1997).

Acer integerrimum (VIVIANI 1833) MASSALONGO 1858

Pl. 7, figs 3, 12, text - fig. 3.32

1833 *Acerites integerrima* VIVIANI, pl. 11, fig. 6.
1856 *Acer trachyticum* KOVÁTS, p. 32, pl. 7, figs 1, 2.
1856 *Acer inaequilobum* KOVÁTS, p. 34, pl. 7, fig. 3.
1858 *Acer integerrimum* (VIVI.) MASSALONGO, p. 94.
1881 *Acer nervatum* VELENOSVKÝ, p. 39, pl 7, figs 5, 6.
1904 *Acer nervatum* VELEN.; Brabenec, p. 20, pl. 1, fig. 6.

Material. About 15 fragments of leaves (impressions), Holedeč, Nesuchyně, Želeč.

Description. Leaves palmately 3- or 5-lobed, 45 to 70 mm long, 48 to 85 mm broad, lobes triangular to ovate, base slightly cordate to round, petiole not preserved, apices acute, margin entire, sinuses round to acute, widely open; venation basal actinodromous, 3 or 5 primary veins strong, moderate, slightly curved, originating at 33 to 48°; secondary veins looping, originating at 54 to 64°; tertiary veins percurrent or forked.

Remarks. Assigning of the material to *Acer integerrimum* (VIVI.) MASSAL. is based on the leaf morphology (see description). Vivianni (1883) published in his work schematic figure of leaf impression, which was described as *Acerites integerrima* VIVIANI. Identity of this illustration can be doubted (see in detail Procházka 1952). Therefore this species is designated sometimes as *A. trachyticum* KOV. and *A. inaequilobum* KOV. (see Kováts 1856). Occurrences of 5 and 7 lobed leaves were described as *Acer nervatum* VELEN. from the Most Basin (see, e. g., Velenovský 1881, Brabenec 1904). Procházka (1952) referred to *Acer integerrimum* (VIV.) MASSAL. samples of small 3-lobed leaves, which were originally described as *Acer decipiens* AL. BR. Brabenec (1904) referred to abundant occurrences of this species in surroundings of Holedeč. However, these occurrences were revised by Procházka and Bůžek (1975) and referred to *A. pseudomonspessulanum* UNG.

Acer L. includes at present about 150 species (Novák 1972). *Acer integerrimum* (VIV.) MASSAL. matches the recent species *A. cappadocicum* GLEDITSCH (see Mai 1995), which is an element of Near East Asian mesophytic deciduous forests and the Mixed Mesophytic Forest of Himalays (Kvaček and Bůžek 1982).

Acer dasycarpoides HEER 1859 sensu Procházka et Bůžek 1975

Pl. 6, fig. 12, text - fig. 3.30

1859 *Acer dasycarpoides* HEER, p. 198, pl. 114, figs 3, 9, pl. 115, fig. 6, pl. 155, figs 6-8.
1859 *Acer rüminianum* HEER, p. 59, pl. 118, figs 11-13
1869 *Acer trilobatum* AL. BR.; Ettingshausen, p. 18, pl. 44, fig. 7.
1870 *Acer trilobatum* AL. BR.; Engelhardt, p. 28, pl. 8, figs 1, 2.
1885 *Acer trilobatum* AL. BR.; Engelhardt, p. 52, pl. 19, figs 13, 15, 17-19, pl. 20, figs 1-3, 7, 17, pl. 28, fig. 11.
1891 *Acer augustilobum* HEER; Engelhardt, p. 180, pl. 14, figs 2, 3

1891 *Acer magnum* VELEN.; Engelhardt, p. 181, pl. 15, figs 12, 13.
1904 *Acer rüminianum* HEER; Brabenec, p. 19.
1932 *Acer teilobatum* AL. BR.; Konjarov, p. 129, pl. 43, fig. 7.
1975 *Acer dasycarpoides* HEER sensu Procházka et Bůžek, p. 36, pl. 21, figs 6-10, text.figs 4a-c, 14, 15.

Material. 5 incomplete leaves - original material (Brabenec 1904), Holedeč.

Description. Leaves palmately 3-lobed, 19 to 42 mm long and 22 to 58 mm broad, base distinctly cordate to broadly cuneate, lobes oblong or oblong - lanceolate, approximately same in size, apices acute, sinuses round, widely open, margin simple serrate with relatively long, acute teeth; venation basal actinodromous, 3 primary veins strong, moderate, originating at 40 to 68°; secondary veins, straight, rare curved, almost alternate, originating at acute angles; tertiary veins percurrent or forked with venation of higher order creating dense polygonal net.

Remarks. This material can be assigned to *Acer dasycarpoides* HEER sensu Procházka et Bůžek on the basis of its leaf morphology. Of the forms, which have been defined by Procházka (1952) and Procházka and Bůžek (1975), the primitive (first) form *A. dasycarpoides* HEER f. *angustilobum* with relatively narrower lobes occurs in the surroundings of Holedeč. The second form is *A. dasycarpoides* HEER f. *dasycarpoides*, which is more derived with broader to pentagonal lobes. To this form can be assigned the material, which was originally described by Brabenec (1904) as *Acer rüminianum* HEER (Procházka and Bůžek 1975). A suggestion by Hantke (1965), to treat both these forms as independent species, is not accepted (see in detail Bůžek 1971).

As a recent analogue of *Acer dasycarpoides*, *Acer sacharinum* L (syn. *A. dasycarpum* EHRH.) can be suggested. It is a deciduous element, which dominates in riparian forests of the east area of USA (Kvaček and Bůžek 1982), but not directly in swamps (Procházka and Bůžek 1975).

Acer pseudomonspessulanum UNGER 1847

Pl. 7, fig. 2, text - fig. 3.48

1833 *Acer monspessulanum* L.; Viviani, p. 130, pl. 10, fig. 1.
1847 *Acer pseudomonspessulanum* UNGER, p. 132, pl. 43, figs 1 (?), 2.
1847 *Acer pseudocampestre* UNGER, p. 133, pl. 43, figs 6-9.
1859 *Acer decipiens* AL. BR.; Heer, p. 58, pl. 117, figs 15-21.
1881 *Acer decipiens* AL. BR.; Wentzel, p. 260, fig. 8.
1888 *Acer integrilobum* O. WEBER; Saporta, p. 283, fig. 40/4 (sic!).
1904 *Acer decipiens* AL. BR.; Brabenec, p. 21, pl. 1, figs 7, 8.
1975 *Acer pseudomonspessulanum* UNGER; Procházka and Bůžek, pp. 61-64, text-figs 1 c-f, 21 a-e.

Material. 5 incomplete leaves, original material (Brabenec 1904), Holedeč.

Description. Leaves palmately 3-lobed, 24 to 35 mm long and 23 to 34 mm broad, base cordate to round, lobes approximately same in size, triangular to ovate, apices acute, sinuses round, widely open, margin entire; venation basal actinodromous, 3 primary veins strong, slightly curved, originating at 42 to 70°; secondary veins looping, almost alternate, rare opposite, originating at acute angles; tertiary veins percurrent or forked with venation of higher order creating a dense polygonal net.

Remarks. This material was originally described by Brabenec (1904) as *Acer decipiens* AL. BR. Individual impressions of leaves are assigned to *Acer pseudomonspessulanum* UNG. on the basis of leaf morphology (see description). This species is based on the lectotype, which was chosen from Unger's original material from the locality Parschlug (see Unger 1847).

As a recent native analogue of *Acer pseudomonspessulanum* UNG., *Acer floridanum* (CHAPM.) PAX has been suggested, which is distributed in swampy areas from Texas to Florida with characteristic seeming "xerophytic" adaptation for extreme humid environment (Procházka and Bůžek 1975).

Acer cf. *sepultum* ANDRAE 1855

Pl. 7, fig. 4

1855 *Acer sepultum* ANDRAE, p. 21, pl. 2, figs 9-10.
1861 *Acer acute-lobatum* LUDWIG pro parte, p. 177, pl. 119, fig. 2 (fructus).

Material. 2 fragments of seed parts and 1 complete winged samara G 7757, Holedeč, Nesuchyně.

Description. Samara with relatively small endocarp, ovate to elliptic, in apical part (by wing) asymmetric, perpendicularly cut off, 6 mm long and 5 mm broad, course distinct main bunch of veins, innervating wing, similar veins arise from basal part of endocarp periphery, creating 1 to 3 mm broad winged welt; wing gradually asymmetrically broadened, 18 mm long and max. 8 mm broad, upper part straight with distinct bunch of veins, thin veins gradually originating, straight, rarely forked, lower part broadened, at 30°, both parts meet, creating a terminal lobe.

Remarks. This material can be assigned to *Acer sepultum* ANDRAE on the basis of morphology and comparison with the figure in Mai (1995, p.163). Identical winged samaras were described as *Acer integerrimum* (VIVI.) MASSAL. (see, e. g., Pax 1885, Bůžek 1971, pl. 37, fig. 3 a pl. 38, figs 8 - 9) or *Acer palaeomiyabei* MÄDLER (see, e. g., Mädler 1939, Mai 1964), which correspond in the case of *Acer integerrimum* with the samples from the Hlavačov gravel and sand and surroundings of Holedeč.

Acer sepultum Andrae is related to the recent species *A. cappadocicum* GLEDITSCH (see Mai, 1995), which is distributed in an area from the Caspian Sea to China, and with *A. lobelii* PAX (see Reid, C. and Reid, E., M. 1915), which is distributed in the area of south Italy, and with *A. platanoides* L. from Europe (see Mai 1997).

Acer sp.

Pl. 7, figs 7, 10

Material. 3 fragments of winged samaras and 1 complete samara G 7748, Holedeč, Velká Černoc.

Description. Samara with relatively small endocarp, ovate to elliptic, in apical part (by wing) asymmetric, 4 mm long and 3, 5 mm broad, course distinct main bunch of veins, innervating wing; wing gradually asymmetric broadened, 13 mm long and max. 6 mm broad, upper part straight with distinct bunch of veins, thin veins gradually originated, forked, lower part broadened at 40°, both parts meeting, creating a terminal lobe. Fragments of wings identical in morphology, 15 mm and 18 mm long and max. 11 mm and 8 mm broad, minimum 2 mm and 4 mm broad in part of missing endocarps.

