

## THE LATE EOCENE FLORA OF KUČLÍN NEAR BÍLINA IN NORTH BOHEMIA REVISITED

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**Abstract.** A detailed survey of the Late Eocene flora of the diatomite of Kučlín, the Trupelník Hill in North Bohemia, České středohoří Mountains, is given based on the morphological study of most of the so far published macrofossil records since Ettingshausen's pioneer study and many newly acquired taxa. Both extinct and some modern genera represented mostly by leaf morphotypes and less commonly by fruits and seeds have been encountered. They belong to the ferns (Osmundaceae, Thelypteridaceae, Blechnaceae etc.), conifers (Cupressaceae, Doliostrubaceae) and prevailing to Angiosperms. Representatives of e.g., Nymphaeaceae, Magnoliaceae, Lauraceae, Platanaceae, Ulmaceae, Fagaceae, Juglandaceae, Fabaceae and some more exotic families such as Icacinaceae, Simaroubaceae and Rutaceae are most numerous, while many belong to extinct groups not assignable to any modern family (e.g., *Raskya*). A considerable part of fossil taxa is not assignable to the natural system at all. In sum the flora contains according to this survey 95 taxa based on foliage and 34 taxa based on fruits and seeds. The plant assemblage of Kučlín includes both Eocene markers (*Hooleya*, *Bytneriopsis*) and a number of elements that survived till the Oligocene (*Eotrigonobalanus*) and Miocene (*Platanus neptuni*). Palaeoenvironmental and climatical proxies based on angiosperm leaf record are presented here and compared with other nearby sites of Eocene and Oligocene age. Such comparisons add information on the climatic development of central Europe in this time interval.

■ Late Eocene, plant macrofossils, north Bohemia, CLAMP, IPR-vegetation analysis

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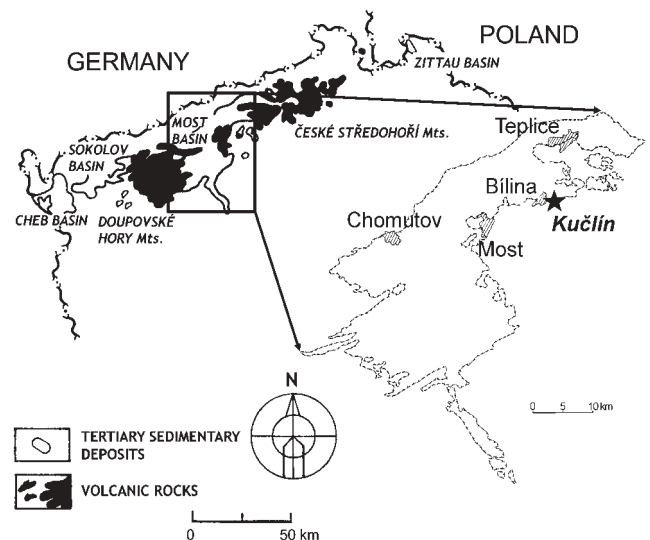
### Introduction

The diatomite of Kučlín (Kutschlin) belongs to classical palaeontological sites of Europe (Text-fig.1). The first August Emanuel Reuss (1840), the son of Franz Ambrozius Reuss, spa physician of the owner of the Bílina spa, count Lobkowitz, published detailed information on this diatomite, which crops out on slopes and the summit of the Trupelník Hill (Trippelberg in German) near the village Kučlín (Kutschlin) south of the town of Bílina. This site belongs to the most known and stratigraphically important localities of the North Bohemian Tertiary (Radoň 2001, Mach and Dvořák 2011, this volume). By the palaeontological content it deviates from the other Cenozoic “Lagerstätte” in North Bohemia in its ancient character. Also radiometric dating places it to the earliest volcanogenic deposits of the České středohoří Mountains (Bellon et al. 1998, Kvaček and Walther 2003, Kvaček and Teodoridis 2007).

The diatomite of Kučlín belongs, besides fossil plants, to the first places where studies of fossil diatoms have been initiated (Ehrenberg 1836, 1844, 1854). Later Jokély (1858) published a short account on the Kučlín fossils. Since his first collections, Reuss soon expanded collection activities carried out at Kučlín and built up a considerable collection

of fossils in the Lobkowitz castle in Bílina (now housed in the Hungarian Natural History Museum, Budapest).