Remarks. On the basis of morphological similarity, these fragments of samaras could be assigned to samples, which are associated with the leaves of *Acer dasycarpoides* HEER as mentioned by Bůžek (1971, pl. 40, figs 3 - 5), or with the leaves of *Acer tricuspidatum* BRONN sensu Procházka et Bůžek also mentioned by Bůžek (1971, pl. 35, figs 7, 8, 10, 12; pl. 36, figs 3, 4, 10, 11). The complete samara is morphologically identical with the occurrences from the Pětipsy area, which were described in association with *Acer tricuspidatum*. Individual fragments of samaras can be interpreted as the fruit remains of both mentioned species of *Acer* L. This statement is corroborated also by the fact that the foliage of these taxa and samaras co-occur, on the localities Velká Černoc and Holedeč.

Simaroubaceae

Ailanthus DESF.

Ailanthus confucii UNGER 1850

Pl. 6, fig. 4, text - fig. 3.39

1850c *Ailanthus confucii* UNGER, p. 23.
1859 *Ailanthus confucii* UNG.; Heer, p. 87, pl. 127, fig. 36.
1866 *Ailanthus confucii* UNG.; Unger, p. 54, pl. 17, figs 6, 7.

Material. Only 2 incomplete impressions of samaras, Holedeč, Nesuchyně.

Description. Winged samaras oblong to elliptic, 32 mm and 15 mm long, 8 mm and 6 mm broad, apex acute, base not preserved, probably cuneate, margin entire; endocarps elliptic to oval, central, 4 mm long, 3 mm and 2 mm broad, sculptated by thin veins, creating polygonal net; venation of wing parallel, thin veins arising from endocarp to apex, relatively strong veins run probably from base, innervating endocarp, creating polygonal net around seed area, other thin parallel veins at margin, running from base to apex.

Remarks. The material is possible to assign to *Ailanthus confucii* UNGER on the basis of morphological parameters of fruits (see, e. g., Heer 1859, Unger 1866, Weyland 1937, Žilin 1967). Fragmentary specimens of similar size, form and venation of the endocarp, separated by washing, were described under the same name (see Negru 1972) or as *Ailanthus tertiaria* DOROFFEEV (see, e. g., Kolalovskij 1958, Dorofeev 1963). According to Bůžek, Holý and Kvaček (1996), *Ailanthus confucii* UNG. represents a young element of the Europan Tertiary, which became a common element of European floras till the Late Miocene. According to Krištofovič et al. (1956) and Žilin (1967), this species occurred also in the Oligocene of Asia. However, Oligocene occurrences from Europe are different and do not match samples from the Miocene. The oldest of the latter are considered the occurrences from the Lower and Middle Miocene from Hungary (see Pálfalvy 1950, 1965) and Romania (see Sitár et al. 1978).

Fruits of this species are usually compared with the recent species *A. altissima* (MILL.) SWINGELE (syn. *A. glandulosa* DESF., *A. peregrina* (BUCHOLZ) F. A. BARKLEY). These gigantic trees are typical of forests of south China.

Rhamnaceae

Paliurus MILL.

Paliurus tiliaefolius (UNGER 1847) BŮŽEK 1971

Pl. 6, fig. 11, Pl. 7, fig. 11, text - figs 3.28, 3.29

1847 *Ceanothus tiliaefolius* UNGER, p. 143, pl. 49, figs 1-6.
1847 *Paliurus favonii* UNGER, p. 147, pl. 50, figs 6 (fructus), 7, 8.
1859 *Ziziphus tiliaefolius* (UNG.) HEER, p. 75, pl. 123, figs 1-7.
1869 *Ziziphus tiliaefolius* (UNG.) HEER; Ettingshausen, p. 39, pl. 50, figs 8, 14, 15, 17, 18.
1881 *Zizyphus tiliaefolius* (UNG.) HEER; Velenovský, p. 41, pl. 8, figs 22-23.
1904 *Paliurus friči* BRABENEC, p. 18, pl. 1, fig. 11a.
1971 *Paliurus tiliaefolius* (UNG.) BŮŽEK, p. 74, pl. 33, figs 1-21, pl. 34, figs 1-17.

Material. Only 1 incomplete leaf G 7635, 1 fruit G 2564 (original material Brabenec 1904), Holedeč.

Description. Leaf slightly asymmetric, ovate, triveined, 35 mm long and 29 mm broad, base round, apex not preserved, probably acute or obtuse, margin probably subentire, poorly preserved; midrib straight, strong, lateral primary veins thin, opposite, originating at 35 to 40°, converging towards margin; secondary veins and venation of higher order not preserved. Fruit flatted, disc-shaped, orbicular in outline, with flat wing forming a rim around whole nut, 18 mm long and 13 mm broad, wing unequally broad, margin fine undulated with radial veins spreading from the centre; seed area round, 7 mm long and 5 mm broad, divided Y – like in 3 segments.

Remarks. Identification of this incomplete leaf impression with *Paliurus tiliaefolius* (UNG.) BŮŽEK is based on characteristic triveined primaries and other morphologic features in common with the material from the locality Čermníky (Bůžek 1971). For assigning of the fruit, the main character is a typical radial division in 3 segments, which is diagnostic for fruits of the genus *Paliurus* MILL. Unger (1847) described such leaves as *Ceanothus tiliaefolius* UNG. from the locality Bílina on the basis of resemblance with the recent species *C. americana* L. Likewise on the basis of comparison with the recent species *Zizyphus mucronata* WILLD. and *Zizyphus jujuba* MILL., Heer (1859) regarded similar impressions of these leaves as belonging to *Zizyphus* MILL. From the locality Čermníky, morphologically similar leaves were found in association with the fruits, which safely belonged to the genus *Paliurus* MILL. Leaves from this locality show specific morphological characteristics, which makes it possible to assign them to the genus *Paliurus* (cordate and symmetric leaves with serrate to subentire margin) or to the genus *Ziziphus* (broadly crenulate margin). Nevertheless, exceptions exist there (e. g., *P. ramossissima* POIP.). Similar fruits occur also in other localities, e. g., Záhoří near Žatec (Pl. 7, fig. 7), Březánky and Zabrušany (see Ettingshausen 1869).

This taxon was probably a fruticose element, distributed on wetland habitats, like today in East Asia (e. g., *P. ramossissima* POIR.), in the formation of the Mixed Mesophytic Forest (Kvaček and Bůžek 1982).

Vitaceae

Vitis L.

Vitis stricta (GOEPPERT 1855) KNOBLOCH 1969

Pl. 6, fig. 7, Pl. 7, fig. 13, text - fig. 3.35

1854 *Vitis teutonica* AL. BRAUN, p. 147, pl. 3.
1855 *Acer strictum* GOEPPERT, p. 35, pl. 23, figs 1-5.
1861 *Vitis teutonica* AL. BR.; Unger, p. 23, pl. 9, figs 1-8.
1885 *Vitis teutonica* AL. BR.; Engelhardt. p. 342, pl. 10 (17), figs 1, 6, 7.
1887 *Platanus aceroides* GOEPP.; Staub, pp. 298-303, pl. 27, fig. 4.
1904 *Acer magnum* VELEN.; Brabenec, p. 20.
1955 *Vitis teutonica* AL. BR.; Berger, p. 103, text-figs 152, 153.
1969 *Vitis strictum* (GOEPP.) KNOBLOCH, p. 125, pl. 64, fig. 9, text-fig. 296.

Material. About 10 fragments of leaves (impressions), Holedeč, Nesuchyně.

Description. Leaves asymmetric, palmately 3-lobed, 25 to 93 mm long, 35 to 68 mm broad, apices acute, base broadly or deeply cordate, rarely with fragment of petiole (20 mm long), central lobe distinct triangular, lateral lobes triangular in basal part broadened, sinuses round, open; margin irregular dentate; venation basal actinodromous, 5 primary veins strong, moderate, innervating apices of lobes or big teeth in basal part, originating at 44 to 55°; secondary venation simple craspedodromous, tertiary veins straight or forked, innervating apeces or sinuses of teeth.

Remarks. The above-described samples of incomplete leaves are possible to assign to *Vitis stricta* (GOEPP.) KNOBLOCH on the basis of morphological resemblances with the leaves, which were described in earlier monographs (e. g. Knobloch 1969, pl. 64, fig 9 and Mai and Walther 1991, pl. 38, fig. 1, text-figs 6/12). Main features for determination are asymmetry of lobed leaves, typical margin and innervating. I refer to *Vitis stricta* (GOEPP.) KNOBLOCH also the original material of Brabenec, which was described as *Acer magnum* VELEN. (Brabenec 1904), for a different type of the primary venations, which is not so typical of *Acer tricuspidatum* BRONN sensu Procházka et Bůžek (see Procházka and Bůžek 1975, p. 74).

Vitis stricta is a vine represented in riparian forests of temperate to subtropical zones of the Norther n Hemisphere. This species is usually compared with the recent North American *Vitis cordifolia* MICHX. (Knobloch 1969).

Vitis teutonica AL. BRAUN 1854

Pl. 2, fig. 8

1854 *Vitis teutinica* AL. BRAUN, p. 147, pl. 3, figs 8-15.

Material. Only 2 complete seeds, Nesuchyně.

Description. Seed obovate, 3.5 mm long and 3 mm broad. Apex blunt to emarginate, base round to cuneate, chalasa oval, partly visiable on adaxial side; surface sculptation not preserved.

Remarks. Relatively small seeds are referred herein to *Vitis teutonica* AL. BR. on the basis of morphological similarity with the seeds, which have been described by Mai (1997, pl. 11, figs 11 - 12). Main features for determination are morphological resemblance in form, size of seeds and the size of chalasa. According to these differences, the seeds of *Vitis teutonica*. can be differentiated from those of *Vitis lusatica* CZECZOTT et SKIRGIELLO (see, e. g., Mai and Walther 1991, Mai 1997). The types from the Middle Miocene locality Salzhausen (Braun 1854) and likewise the material described by Ludwig (1860) and Unger (1861) are insufficiently diagnosed and figured, therefore later authors coped with the same problems. Mai and Gregor (1982) revised all the so far described fossil material and they newly re-defined this species (Mai and Gregor 1982).