Reuss reported particularly on fossil fish fauna (Reuss 1844, 1852) and carried out extensive field collections in the Kučlín diatomite. The fauna also includes insects (Deich-



Text-fig. 1. Geographical position of the locality Kučlín.

müller 1881), cancer (Mayer 1852, Frič 1872, Houša 1956), more rarely turtle (Laube 1882), a single frog (Dvořák et al. in prep.) and exceptionally some other vertebrates.

The main part of Reuss's collection of macrofossils represents fossil plants. The paleobotanical studies at Kučlín have been continued later by students of the Tertiary floras of Europe, namely Ettingshausen (1866, 1868, 1869), Sieber (1881), and Menzel (1901). The diatomite was at that time worked for filter matter in sugar industry. The palaeontological collection activities were reduced after the site was abandoned and less and less accessible. Only in 1963 the deposit was temporarily open again and fossiliferous layers in new outcrops became available (Bůžek and Holý 1964, Holý 1964). Since then the diatomite has been visited again and again, also by amateur collectors.

The present account is focused on the first detailed analysis of the Kučlín plant macrofossil assemblage after the pioneer studies by earlier palaeobotanists. So far no comprehensive revision of the fossil biota from Kučlín has been produced, although many partial studies are available after the first description by Ettingshausen (1866, 1868, 1869). The identifiable elements are evaluated here as to their systematic assessment and stratigraphical / palaeoenvironmental significance, the rest of the flora is documented mainly by illustrations to show the variety of morphotaxa although their affinities remain dubious.

## Material and methods

Most plant macrofossils are preserved as leaf impressions with fine details of the venation mostly visible under very oblique light, but without epidermal structures. Besides foliage, also fruits and seeds are available, again as flat compressed impressions without any coaly substance. This was a reason that most taxonomic studies were focused on distinguishing morphotypes and more attention was focused on palaeoenvironmental analyses, in which the following methodologies were employed.

We applied four different paleoenvironmental methods on the studied fossil flora of Kučlín. The techniques allow a reconstruction of the zonal vegetation character provided by the Integrated Plant Record vegetation analysis (IPR-vegetation analysis) and Leaf Size Analysis (LSA), and an estimation of paleoclimatic proxies derived from Climate Leaf Analysis Multivariate Program (CLAMP) and Leaf Margin Analysis (LMA).

The IPR-vegetation analysis was developed by Kovar-Eder and Kvaček (2003) as a tool for mapping the integrated fossil plant records (leaf, fruit, and pollen assemblages) in terms of the zonal vegetation (Kovar-Eder and Kvaček 2007; Teodoridis et al. 2011a, b). Methodologically, the IPR-vegetation analysis follows plant taxonomy, physiology and autecological properties to classify vegetation into several zonal and azonal taxonomic-physiognomic components, i.e., CONIFER (zonal and extrazonal conifers), BLD (broad-leaved deciduous woody angiosperms), BLE (broad-leaved evergreen woody angiosperms), SCL (sclerophyllous woody angiosperms), LEG (legume-like woody angiosperms), ZONPALM (zonal palms), ARBFERN (zonal arborescent ferns), DRY HERB (open woodland and grassland elements), MESO HERB

(mesophytic forest undergrowth), AZONAL WOODY (azonal woody tree and shrubs), AQUATIC (aquatic elements), AZNW (azonal non-woody elements) and PROBLEMATICA taxa. Percentages of the different groups/components of a fossil assemblage, i.e., percentage of the BLD and BLE components of zonal woody angiosperms, percentage of SCL + LEG, DRY HERB and MESO HERB of zonal angiosperms, have been defined to distinguish 8 zonal vegetation types including their ecotones (Teodoridis et al., 2011a, table 8): 1) temperate to warm-temperate broad-leaved deciduous forests (BLDF); 2) warm-temperate to subtropical mixed mesophytic forests (MMF); 3) subtropical broad-leaved evergreen forests; 4) subtropical, sub-humid sclerophyllous or microphyllous forests (ShSF); 5) ecotone vegetation of BLDF/MMF; 6) ecotone vegetation of BLEF/MMF; 7) xeric open woodlands; and 8) xeric grasslands or steppe (= Xeric grassland). The first four mentioned vegetation units were tested on several living vegetation types from China and Japan (Teodoridis et al. 2011a) to verify thresholds between them originally defined only on the fossil record and their "palaeoenvironmental" habitats. Recently, the new IPR-vegetation database was built to organize and summarize the existing fossil and modern results (Teodoridis et al. 2011a, b, c the present volume).