According to Mai (1997), the recent analogue of *Vitis teutonica* AL. BR. is probably a representative from the group of South Asian species, as, e. g., *Vitis balsamaeana* PLANCHON (Hainan) or *Vitis thunbergii* SIEB. et ZUCC. (Japan, China, Korea, Taiwan).

Oleaceae

cf. *Fraxinus* sp.

Pl. 5, fig. 1, text - fig. 3.43

Material. Only 1 fragment of leaf Nn - 27 (impression), Nesuchyně.

Description. Leaf probably elliptic or obovate, 54 mm long and 22 mm broad, apex not preserved, base round with fragment of petiole (5 mm long); margin regularly serrate; venation brochidodromous, midrib distinct, strong, straight, moderate; secondary veins looping, distinct, thin, alternate, originating at 65 to 84°, interspaces 4 to 8 mm broad; tertiary veins distinct, percurrent, rarely forked, innervating serrate sinuses between teeth, venation of higher orders not preserved.

Remarks. The identification of the specimen as cf. *Fraxinus* sp. is based on the characteristic leaf morphology (venation brochidodromous, innervating sinuses between teeth, and the whole habit) and comparison with the leaf impressions, which were described by Knobloch (1969) and Knobloch and Kvaček (1976). Owing to poor preservation of the material, cuticle was not possible to separate. Therefore an alternative reference directly to *Fraxinus ungeri* (GAUDIN) KNOBLOCH et Z. KVAČEK (or *F. bilinica* (UNG.) Z. KVAČEK et HURNÍK) is inconclusive, but possible. A similar course of the venation is known in *Juglans juglandiformis* (STERNB.) GIEBEL. However, the margin of leaves (see, e. g., Bůžek 1971, pl. 11, fig. 7) has other characters than in our sample (Nn - 27).

Recent analogues are probably species of ash, distributed in the moist habitats, like riparian forests from the southeast USA or in the mountain subtropical zone of Assam (Kvaček and Bůžek 1982).

Hydrocharitaceae

Stratiotes L.

Stratiotes kaltennordheimensis (ZENKER 1833) KEILHACK 1896

Pl. 6, fig. 3

1833 *Folliculites kaltennordheimensis* ZENKER, p. 177, pl. 4, fig. A 3-7.

1896 *Stratiotes kaltennordheimensis* (ZENKER) KEILHACK, p. 504.
1949 *Stratiotes kaltennordheimensis* (ZENKER) KEILHACK; Němejc, p. 29, pl. 2, figs 1-3.

Material. Only 2 complete seeds, Holedeč.

Description. Seeds oblong, cylindric, towards ends slightly flatted, 6 mm and 5 mm long, 2 mm and 2.1 mm broad, dorsal and ventral part convex, apex round, symmetric, base asymmetric, ventrally hooked, collar distinct, basoventral, oblong flatted, verged into neck and then distinct keel bordering dorsal part to apex, micropyle basoventral, sub-basal, surface structure distinctly sculptated with parallel striae.

Remarks. Two complete seeds can be assigned to *Stratiotes kaltennordheimensis* (ZENK.) KEILH. on the basis of the form and the size of seeds. This species is based on the type material from the Lower Miocene locality Kaltennordheim in Germany (Zenker 1833), which was described as *Folliculites kaltennordheimensis* ZENK. Later, such seeds were found and described from many other localities (see Holý and Bůžek 1966, p. 127) and extended the stratigraphical range of this taxon from the Upper Oligocene to the Middle Miocene. Keilhack (1896) recognized an analogue of these seeds with the recent genus *Stratiotes* L. and created a new combination *Stratiotes kaltennordheimensis* (ZENKER) KEILHACK. In the area of the Most Basin and of the Central Bohemia this species was described from many localities, including Klínec (see, e. g., Reuss 1840, Kettner 1912, Kunský 1929, Němejc 1949, Bůžek and Holý 1963, 1964, Holý in Čtyroký et al. 1964). Holý and Bůžek (1966) re-evaluated the original opinion of Němejc (1949) on the correlation of sediments of the Klínec phase with the overlying complex of the Most Basin, which was based on occurrences of the seeds of *S. kaltennordheimensis*. After a detailed floristic investigation of the deposits of the Žatec facie, Holý and Bůžek (1966) correlated the Klínec phase with the lower levels of the coal - bearing formation of the Most Basin.

The seeds of *Stratiotes kaltennordheimensis* are similar to the recent species *Stratiotes aloides* L., which is distributed in stagnant to slow running waters of the cold temperate zone in the Northern Hemisphere (Holý and Bůžek 1966).

Zingiberacecae

Zingiberoideophyllum KRÄUSEL et WEYLAND

Zingiberoideophyllum liblarense KRÄUSEL et WEYLAND 1954

Pl. 5, fig. 6

1954 *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND, p. 120-121, pl. 23, figs 1-4.
1976 *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND; Knobloch and Kvaček, p. 88, pl. 13, fig. 8, pl. 14, fig. 5, pl. 31, fig. 1, pl. 40, figs 6-7.

Material. 2 fragments of leaves VČ - 57, Nn - 154, Nesuchyně, Velká Černoc.

Description. Fragments of leaves originally probably elongated, obovate, 64 mm long and 37 mm broad, margin entire; strong costa (2 mm broad), secondary venation parallel, equally thick, at acute angles to the costa, interconnected with perpendicular cross-veins, forming quadrangular areoles.

Remarks. These remains of leaves from the localities Nesuchyně and Velká Černoc could be assigned on the basis of the typical venation to *Zingiberoideophyllum liblarense* KRÄUSEL et WEYLAND, which was described as a new species and genus of the family *Zingiberacecae* by Kräusel and Weyland (1954). These authors suggested also a connection of this species based on leaves with the fruits and seeds of *Spirematospermum wetzleri* (HEER) CHANDLER, which occurred in association on the locality Liblar. Knobloch and Kvaček (1976) confirmed this assumption and reported on the same association from the localities of the German, Bohemian and Moravian Tertiary. Impressions of *Musa bilinica* ETT. from the Late Eocene locality Kučlín are different in the fine venation. However, this species may belong to the same group of fossil monocots (Kvaček and Hurník 2000).

According to Koch and Friedrich (1971), *Spirematosermum* is similar to the recent genus *Cenolophon* BLUME, namely to *C. oxymitrum* (SCHUM.) HOLTTUM, which is distributed in Thailand.

Plantae incertae sedis

"Porana" macrantha HEER 1859 var. *punctata* BRABENEC 1904

Pl. 7, fig. 6, text - fig. 3.36

1859 *Porana macrantha* HEER, p. 19, pl. 103, fig. 22.
1904 *Porana macrantha* HEER var. *punctata* BRABENEC, p. 23.

Material. Only 1 fragment of calyx G 2554 (original material Brabenec 1904), Holedeč.

Description. Calyx originally 5-merous, 3 sepals only preserved, oblong to ovate, 18 mm long and 6 to 7 mm broad, apex obtuse, bases broadly cuneate, in contact together on nodus, orbicular (2 mm diameter), margin entire; 5 to 7 veins, running from bases, multiple branched, creating oblong polygonal areoles, distinctly punctate.

Remarks. The fragment of a calyx must be left in a previsionally designated taxon *"Porana" macrantha* HEER var. *punctata* BRABENEC. Brabenec (1904) assigned it on the basis of resemblance with the impression of calyx described and figured by Heer (1859). The new variety differs in a distinct punctate pattern of individual polygonal areoles. The validity and reference of this taxon to the genus *Porana* L. are doubtful, but the solution of this problem is beyond the scope of this work.

"Ficus" truncata HEER 1859 sensu Bůžek 1971

Pl. 3, fig. 5, text - fig. 3.44

1859 *Ficus truncata* HEER, p. 183, pl. 152, fig. 15.
1859 *Ficus rüminiana* HEER, p. 183, pl. 152, figs 11, 12 (?).
1866 *Populus mutabilis* HEER; Ettingshausen, p. 85, pl. 22, fig. 11.
1866 *Ficus titanum* ETTINGSHAUSEN, p. 77, pl. 22, fig. 12.
1881 *Ficus truncata* HEER; Velenovský, p. 29, pl. 6, fig. 5.
1891 *Ficus titanum* ETT.; Engelhardt, p. 163, pl. 10, fig. 17.
1954 *Magnolia ? rüminiana* (HEER) HANTKE, p. 65, pl. 10, figs 1-3.
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.

Table 1. Summary of the floristic composition on the localities: Hlavačov (Hlav.), Holodeč (Hol.), Nesuchyně (Nes.), Velká Černoc (V. Čer.), Záhoří u Žatce (Záhoří), Želeč (Žel.), Na Bendovce (Bend.)

Taxons	Localities:						
	Hlav.	Hol.	Nes.	V. Čer.	Záhoří	Žel.	Bend.
cf. *Acer sepultum*	-	♣♣	♣♣	-	-	-	-
Acer sp.	-	-	-	♣	-	-	-
Acer dasycarpoides	-	♣♣	-	-	-	-	-
Acer integerrimum	-	♣♣	♣♣	-	-	♠	-
Acer tricuspidatum	-	♣♣	-	♣♣	-	♠	-
Acer pseudomonospessulanum	-	♣♣	-	-	-	-	-
Ailanthus confucii	-	♣	♣	-	-	-	-
Alnus kefersteinii	-	♣♣	♣♣	♣♣	-	?♠	-
Alnus julianiformis	-	♣♣	♣♣	♣♣	-	♠	♠
Alnus sp.	♠	♣♣	♣♣	♣♣	-	-	-
Betula sp.	♠♣♣	♣♣	♣♣♣	♣♣	-	-	-
Betulaceae	-	♣♣	♣♣	♣♣	-	♠♣♣	-
Carpinus grandis	-	♣♣	♣♣	-	-	-	-
Carya bohemica	-	♣	-	-	-	-	-
Carya cf. *Serrifolia*	-	♣♣	-	-	-	-	-
cf. *Castanea atavia*	-	-	♣	-	-	-	-
Comptonia difformis	-	♣	♣♣	-	-	-	-
Daphnogene cinnamonifolia f. *cinnamomifolia*	-	♣♣	♣♣	-	-	♠	-
Fagus deucalionis	-	♣♣	♣	-	-	♠	-
Fagus saxonica	-	♣♣	♣♣♣	♣♣	-	♠♣	♠
"Ficus" truncata	-	♣♣	-	-	-	-	-
cf. *Fraxinus* sp.	-	-	♣	-	-	-	-
Glyptostrobus europaeus	-	♣♣	♣♣	♣♣	-	♠	-
Juglans acuminata	-	♣	-	-	-	-	-
Leguminosites tobischii	-	♣♣	-	-	-	-	-
Liquidambar europaea	♠♣♣	♣♣♣	♣♣♣	-	-	♠	-
Koelreuteria reticulata	-	♣♣	-	-	-	-	-
Mahonia bilinica	-	-	♣♣	-	-	-	-
Myrica sp.	-	-	♣♣	-	-	♠	-
Paliurus tiliaefolius	-	♣	-	-	♣	-	-
? *Persoonia* sp.	-	♣♣	-	-	-	-	-
Pinus sp.	-	-	-	♣	-	-	-
Podocarpium podocarpum	-	♣	-	-	-	-	-
Populus populina	-	♣	-	-		-	-
Populus zaddachii var. *brabenecii*	♣♣	♣♣♣	-	-	-	-	-
"Porana" macrantha var. *punctata*	-	♣	-	-	-	-	-
cf. *Potamogeton* sp.	-	-	-	-	-	♠	-
Pseudolarix schmidtgenii	♠	-	♣♣	-	-	-	-
Rosa europaea	-	♣♣	-	-	-	-	-
Rubus merianii	-	♣♣	-	-	-	-	-
Salix haidingeri	-	♣♣♣	-	-	-	-	-
Salix macrophylla	-	-	♣	-	-	-	-

Taxons	Localities:						
	Hlav.	Hol.	Nes.	V. Čer.	Záhoří	Žel.	Bend.
Salix varians	♠ ♣	♣ ♣ ♣	♣ ♣ ♣	♣	-	-	♠
Salvinia reussii	-	♣ ♣ ♣	♣ ♣	♣	-	♠	-
Stratiotes kaltennordheimensis	-	♣ ♣	-	-	-	-	-
Taxodium dubium	♠ ♣ ♣	♣ ♣ ♣	♣ ♣ ♣	♣ ♣	-	♠ ♣ ♣	-
Tetraclinis salicornioides	-	-	♣	-	-	-	-
Tilia brabenecii	-	-	♣ ♣	-	-	-	-
cf.*Trigonobalanopsis rhamnoides*	-	-	♣	-	-	-	-
Ulmus pyramidalis	♠ ♣ ♣	♣ ♣ ♣	♣ ♣ ♣	-	-	♠	? ♠
Ulmus sp.	-	♣	♣	-	-	-	-
"Viburnum" atlanticum	-	♣	♣	-	-	-	-
Vitis stricta	-	♣ ♣	♣ ♣	-	-	-	-
Vitis teutonica	-	-	♣ ♣	-	-	♠	-
? *Wisteria* aff. *fallax*	-	♣ ♣	-	-	-	-	-
Woodwardia muensteriana	-	-	♣	-	-	-	-
Zelkova zelkovifolia	-	♣ ♣	♣ ♣	-	-	♠	-
Zingiberoideophyllum liblarense	-	-	♣	♣	-	-	-

Classes of frequencies in samples: ♣ - 1, ♣ ♣ - 2 to 25, ♣ ♣ ♣ - more 26.
Material not available for the revision is marked by this symbol "♠" (Hlavačov - collected by Bretšnajdr and Němejc - determination by Němejc (see Bretšnajder 1952, Němejc 1953a, b) - part of material is revised by Bůžek and Kvaček (1989a); Želeč - collected by Bůžek and Kvaček – determination by Bůžek and Kvaček (1989b); Na Bendovce near Rakovníka - collected by Němejc - revised by Bůžek and Kvaček (1989a).

Material. 2 fragments of leaves (G 7752, G 7754), Holedeč.

Description. Leaves probably ovate, 63 mm and 60 mm long, 37 mm and 23 mm broad, apex acute, base broadly cuneate, margin entire; venation basal actinodromous, 3 and 5 primary veins strong, moderate, innervating apices, lateral veins thinner, originating at 30°; secondary veins looping, distinct, originating at 30 to 60°; tertiary veins distinct, thin, percurrent or forked, originating at right angle; venation of higher order poorly preserved, creating with tertiary venation irregular polygonal net.

Remarks. The material is possible to assign to *"Ficus" truncata* HEER sensu Bůžek, a species with a doubtful taxonomic position. The designation is based on morphologic features, mainly the entire margin and character and course of venation. The new content of this taxon given by Bůžek (1971) is based on morphologic resemblance of the original material, which was earlier described under various names as *Ficus truncata* HEER, *Ficus rüminiana* HEER, *Ficus titanum* ETT. and *Populus mutabilis* sensu Ett. (non Heer). *Ficus trun-cata* HEER (Heer 1859) was described from the locality Öhningem for the first time. A similar leaf from Zabrušany (Ettingshausen 1866) is a type of *Ficus titanum* ETT. Another sample was described as *Populus mutabilis* HEER by the same author from the locality Břežanky. Its morphological parameters correspond with the new concept of *Ficus truncata* HEER sensu Bůžek. *Ficus rüminiana* HEER was originally based on two leaf fragments (Heer 1859). The first one was described from the locality Öhningen and is morphologically acceptable for the newly emended Bůžek's taxon. The second sample, a leaf from the locality Schrotzburg, is not compatible. Likewise, Weyland (1934) and Kräusel (1938) assumed the identity with *Ficus truncata* HEER.

The systematic position of *"Ficus" truncata* HEER sensu BŮŽEK and its recent analogue is problematic. Hantke (1954) saw a resemblance with the genus *Magnolia* L., which was criticized by Kvaček (1960). According to Bůžek (1971), *"Ficus" truncata* is morphologically similar to *Halesia diptera* ELLIS, which is distributed in North America.

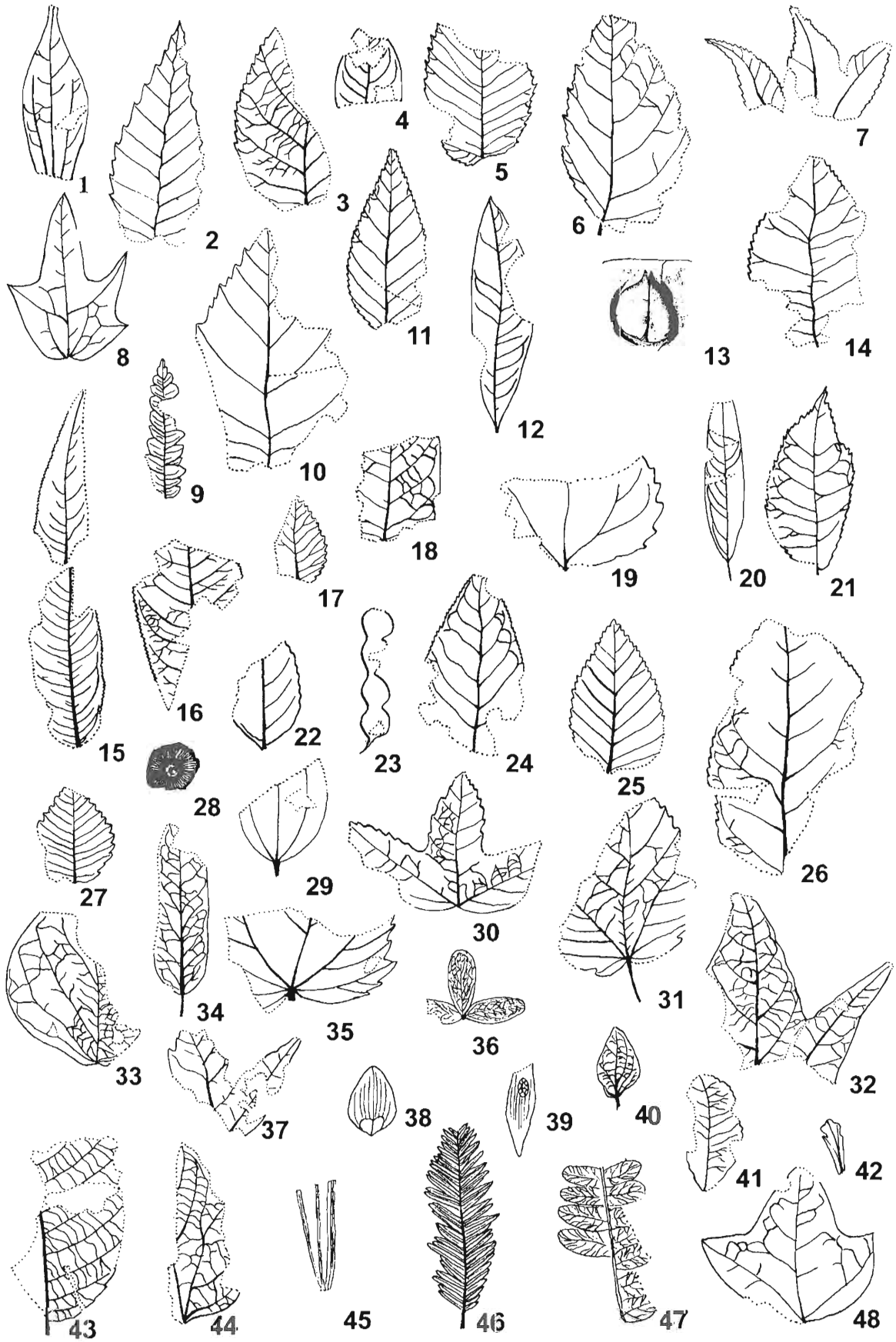
"Viburnum" atlanticum ETTINGSHAUSEN 1866

Pl. 2, fig. 6, text - fig. 3.41

1868 *Viburnum atlanticum* ETTINGSHAUSEN, p. 209, pl. 36, fig. 2.
1885 *Viburnum atlanticum* ETT. partim; Engelhardt, p. 332, pl. 15, figs 14, 18, non figs 15-17.
1891 *Viburnum atlanticum* ETT.; Engelhardt, p. 172, pl. 11, figs 15, 16.