Climate Leaf Analysis Multivariate Program (CLAMP) is based on the multivariate statistical technique for quantitative determining a range of palaeoclimate parameters based on leaf physiognomy of woody dicotyledonous flowering plants. CLAMP has first been introduced by Wolfe (1993) and subsequently this technique has been refined mainly by Wolfe and Spicer (1999), Spicer et al. (2004) and Spicer (2000, 2007), Spicer et al. (2009), Teodoridis et al. (2011b, c), Yang et al. (2011). The CLAMP employs 31 different leaf physiognomic characteristics (see Table 1) to estimate 11 climatic parameters, i.e., MAT (Mean Annual Temperature), WMMT (Warmest Month Mean Temperature), CMMT (Coldest Month Mean Temperature), GROWSEAS (Length of the Growing Season), GSP (Growing Season Precipitation), MMGSP (Mean Monthly Growing Season Precipitation), 3-WET (Precipitation during 3 Consecutive Wettest Months), 3-DRY (Precipitation during 3 Consecutive Driest Months), RH (Relative Humidity), SH (Specific Humidity) and ENTHAL (Enthalpy). Mathematically, this method is based on Canonical Correspondence Analysis (CCA) – see Ter Braak (1986). To select relevant CLAMP physiognomic datasets from 144, 173 and 189 modern sites and relevant modern gridded meteorological calibration datasets (i.e., Physg 3br, Physg 3ar and PhysgAsia1; GRIDMet3b, GRIDMet3a and GRIDMetAsia1), we used an updated version of the special tool developed by Teodoridis et al. (submitted). All the mentioned reference files and datasets are freely downloadable from the CLAMP website (Spicer 2011).

Leaf Margin Analysis (LMA) is a univariate leaf physiognomic technique based on the empirical positive correlation between the proportions of taxa with toothed vs. taxa with entire leaf margins (woody dicots) of non-pioneer vegetation and Mean Annual Temperature (MAT). Wolfe (1979) devised this method and compiled 34 humid to mesic floras from East Asia, including reference datasets of Wang (1961), to build a linear regression equation ( $MAT_1 =$

=  $30.6 P + 1.41$ ) to predict temperature. Recently, Su et al. (2010) introduced a new equation from humid to mesic forests from China. This equation ( $\text{MAT}_2 = 27.6 P + 1.038$ ) includes the term of sampling error sensu Miller et al. (2006), i.e.,  $\text{SE}(\text{MAT}) = \text{SQRT}[1 + \varphi(n-1)P(1-P) \times P(1-P)/n]$ , where  $\varphi = 0.052$  (dispersion factor);  $P$  is the percentage of woody dicots with untoothed leaves; and  $n$  is the total number of woody dicots).

Leaf Size Analysis (LSA) determines ratio of percentage of the leaf size categories/elements. We follow leaf size categories sensu Webb (1959) widely, i.e., microphyll (2.25–20.25 cm<sup>2</sup>), notophyll (20.25–45.0 cm<sup>2</sup>), mesophyll (20.25–182.25 cm<sup>2</sup>) and macrophyll (182.25–1640.25 mm<sup>2</sup>). These notophyll and mesophyll categories correspond to mesophyll leaf category sensu Raunkier (1934). The categories are comparable to those used by CLAMP (table 1), where microphyll 3 and mesophyll 1 category equal to notophyll leaf size and mesophyll 2 and 3 to mesophyll leaves.

Besides leaf impressions and carpological material, also a permineralized trunk was excavated when the diatomite was open in 1963. It was studied by Březinová, Holý, Kužvartová and Z. Kvaček (1994) and the palaeoxylotomy was later corrected by Sakala (2003, 2011 the present volume). The documentation material to this study is available in the National Museum Prague. Revisions and new taxonomical treatments of the previously collected leaf and fruit/seed material (Ettingshausen 1866 – 68, see also Hably et al. 2001) as well as new specimens obtained by extensive field activities (Pl. 19, e.g., by Menzel, Kafka, Bůžek, Holý and Z. Kvaček) and amateur collectors (mainly Pavel and Zdeněk Dvořák, Valíček and others) are presented herein. The following collections of the fossil plant material have been re-studied:

- Lobkowitz collection, the Hungarian Natural History Museum, Budapest – BP
- Geologische Bundesanstalt, Wien
- Naturhistorisches Museum, Wien
- Senckenberg Naturhistorische Sammlungen, Museum für Mineralogie und Geologie, Dresden – MMG, KIN
- Czech Geological Survey, Praha – ČB, CGS
- Department of Palaeontology, National Museum, Praha – NM,
- Regional Museum, Teplice
- Bílina Mine, Zdeněk Dvořák's collection – DB, KUC

Comparative studies carried out on the Eocene sites Messel, Eckfeld and in the Weissenlster Basin in co-operation with Volker Wilde, Frankfurt am Main, H. Frankenhäuser, Mainz and Harald Walther, Dresden and Josef Bogner, Munich as earlier studies of plant collections from the Eocene of England (British Natural History Museum, London) and Oligocene plants from Hungary (in collaboration with Lilla Hably, Budapest) contributed to a better understanding of the studied flora.

The photographic documentation was done by the first author during his visits in Budapest, London, Vienna, Dresden and collections in Prague and Bílina

## Geology

First information on the position and structure of the fossiliferous diatomite at Kučlín was published by Reuss

(1840). Several other contributions followed and expanded knowledge on to this “prae-Grand coupure” Palaeogene site of the České středohoří Mountains (abbrev. ČSM in further text) by Reuss (1844), Reuss and Meyer (1852), Kafka (1908, 1911), Hibsich (1905, 1908, 1924, 1926, 1927, 1930, 1935), Hibsich and Seemann (1913) to name most important works before the Second World War. Much more data were obtained thanks to detailed geological mapping (Kopecký et al. 1990a,b), geological prospecting (Horáčková et al. 1967) and other field activities (Váně 1999, 2001, Radoň 2001). Also parallel petrological, geochemical and stratigraphical research (e.g., Shrubný in Klomínský 1994, Bellon et al. 1998, Cajz 2000, Ulrych et al. 1998, 2001) were carried out.

The Tertiary of the České středohoří Mts. has been traditionally divided into two lithostratigraphic units – the Staré Sedlo Formation (including the quartzite sandstone at Skalice, Žitenice and Volfartice) of and the České středohoří Complex (alkalic volcanites and pyroclastics) ranging from a Late Eocene to earliest Miocene age (Shrubný in Klomínský 1994). In a recent study, Kvaček (2002a) attempted to review the position of various sites of the České středohoří Mts. of Late Eocene age and provided evidence for their correlation and facial differentiation. The section of the Trupelník Hill at Kučlín (see Mach and Dvořák 2011, this volume) forms an erosion remnant of volcanogenic material and sediments near Bílina (Hibsich 1924, Kopecký et al. 1990a,b) and it is the best-known site of Late Eocene age in the České středohoří Mts. Its structure and lithology was reported in many accounts, starting with Reuss (1840). Several cores (Mrázek and Procházka 1953, Horáčková et al. 1967) are available to date to follow the section in detail. The core V 2 situated 50 m NE off the summit (356.5 m alt.) did not reach the Upper Cretaceous, and was petrologically characterised in detail (Kafka and Holá in Horáčková et al. 1967). The cores V 2 (depth of 33.5 m) and V 3 (depth of 19.8 m and 28.6 m) yielded darker organogenic sediments, from which palynological data were obtained (Mazancová in Horáčková et al. 1967).