Material. 2 leaf fragments Nn - II, G - 389 (impressions), Holedeč, Nesuchyně.

Description. Leaves elliptic, 39 mm long a 18 mm broad, apices not preserved, probably acute or obtuse, base asymmetric, cuneate, margin broadly serrate or crenulate with rounded teeth (3 mm broad in base); venation simple craspedodromous to semicraspedodromous, midrib strong, moderate, straight or secondary curved; secondary veins opposite, branched at midrib; tertiary veins thin, forked, rarely percurrent, originating at acute angles (perpendicular to midrib); venation of higher order



Text-fig. 3. Floral picture of the localities from the Hlavačov and the Holedeč deposits (x 0.5 - Holedeč (Hol), Nesuchyně (Nn), - Velká Černoc (VČ), Záhoří at Žatce (Zah)). (captions continue on p. 131)

poorly preserved, creating with tertiary venation dense polygonal net.

Remarks. The material can be referred to *"Viburnum" atlanticum* ETT., whose taxonomical position is uncertain. This species was originally described by Ettingshausen (1868) from the locality Žichov, by Engelhardt (1891) from the Most Basin and also from the locality Kundratice (Engelhardt 1885). Leaves, which were described from the Most Basin, have a large variability in the form and character of the margin. However, the leaves are absolutely of the same type and the course of venation, which proves its identical systematic alliance. Bůžek (1971) notes, that a comparison of *"Viburnum" atlanticum* ETT. with the genus *Viburnum* L. is improbable owing to large leaf morphological variability of the latter. Bůžek (1971) suggests potential affinities of this taxon to the families Theaceae (*Camellia* L.), Rutaceae (*Phellodendron* RUPR.), Rosaceae (*Prunus* L.) or Myrsinaceae (*Rapanea* AUBEL.). The affinity to Theaceae is supported by the seeds of *Eurya stigmosa* (LUDW.) MAI from the Most Basin and the České Středohoří Mts. (see Bůžek and Holý 1964).

It is probably a subtropical, thermophile element, which can be an evergreen component of the Mixed Mesophytic Forest.

? ***Persoonia*** sp. sensu Brabenec 1904 (bractea)

Pl. 1, fig. 12, text - fig. 3.40

1856 *Persoonia firma* HEER, p. 95, pl. 97, fig. 24.
1904 *Persoonia firma* HEER; Brabenec, p. 14.

Material. 3 complete bracts and 1 counterpart (original material Brabenec 1904), Holedeč.

Description. Bracts distinctly asymmetric, ovate, 12 to 25 mm long, 5 to 13 mm broad, apex obtuse, base narrowly round with strong petiole, 3 to 4 mm long and 1.5 mm broad; margin entire; 4 to 5 veins arising from base strong, undulate in course, compressed in one part by base, lateral veins brochidodromous, running along margin, curved to midrib, venation of higher orders strong, often forked, creating a dense polygonal net.

Remarks. The above-described fossils are probably bracts of an unknown plant. This statement is supported by the fact that no leaf has a so distinctly asymmetric form and irregular course of venation. Brabenec (1904) originally described this material as *Persoonia firma* HEER from surroundings of Holedeče. He evidently based his determination on the comparison with the material illustrated by Heer (1856).

Ecological interpretation of vegetative cover

Individual floristic associations, which were described from the localities of the Hlavačov gravel and sand (Na Bendovce, Hlavačov, Nesuchyně, Velká Černoc and Želeč), resemble each other. Main differences of individual assemblages are in the occurrences and frequency of the above-described taxa. It is necessary to say that the abundance of species is effected also by the intensity of collections on the pertinent localities. Among elements, which occurred on most of the localities, are representatives of the families: Betulaceae (*Betula* sp., *Alnus* sp., *A. julianiformis*, *A. kefersteinii*), Taxodiaceae (*Taxodium*, *Glyptostrobus*), Salicaceae (*S. varians*), Ulmaceae (*U. pyramidalis*), Salviniaceae (*S. reussii*), Hamamelidaceae (*Liquidambar europaea*), Fagaceae (*F. saxonica*) and Aceraceae (*A. tricuspidatum*, *A. integerrimum*) - see table 1. The fossil impression material is bound to clay lenses, which are irregularly distributed within sediments of the Hlavačov gravel and sand. Their correlation in the vertical direction has not been discussed in the literature. A very remarkable phenomenon is a more frequent occurrence of clay horizons on the western bank of the sedimentary belt, which can be interpreted as a flat bank or system of oxbow lakes in the alluvial plane with lacustric sedimentation. The character of the fossil material is altogether fragmented, only with rare occurrences of complete leaf impressions, which is a typical feature of fluviatile deposits with allochtonous taphocenoses. Incompleteness of impressions and unique occurrences of some taxa agree with an allochtonous character of assemblages as well. The overall vegetation of the Hlavačov gravel and sand can be interpreted as a rela-

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1. *Daphnogene cinnamomifolia* (BRONGN.) UNG. f. *cinnamomifolia* Z. KVAČEK et WALTHER, G5154 (Hol), 2. *Fagus saxonica* Z. KVAČEK et WALTHER, Nn 140 (Nn), 3. *Betula* sp., G5218 (Hol), 4. cf. *Trigonobalanopsis rhamnoides* (ROSSM.) Z. KVAČEK et WALTHER, Nn 135 (Nn), 5. *Carpinus grandis* UNG. emend. HEER, G3664 (Hol), 6. *Alnus julianiformis* (STERNB.) Z. KVAČEK et HOLÝ, Nn 72b (Nn), 7. *Liquidambar europaea* AL. BR. in BUCKLAND, Nn 87 (Nn), 8. *Mahonia bilinica* (UNG.) Z. KVAČEK et BŮŽEK, G7162b (Hol), 9. *Comptonia difformis* (STERNB.) BERRY, Nn 62 (Nn), 10. *Alnus* sp. sensu Bůžek, VČ I (VČ), 11. *Betula* sp., Nn III (Nn), 12. *Myrica* sp., Nn 32 (Nn), 13. *Carya bohemica* BRABENEC, Brabenec (1904: pl. 1, fig. 10a), 14. *Carya serrifolia* (GOEPP.) KRÄUSEL, G5186 (Hol), 15. *Salix varians* GOEPP., Nn 35 (Nn), 16. *Salix macrophylla* HEER, G5159 (Nn), 17. *Ulmus pyramidalis* GOEPP., Nn 59 (Nn), 18. *Juglans acuminata* AL. BR. ex UNGER, G2538 (Hol), 19. *Populus populina* (BRONGN.) KNOBLOCH, G2549 (Hol), 20. *Salix haidingeri* ETT. emend. BŮŽEK, 216/61-16 (Hol), 21. *Carya* cf. *serrifolia* (GOEPP.) KRÄUSEL, G28386 (Hol), 22. *Rosa europaea* (ETT.) Z. KVAČEK et HURNÍK, Hol I (Hol), 23. *Leguminosites tobischii* ENGELH., G2555 (Hol), 24. *Rubus merianii* (HEER) KOLAKOVSKIJ, G385 (Hol), 25. *Ulmus pyramidalis* GOEPP., Nn 17 (Nn), 26. *Populus zaddachii* HEER var. *brabenecii*, 207/61-102 (Hol), 27. *Zelkova zelkovifolia* (UNG.) BŮŽEK et KOTLABA, G5171 (Hol), 28. *Paliurus tiliaefolius* (UNGER) BŮŽEK (fruit), G2564 (Hol) - illustrated by Brabenec (1904: pl. 1, fig. 11a), 29. *Paliurus tiliaefolius* (UNGER) BŮŽEK (leaf), G7635 (Zah), 30. *Acer dasycarpoides* HEER sensu Procházka et Bůžek, G2578 (Hol), 31. *Tilia brabenecii* BŮŽEK et Z. KVAČEK (leaf), G7122a (Nn), 32. *Acer integerrimum* (VIVI.) MASSAL., Nn 81 (Nn), 33. ? *Wisteria* aff. *fallax* (NATHORST) TANAI et ONOE, 1801/60-2 (Hol), 34. *Tilia brabenecii* BŮŽEK et Z. KVAČEK (bract), G7083 (Nn), 35. *Vitis stricta* (GOEPP.) KNOBLOCH, 216/61-15 (Hol), 36. *"Poorana" macrantha* HEER var. *punctata* BRABENEC, G2554 (Hol), 37. *Acer tricuspidatum* BRONN sensu Procházka et Bůžek, VČ 48 (VČ), 38. *Pseudolarix schmidtgenii* KRÄUSEL (scale), Nn 50 (Nn), 39. *Ailanthus confucii* UNG., Nn 43 (Nn), 40. ? *Persoonia* sp. sensu BRABENEC, G382 (Hol), 41. *"Viburnum" atlanticum* ETT., Nn II (Nn), 42. *Tetraclinis salicornioides* (UNG.) Z. KVAČEK, Nn 39 (Nn), 43. cf. *Fraxinsus* sp., Nn 27 (Nn), 44. *"Ficus" truncata* HEER sensu Bůžek, 196/61-1 (Hol), 45. *Pinus* sp., VČ 64 (VČ), 46. *Taxodium dubium* (STERNB.) HEER, Nn 103 (Nn), 47. *Woodwardia muensteriana* (C. PRESL in STERNB.) KRÄUSEL, Nn 51 (Nn), 48. *Acer pseudomonspessulanum* UNG., G2553 (Hol).