The Palaeogene of the Kučlín and other parts of this late Eocene unit rests directly on the Upper Cretaceous and is irregular in the thickness due to tectonics and geomorphology (Mach and Dvořák 2011). According to Mrázek and Procházka (1953) the lowermost layers of the Tertiary start with pyroclastics. The quartzite layer is absent. The lower part of the section is built of an about 15 m thick marlstone. This mighty layer is composed of re-deposited material from the Upper Cretaceous at the base, and organogenic lacustrine marlstone to limestone of various characters: breccia, sandy-silty marlstone recalling diatomite, often thinly bedded and laminated rarely massive limestone (Kafka in Horáčková et al. 1967). Rarer and thin are volcanoclastic admixtures and darker coaly clay layers. The rest of the sedimentary body comprises various kinds of the diatomite with thin volcanoclastic intercalations. The fossiliferous diatomite is whitish pale, well oxidised and consists of a variety of technological sorts (Holá in Horáčková et al. 1967). It is partly cemented by silica, partly soft, mostly well bedded, with transitions to the diatomite marl in the lower positions. A thicker layer of the bazanite tuff overlies the diatomite, and partly laterally replaces the upper portion of the diatomite, which is outcropping on the Trupelník hill.

Two kinds of magmatic bodies are connected with the sedimentary fill. A thin basaltoid sheet, partly disintegrated, partly transformed by weathering (autometamorphic?) processes covers the top of the sedimentary body. A tephrite flow has been sampled from large loose rock slabs on the top of the hill and is age source of the radiometric data by Bellon et al. (1998) – 38.3±0.9 MA. A tephrite dyke (?) on the slope yielded a slightly younger age (Ulrych et al. 2001 – 33.5±1.5 MA). A most popular palaeontological collecting site from the 19<sup>th</sup> century was at an old mill below the hill (Ettingshausen 1869). Due to extensive landslide processes common in the volcanic region, several blocks of the diatomite were dislocated downslope, much lower than the rest of the diatomite and were fully exploited. The main section is much higher, at about 335 m alt., as documented by the core Kč 1 (Kopecký et al. 1990a,b). We suspect that Kafka (1908, 1911), when he carried out four test pits over the Trupeník hill, was unaware of this landslide. Therefore, his description of the sedimentary content of the Kučlín site is obviously misleading (his sections I–III repeat in the upper section IV). Within the main diatomite, a fault caused the northern part to be thrown down by 12–15 m.

These sediments are interpreted as the fill of the freshwater lake, which formed in a calmer period of volcanic activity in consequence of first large-scale movements of the Ohře rift and was (partly) supplied by mineral springs (Obrhelová and Obrhel 1987). The radiometric data (Bellon et al. 1998) and palynology (Konzalová 1981) indicate Late Eocene age.

## History of the research

The macroflora of Kučlín was first described by Ettingshausen (1866, 1868, and 1869) with small additions by Sieber (1879, 1881) and Menzel (1901). New studies (e.g., Bůžek et al. 1967, 1968a, 1990, Březinová et al. 1994, Kvaček and Bůžek 1995, Manchester and Hably 1997, Mai 1999, Kvaček et al. 2001, Kvaček and Wilde 2010) have elucidated the systematic position of many components. Some more are added for the first time (in co-operation with S.R. Manchester) in the present account. The type and original specimens published by Ettingshausen (1866, 1868, 1869) and housed at BP has been included in a catalogue with some taxonomic revisions (Hably et al. 2001). Kvaček (2002a) documented more interesting taxa in connection with a stratigraphical correlation of the Upper Eocene in North Bohemia. Previous taxonomic reviews (Brabenec 1909) and lists of the Kučlín flora (e.g., Kafka 1908, 1911) include many misidentifications due to an exotic character of the flora. Even now, many of the recovered plant fossils cannot be unambiguously assigned into the natural system and must remain for the future research.

## Systematic descriptions

The system follows newly suggested corrections in particular of angiosperms according to results of molecular phylogeny (Judd et al. 2002). We have tried to recognize at least affinities of fossil taxa to the families, although many of them must be attached behind the natural system as incertae sedis. Due to poor preservation of the material in

the diatomite without any traces of leaf epidermal features, some treatments of foliage rely on the better preserved material from other sites, mainly from Messel and elsewhere in Europe.