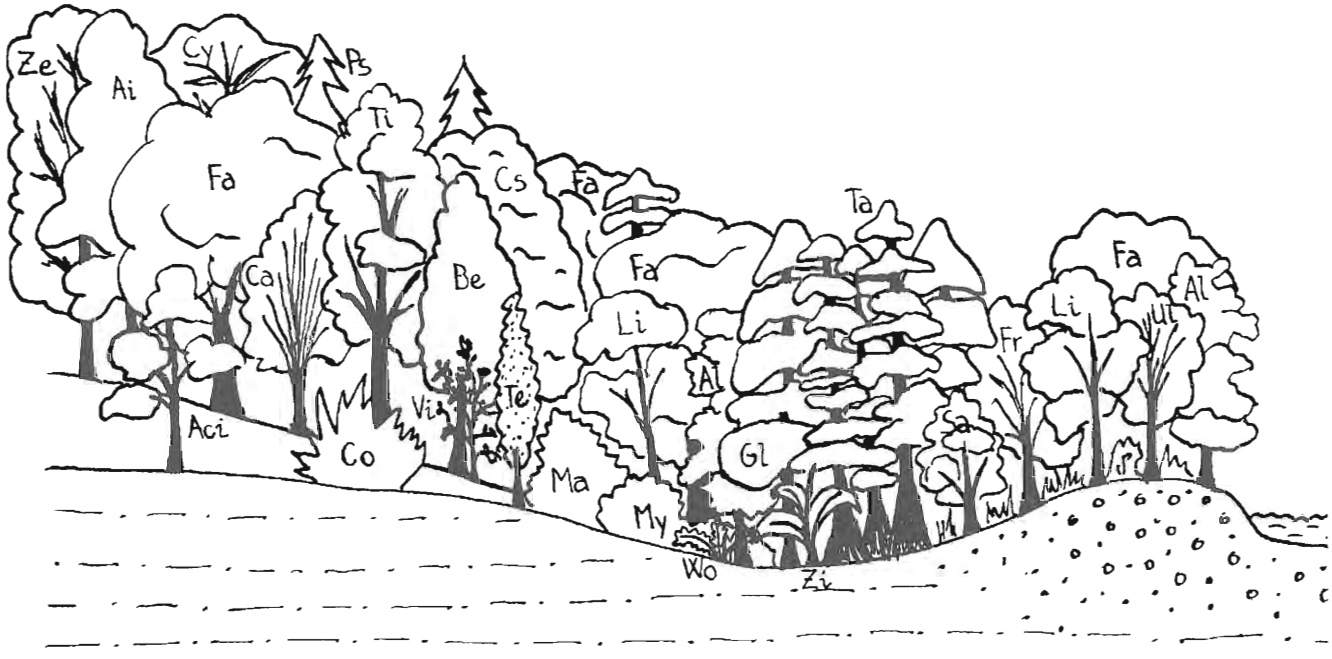
tively temperate riparian forest with dominating *Taxodium dubium*, *Fagus saxonica*, *Salix varians*, *Liquidambar europaea* and the families Betulaceae, Ulmaceae, and with accessory elements of the Mixed Mesophytic Forest, as, e. g., *Pseudolarix schmidtgenii*, *Tilia brabenecii*, *Acer integerrimum*, "*Viburnum*" *atlanticum*. This interpretation to asume a colder climatic phase reflected by this vegetation may not be valid for all the area of the Most Basin. According to Kvaček (personal communication), the riparian vegetation has mostly colder aspects in comparison with the zonal vegetation.

The described plant association of the Hlavačov gravel and sand has a specific relation to the flora from the clay of the lower part of the Žatec facies (Brabenec 1904), in which *Fagus saxonica* was newly described including cupules of *F. deucalionis* (Bůžek and Kvaček 1989a). It is the only reliable occurrence of *Fagus* L. in the whole area of the Most Basin. Just the representatives of this genus are the main common elements in the flora of the Hlavačov deposits. On the other hand, floristic differences of these associations are, e. g., in the dominant representation of *Populus zaddachii* var. *brabenecii* in the Žatec area (only 2 incomplete impressions from Hlavačov), as well as an abundant occurrence of *Salix haidingerii* and *Acer dasycarpoides*, *A. pseudomonospessulanum*, *Paliurus tiliaefolius* and representatives of the family Juglandaceae (in detail see table 1). It is possible to interpret sedimentary conditions on the locality Holedeč as an oxbow lake or lacustric sedimentation, e. g., in a form of small isolated lakes on the periphery of the basin or directly on the basin border. This taphocoenose is altogether of parautochtonous character with rare allochtonous layers. It can be said in general, that in the plant association from the locality Holedeč, dominant elements are representatives of Aceraceae, Salicaceae (*Salix*, *Populus*), Juglandaceae (*Carya*, *Juglans*), Taxodiaceae (*Taxodium*, *Glyptostrobus*), Ulmaceae (*Ulmus*, *Zelkova*) and relatively accessory occurrences of Betulaceae (*Betula*, *Alnus*, *Carpinus*) and Fagaceae (*Fagus*). In comparison with the localities from the Hlavačov gravel and sand, futher differences are apparent in new mainly mesophytic elements, as, e. g., *Leguminosites tobischii*, *Koelreuteria reticulata*, *Paliurus tiliaefolius*, *Podocarpium podocarpum*, *Rosa europaea*, and ? *Wisteria* aff. *fallax*. An increasing representation of relatively thermophilic elements and decrease of relatively colder deciduous elements can be interpreted as a more marked connection of the Holedeč flora with that of the basin rather than vegetation of the riparian type. This hypothesis can explain the presence of *Fagus saxonica* and other riparian elements as ecotonal minority elements.

Reconstruction of the vegetation cover on the locality Nesuchyně

Generally, three partial ecological associations can be distinguished, which are bound to specific environmental conditions. These associations mutually integrate on their ecotones (see text-fig. 4).

1. **Association of wet soils** is typical of plants, which prefer the waterlogged substrate, as it is characteristic of riparian ecosystems: *Ulmus pyramidalis* (E3), *Alnus julianiformis* (E3), *Alnus* sp. (E3), *Fagus saxonica* (E3), *Liquidambar europaea* (E3), *Salix macrophyla* (E2), *Salix haidingeri* (E2) and *Fraxinus* sp.(E3).



Text-fig. 4. Reconstruction of vegetation cover on the locality Nesuchyně
Aci - *Acer integerimum*, **Al** - *Alnus* **sp.**, *Alnus julianiformis*, **Ai** - *Ailanthus confucii*, **Be** - *Betula* **sp.**, **Ca** - *Carpinus grandis*, **Co** - *Comptonia difformis*, **Cs** - *Castanea atavia*, **Cy** - *Carya serrifolia*, **Fa** - *Fagus saxonica*, **Fr** - *Fraxinus* **sp.**, **Gl** - *Glyptostrobus europaeus*, **Li** - *Liquidambar europaea*, **Ma** - *Mahonia bilinica*, **My** - *Myrica* **sp.**, **Ps** – *Pseudolarix schmidtgeni*, **Sa** - *Salix varians*, **Ta** - *Taxodium dubium*, **Te** - *Tetraclinis salicornioides*, **Ul** - *Ulmus pyramidalis*, **Vi** - *Vitis stricta*, **Wo** - *Woodwardia muensteriana*, **Ze** - *Zelkova zelkovifolia*, **Zi** - *Zingiberoideophyllum liblarense*

Text-fig.5. Reconstruction of vegetation cover on the locality Holedeč (maximal floading)
Ac - *Acer tricuspidatum*, **Acp** - *Acer pseudomonospesulanum*, **Acd** - *Acer dasycarpoides*, *Acer integerrimum*, **Ai** - *Ailanthus confucii*, **Al** - *Alnus* sp., *Alnus julianiformis*, **Be** - *Betula* sp., **Ca** - *Carpinus grandis*, **Co** - *Comptonia difformis*, **Da** - *Daphnogene cinnamomifolia* f. *cinnamomifolia*, **Fa** - *Fagus saxonica*, **Gl** - *Glyptostrobus europaeus*, **Ju** - *Juglandaceae*, **Ko** - *Koelreuteria reticulata*, **Le** - *Leguminosites tobischii*, **Li** - *Liquidambar europaea*, **Pa** - *Paliurus tiliaefolius*, **Pd** - *Podocarpium podocarpum*, **Po** - *Populus zaddachii* var. *brabenecii*, **Ro** – *Rosa europaea*, **Ru** - *Rubus merianii*, **Sa** - *Salix varians*, **Sah** - *Salix haidingeri*, **St** - *Stratiotes kaltennordheimensis*, **Sv** - *Salvinia reussii*, **Ta** - *Taxodium dubium*, **Ul** - *Ulmus pyramidalis*, **Vi** - *Vitis stricta*, **Ze** - *Zelkova zelkovifolia*

2. **Association of back swamps** is typical of plants, which more or less prefer environment with stagnant water table or periodical, relatively long-lasting floods. These associations are characteristic of basins or areas of oxbow lakes: *Taxodium dubium* (E3), *Glyptostrobus europaeus* (E3), *Alnus julianiformis* (E3), *Acer tricuspidatum* (E4) - only on the locality Velká Černoc, *Woodwardia muensteriana* (E2), *Salix varians* (E2), *Zingiberoideophyllum liblarense* (E2), *Myrica* sp. (E2) and *Salvinia reussii* (E1).

3. **Association of slopes** is typical of mesophytic elements (Mixed Mesophytic Forest type), which are in principle in the humid enviroment, but do not tolerate much waterlogged soils: *Pseudolarix schmidtgenii* (E4), *Ailanthus confucii* (E4), *Tilia brabenecii* (E4), *Acer integerrimum* (E3), *Mahonia bilinica* (E2), *Tetraclinis salicornioides* (E3), *Trigonobalanopsis rhamnoides* (E4), *Castanea atavia* (E4), *Daphnogene cinnamomifolia* f. *cinnamomifolia* (E3), *Comptonia difformis* (E2), *Carpinus grandis* (E3), *Carya serrifolia* (E4), *Zelkova zelkovifolia* (E4), "*Viburnum*" *atlanticum* (E2), *Betula* sp. (E3), *Vitis stricta* (E2).

Reconstruction of the vegetation cover on the locality Holedeč

As on the locality Nesuchyně, also at Holedeč, three partial ecological associations can be distinguished (see text-fig. 5).

1. **Association of back swamps**: It includes *Taxodium dubium* (E3), *Glyptostrobus europaeus* (E3), *Alnus julianiformis* (E3), *Acer tricuspidatum* (E4), *Salix varians* (E2), *Salvinia reussii* (E1), *Stratiotes kaltennordheimensis* (E1), *Rubus merianii* (E2).

2. **Association of wet soils**: It is characteristic of *Ulmus pyramidalis* (E3), *Alnus julianiformis* (E3), *Alnus* sp. (E3), *Fagus saxonica* (E3), *Liquidambar europaea* (E3), *Rosa europaea* (E2), *Populus populina* (E3), *Populus zaddachii* var. *brabenecii* var. n. (E3), *Salix haidingeri* (E2).

3. **Association of slopes**: It comprises *Ailanthus confucii* (E4), *Acer integerrimum* (E3), *Acer dasycarpoides* (E3), *Daphnogene cinnamomifolia* f. *cinnamomifolia* (E3), *Comptonia difformis* (E2), *Koelreuteria reticulata* (E3), *Carpinus grandis* (E3), *Carya serrifolia* (E4), *Carya* cf. *serrifolia* (E4) *Juglans acuminata*, (E4), *Zelkova zelkovifolia* (E4), "*Ficus truncata*" (E3), "*Viburnum*" *atlanticum* (E3), *Paliurus tiliaefolius* (E2), *Betula* sp. (E3), *Vitis stricta* (E2), *Wisteria* aff. *fallax* (E2), *Leguminosites tobischii* (E3), *Podocarpium podocarpum* (E2).

Vegetative storeys: E1 - herbs, E2 - shrubs and lianas, E3 - trees under 25 m high, E4 - trees over 25 m high.

Stratigraphy and floristic correlation with Tertiary localities of Central Europe

From repeated occurrences of most species in different combinations on the studied localities of the Hlavačov gravel and sand, it can be probably deduced, that the whole floras belong to the same time interval, i. e., they are isochronic. On the other hand, cone scales of *Pseudolarix schmidtgenii* are restricted only to the localities, Nesuchyně and Hlavačov. This species, in combination with *Fagus saxonica* and other taxa from these localities, creates a plant assemblage, which is well comparable with the Upper Oligocene Floristic assemblage Thierbach (in sense of Mai and Walther 1991). The other localities of the Hlavačov deposits, where *Pseudolarix schmidtgenii* is absent, can be interpreted also as another development phase of the flora, and then the whole flora of the Hlavačov gravel and sand may be considered diachronic. The problem arises in the correlation of "? younger floras" with floristic assemblages of Central Europe. If we accept a more probable isochronic hypothesis of evolution, the floras of the Hlavačov gravel and sand can be well correlated with those

floras included in the mentioned Floristic assemblage Thierbach on the basis of identical occurrence of *Pseudolarix schmidtgenii*, *Fagus saxonica*, *F. deucalionis*, *Trigonobalanopsis rhamnoides* and also *Acer integerrimum*, *Vitis lusatica*, *V. stricta*. The absence of *Pseudolarix schmidtgenii* on the localities Želeč and Velká Černoc can be explained as, e. g., a local anomaly in the structure of vegetation, which is dependent on specific abiotic factors or, more probably, insufficient investigation (short-term collections) of these localities.

It can be said, that the occurrence of *Fagus saxonica* is more or less the only one linking element of the Hlavačov gravel and sand with the surroundings of Holedeč. The floristic composition of the association from the surroundings of Holedeč reflects a definite analogue with the flora, which was described from the upper inter - seam member of the Pětipsy area (Bůžek 1971). Identical taxa from both localities, as, e. g., several species of *Acer* L., *Populus zaddachii* var. *brabenecii* var. n., *Salix haidingerii*, *Salix varians*, *Paliurus tiliaefolius*, *Leguminosites tobischii*, *Wisteria* aff. *fallax*, *Podocarpium podocarpum* etc. confirmed this assumption. On the contrary, the presence of *Fagus saxonica*, which does not occur in the Pětipesy Area, stands against this asumption. Also the pollen of *Fagus* L. occurs in largest frequencies in palynological spectra of the basal coal seam in surroundings of the Chomutov and the Žatec facies (see in detail Konzalová 1976). On the basis of these stratigraphical disproportions, the presumption that the Holedeč and Pětipsy floras are diachronous can be safely accepted. According to my opinion, the flora of the locality Holedeč could be correlated also with the Floristic assemblage Thierbach from the underlyinig of the Bitterfeld Seam. This correlation is mainly coroborated by the occurrence of *Fagus saxonica* and *F. deucalionis*. Specific differences in the structure of the Holedeč flora can be explained by other ecological conditions, which resulted from the proximity of the basin. A detailed characteristic of the Upper Oligocene Floristic assemblage Thierbach is given in, e. g., by Mai (1967, 1995), Mai and Walther (1991) and Gastaldo et al. (1998).

According to Mai (1995), the flora from Nesuchyně including the flora of the Holedeč deposit as well as the Žatec beds is to be correlated with the Lower Miocene Floristic assemblage Münzenberg – Bitterfeld, i. e., floristic zone III (in sense of Mai 1967). According to my opinion, this correlation is incorrect for the absence of *F. saxonica* in this floristic assemblage and the absence of species *Eotrigonobalanus furcinervis* on the localities of the Hlavačov gravel and sand, the surroundings of Holedeč and the Žatec facies. The occurrence of *Pseudolarix schmidtgenii* is very interesting as well as a generally colder character of this floristic assemblage.

Fagus saxonica and *F. deucalionis* are also known from the localities Počerny and Podlesí, which are situated within the volcanic series of the Sokolov Basin. Their age is estimated as the Middle Oligocene (Holý 1984). Mai (1995) refers these localities to the Floristic assemblage Rott – Thierbach, Late Oligocene in age. The next problematic occurrence of leaf impressions of *Fagus saxonica* is in the locality Přívlaky (NW from Žatce), which is generally referred to the Overlying Complex. The position and correlation of this locality must be postponed until the whole flora is better studied.

Acknowledgements

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Terciérní flóra a vegetace hlavačovských štěrkopísků a sedimentů okolí Holedeče v mostecké pánvi (Česká republika)

Vasilis Teodoridis

Sedimenty pásu hlavačovských štěrkopísků a sedimenty okolí Holedeče byly intenzivně studovány již v minulém století. Hlavačovské štěrkopísky jsou litologicky charakteristické svým pestrým valounovým materiálem, kde především převládá bílý až nažloutlý křemen a černý buližník. Významným litologickým znakem je i značná jílovitost, která místy dosahuje až 8 %. Tyto říční sedimenty jsou obvykle interpretovány jako terminální zbytek původně mohutného toku "C", který odvodňoval celou oblast středních a západních Čech a ústil na Žatecku do oblasti mostecké pánve (Pešek a Spudil 1986) nebo vytvářel s tzv. tierbachšskou řekou plošně rozsáhlý říční systém, který ústil v oblasti Saska (Lotsch et al. 1994). V rámci této práce byla provedena podrobná revize otiskového materiálu, který byl nasbírán na jednotlivých lokalitách pásu hlavačovských štěrkopísků (Na Bendovce, Hlavačov, Nesuchyně, Velká Černoc, Želeč) a na lokalitě Holedeč, která již geneticky náleží spodním vrstvám žatecké facie (mostecká pánev). Terciérní flóra hlavačovských štěrkopísků je vázaná na nepravidelně rozmístěné jílovité čočky, které jsou velice obtížně vertikálně korelovatelné. Z výše uvedených lokalit bylo determinováno 58 taxonů (2 kapradiny, 5 nahosemenných a 51 krytosemenných rostlin), a to na základě morfologických znaků, neboť vlivem špatného zachování nebylo možné využít metod kutikulární analýzy. Z lokalit Holedeč a Hlavačov byl popsán nový taxon *Populus zaddachii* var. *brabenecii*. Jednotlivá rostlinná společenstva, která byla popsána z lokalit hlavačovských štěrkopísků, jsou si vzájemně velice podobná. Fosilie jsou vesměs fragmentární, jen ojediněle zcela kompletní, což je typické pro fluviatilní sedimenty s allochtonními tafocenózami. Celkově lze vegetaci těchto sedimentů interpretovat jako poměrně chladnomilný lužní les s dominancí druhů *Taxodium dubium*, *Fagus saxonica*, *Salix varians*, *Liquidambar europaea* a čeledí Betulaceae, Ulmaceae s akcesorickými elementy typu Mixed Mesophytic Forest, jako např. *Pseudolarix schmidtgenii*, *Tilia brabenecii*, *Acer integerrimum*. Floristické společenstvo pásu hlavačovských štěrkopísků má určité vztahy k flóře popsané z jílových lupků spodní části žatecких vrstev (Brabenec 1904), ve které byl nově popsán druh *Fagus saxonica*, včetně číšek druhu *F. deucalionis* (Bůžek a Kvaček 1989a), což je také jediný spolehlivý výskyt rodu *Fagus* L. v celé mostecké pánvi. Na základě dominantního zastoupení listových otisků druhu *Salvinia reussii* na lokalitě Holedeč a výskytu druhu *Stratiotes kaltennordheimensis* je možné usuzovat na sedimentaci v oblasti mrtvého ramene řeky, popř. na sedimentaci v jezerním prostředí. Tafocenóza je vesměs parautochtonního charakteru. Přibývání relativně teplomilných elementů a relativního ubývání chladnomilnějších opadavých elementů lze interpretovat spíše jako výraznější ovlivňování holedečské flóry pánevními vegetačními společenstvy, než jako vegetaci lužního typu. Z opakovaného výskytu většiny druhů v různých kombinacích na uvedených lokalitách hlavačovských štěrkopísků a

sedimentů okolí Holedeče je možné tyto flóry dobře korelovat se svrchně oligocenním floristickým komplexem Thierbach (sensu Mai a Walther 1991) ze spodní části bitterfeldské pánve. Korelace se sedimenty mostecké pánve je problematická pro neexistenci analogické flóry. Jediným vodítkem pro korelaci jsou četné nálezy pylu rodu *Fagus* L. v palynologických spektrech v bazální sloji na Chomutovsku a ve spodních uhelných vrstvách žatecké facie (Konzalová 1976).

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Explanations of the plates

PLATE 1

Salvinia reussii ETT.
1. Leaf, 227/61-4, Holedeč, x 2.5.
2. Floats, G3667, Holedeč, x 2.

Pinus sp.
3. Needles, VČ-64, Velká Černoc, x 1.5.

Taxodium dubium (STERNB.) HEER
4. Sterile twigs, Nn-103, Nesuchyně, x 1.5.

Pseudolarix schmidtgenii KRÄUSEL
5. Cone scale, Nn-50 Nesuchyně, x 2.
6. Cone scale, Nn-47, Nesuchyně, x 1.5.
9. Winged seed, Nn-51, Nesuchyně, x 2.5.

Woodwardia muensteriana (C. PRESL) KRÄUSEL
7. Frond, Nn-51 Nesuchyně, x 1.5.

Glyptostrobus europaeus (BROGN.) UNGER
8. Seed cone, VČ-52a, Velká Černoc, x 2.5.
10. Pollen cones, Nn-19, Nesuchyně, x 2.5.
11. Seed cone, VČ-52b, Velká Černoc, x 2.5.

? *Persoonia* sp.
12. Bract, G382, Holedeč, x 2.5.

Populus zaddachii HEER var. *brabenecii* var.n.
13. Leaf, G5318 (paratype), Hlavačov, x 1.5.

Podocarpium podocarpum (AL. BR.) HERENDEEN
14. Leaf, G2738, Holedeč, x 2 - photo J. Brožek.

Daphnogene cinnamomifolia (BRONGN.) UNGER f. *cinnamomifolia*
15. Leaf, G5154, Holedeč, x 1.5.

PLATE 2

Liquidambar europaea AL. BR.
1. Leaf, Nn-22, Nesuchyně, x 1.5.
11. Infructescence, 216/61-21, Holedeč, x 1.5.

Betula sp.
2. Leaf, G5218, Holedeč, x 1.5.
7. Detail of the leaf margin, G5218, Holedeč, x 2.5.
13. Leaf, Nn-97, Nesuchyně, x 1.5.

Mahonia bilinica (UNG.) Z. KVAČEK et BŮŽEK
3. Leaf, G7162a, Holedeč, x 1.5.

Fagus saxonica Z. KVAČEK et WALTHER
4. Detail of the leaf margin, Nn-76, Nesuchyně, x 2.

Carpinus grandis UNG. emend. HEER
5. Detail of the leaf margin, VČ-62, Velká Černoc, x 2.

"Viburnum" atlanticum ETT.
6. Leaf, G389, Holedeč, x 1.5.

Vitis teutonica AL. BR.
8. Fruit, Nn-98a, Nesuchyně, x 10.

Fagus deucalionis UNGER
9. Fruit, 28386-4, Holedeč, x 1.5.

Myrica sp.
10. Leaf, missing, Nesuchyně, x 1.5 - photo J. Brožek.

Tetraclinis salicornioides (UNG.) Z. KVAČEK
12. Foliage twig, Nn-39, Nesuchyně, x 3.

PLATE 3

Carpinus grandis UNG. emend. HEER
1. Leaf, VČ-62, Velká Černoc, x 1.5.

Salix haidingeri ETT. emend. BŮŽEK
2. Leaf, 216/61-15, Holedeč, x 1.5.

Comptonia difformis (STERNB.) BERRY
3. Leaf, Nn-62, Nesuchyně, x 2.

Ulmus sp.
4. Fruit, G3625, Holedeč, x 2.5.

"Ficus" truncata HEER sensu Bůžek
5. Leaf, 196/61-1, Holedeč, x 1.5.

Fagus saxonica Z. KVAČEK et WALTHER
6. Leaf, G2756, Holedeč, x 1. - photo J. Brožek.

Alnus julianiformis (STERNB.) Z. KVAČEK et HOLÝ
7. Leaf, Nn-96, Nesuchyně, x 1.5.
9. Leaf, Nn-72a, Nesuchyně, x 1.5.

Betula sp.
8. Leaf, 2201/61-4, Holedeč, x 2.

Alnus sp. sensu Bůžek
10. Leaf, Nn-72b, Nesuchyně, x 1.5.

PLATE 4

Carya cf. *serrifolia* (GOEPP.) KRÄUSEL
1. Leaf, G2563, Holedeč, x 1.5.
2. Leaf, G2752, Holedeč, x 1.5 - photo J. Brožek.

Carya serrifolia (GOEPP.) KRÄUSEL
3. Leaf, G386, Holedeč, x 1.5.
9. Leaf, G3629, Holedeč, x 1.5.

Juglans acuminata AL. BR. ex UNGER
4. Leaf, G2538, Holedeč, x 1.5.

Myrica sp.
5. Leaf, Nn-28, Nesuchyně, x 1.5.

Comptonia difformis (STERNB.) BERRY
6. Leaf, Nn-74, Nesuchyně, x 2.5.

Taxodium dubium (STERNB.) HEER
7. Cone scale, 1799/60-12, Holedeč, x 3.

Fagus saxonica Z. KVAČEK et WALTHER
8. Leaf, Nn-159, Nesuchyně, x 1.

Alnus kefersteinii (GOEPP.) UNGER
10. Infructescence, VČ-40, Velká Černoc, x 2.

cf. *Trigonobalanopsis rhamnoides* (ROSS.) Z. KVAČEK et WALTHER
11. Leaf, Nn-135, Nesuchyně, x 1.5.

? *Wisteria* aff. *fallax* (NATHORST) TANAI et ONOE
4. Leaf, 170/61-9, Holedeč, x 1.5.

PLATE 5

cf. *Fraxinus* sp.
1. Leaf, Nn-27, Nesuchyně, x 1.5.

Populus zaddachii HEER var. *brabenecii*
2. Leaf, 207/61-102 (paratype), Holedeč, x 1.
3. Leaf, G2538 (holotype), Holedeč, x 1. - photo J. Brožek.
10. Leaf, G 2547 (paratype), Holedeč, x 1.

Populus populina (BRONGN.) KNOBLOCH
4. Leaf, G2549, Holedeč, x 1.5.

Salix macrophylla HEER
5. Leaf, G5159, Nesuchyně, x 1.5.

Zingiberoideophyllum liblarense KRÄUSEL et WEYLAND
6. Leaf, Nn-154, Nesuchyně, x 1. - photo J. Brožek

Ulmus pyramidalis GOEPPERT
7. Detail of the leaf margin, Nn-59, Holedeč, x 2.5.

Rosa europaea (ETT.) Z. KVAČEK et HURNIK
8. Leaf, Hol- 1, Holedeč, x 2

? *Wisteria* aff. *fallax* (NATHORST) TANAI et ONOE
9. Leaf, 1801/60-2, Holedeč, x 1.5.

PLATE 6

Tilia brabenecii BŮŽEK et Z. KVAČEK
1. Leaf, G7122a, Nesuchyně, x 1.5.

Rubus merianii (HEER) KOLAKOVSKIJ
2. Leaf, G3851, Holedeč, x 1.5.

Stratiotes kaltennordheimensis (ZENKER) KEILHACK
3. Seed, 2201/61-4, Holedeč, x 3.

Ailanthus confucii UNGER
4. Fruit, Nn -43, Nesuchyně, x 2.5.

Fagus deucalionis UNGER
5. Fruit, Nn-121, Nesuchyně, x 2.5.

Salix varians GOEPPERT
6. Leaf, 216/61-16, Holedeč, x 1.5.

Vitis stricta (GOEPP.) KNOBLOCH
7. Leaf, 216/61-15, Holedeč, x 1.5.

Acer tricuspidatum BRONN sensu Procházka et Bůžek
8. Leaf, VČ-48, Velká Černoc, x 1.5.
13. Leaf, VČ-47, Velká Černoc, x 1.5 x.

Rosa europaea (ETT.) Z. KVAČEK et HURNIK
9. Leaf, Hol-196/1, Holedeč, x 2.5.

Zelkova zelkovifolia (UNG.) BŮŽEK et KOTLABA
10. Leaf, 182/61-108, Holedeč, x 1.5.

Paliurus tiliaefolius (UNG.) BŮŽEK
11. Fruit, G2564, Holedeč, x 2.5.

Acer dasycarpoides HEER sensu Procházka et Bůžek
12. Leaf, G2578, Holedeč, x 1.5.

PLATE 7

Tilia brabenecii BŮŽEK et Z. KVAČEK
1. Bract, G7083, Nesuchyně, x 1.5 - photo J. Brožek.

Acer pseudomonspessulanum UNGER
2. Leaf, G2567, Holedeč, x 1.5.

Acer integerrimum (VIV.) MASSALONGO
3. Leaf, VČ-66, Velká Černoc, x 1.
12. Leaf, Nn-49, Nesuchyně, x. 1.

Salix haidingeri ETT. emend. BŮŽEK
5. Leaf, 216/61-21, Holedeč, x 1.5.

"Porana" macrantha HEER var. *punctata* BRABENEC
6. Calyx, G2554, Holedeč, x 2.

Acer sp.
7. Fruit, VČ 17, Velká Černoc, x 2.5.
10. fruit, 222/61-18, Holedeč, x 3.

Leguminosites tobischii ENGELHARDT
8. Fruit, G2555, Holedeč, x 1.5.

Koelreuteria reticulata (ETT.) EDWARDS
9. Valve, G3637, Holedeč, x 1.5.

cf. *Acer sepultum* ANDRAE
10. Fruit, 1800/60-8, Holedeč, x 3.

Paliurus tiliaefolius (UNG.) BŮŽEK
11. Leaf, G7635, Záhoří by Žatec, x 1.5.

Vitis stricta (GOEPP.) KNOBLOCH
13. Leaf, G2577, Holedeč, x 1.5.