## Pteridophytes

### Equisetaceae

#### *Equisetum* L.

#### *Equisetum ettingshausenii* KVAČEK et TEODORIDIS sp. n.

Pl. 1, figs 1-3

- 1866 *Equisetites bilinicus* auct. (non UNGER 1850a nec *Equisetum bilinicum* UNGER 1847); Ettingshausen, p. 12, pro parte pl. 2, fig. 15 (non pl. 2, fig. 14, Břešťany).  
2001 *Equisetites bilinicus* (UNGER) ETTINGSHAUSEN; Hably et al., p. 52, pl. 62, fig. 4.

Sterile articulated flat compressed stems parallel striated by vascular strands that interchange at nodes, only as broad fragments showing variously long internodes. More frequent rounded isolated nodal diaphragms 25 to 30 mm in diameter crenulate on the outline, showing the central pith cavity and crenulate cross section of the stem wall.

**Holotype** designated here: BP 55.2366 (Ettingshausen 1866, pl. 2, fig. 15 as *Equisetites bilinicus*) illustrated in pl. 1, fig. 1.

**Paratype** designated here: NM G 8652a (nodal diaphragm) illustrated in pl. 1 fig.2.

**Remarks:** Similar but narrower sterile stems of horsetails occur commonly in the European Tertiary and are particularly typical of the Arctic Palaeogene (e.g., Boulter and Kvaček 1989, McIver and Basinger 1993, Budantsev and Golovneva 2009). Permineralized remains of similar morphology but with anatomical details preserved were described from the Eocene of USA (Brown 1975). Because of a different preservation mode the material from Kučlín is proposed here to represent an independent fossil species. In the lack of reproductive structures, the systematic position within the genus *Equisetum* s. l. and a closer relationship to the living species must be left open.

According to Jakub Prokop (personal communication 2001) *Equisetum bilinicum* UNGER (1847, p. 124, pl. 37, figs 8-9, syn. *Equisetites bilinicus* (UNGER) UNGER 1850a, p. 60) from the Early Miocene plastic clay of Břešťany (Priesen) is based on remains of insects (larval cases of Trichoptera), which commonly occur in the corresponding strata of the Bílina Mine.

**Material:** stems BP 55.2366, NM G 8651, G 8652a, b, G 8653.

### Osmundaceae

#### *Osmunda* L.

#### *Osmunda lignitum* (GIEBEL) STUR

Pl. 1, figs 4-5.

- 1857 *Pecopteris lignitum* GIEBEL, p. 303, pl. 2, fig. 2.  
1870 *Osmunda lignitum* (GIEBEL) STUR, p. 5.

2002a *Osmunda lignitum* (GIEBEL) STUR; Kvaček, p. 221, pl. 1, fig. 10.

Incomplete pinna 10 mm wide and exceeding 35 mm in length, coarsely toothed on margin according to the pinnules, midrib straight, pinnules short elliptic, acuminate, max. 7 mm long and 4 mm wide, entire-margined, at an angle of 40°, midribs straight to slightly S-shaped, secondaries free, stretching towards the pinnule apex, simple or forked, 5–6 on each side of the midrib.

**Remarks:** This typical Paleogene European fern (Barthel 1976) was recovered only rarely in the České středohoří Mountains (e.g., Kvaček and Walther 1998). The single fragment from Kučlín is more delicate than most other records from Europe. *Osmunda banksiaefolia* (K. PRESL) KUHN. from East Asia was considered by Holttum the nearest living species.

**Material:** NM G 7896a.

## Thelypteridaceae

### *Pronephrium* C. PRESL

#### *Pronephrium stiriacum* (UNGER) E. KNOBLOCH et KVAČEK

Pl. 1, figs 6, 10

- 1847 *Polypodites styriacus* UNGER; p. 121, pl. 36, figs 1-5.  
1866 *Aspidium fischeri* auct. (non HEER); Ettingshausen, p. 17, pl. 3, figs 9-11.  
1852 *Goniopteris stiriaca* (UNGER) A. BRAUN, p. 553.  
1855 *Lastraea stiriaca* (UNGER) HEER, p. 31, pls 7-8.  
1960 *Cyclosorus stiriacus* (UNGER) CHING et TAKHTAJAN in Fataliev, p. 1217.  
1962 *Cyclosorus stiriacus* (UNGER) GRAMBAST, nom. illegit., p. 24, text-fig. 4.  
1963 *Abacopteris stiriaca* (UNGER) CHING, p. 298.  
1976 *Pronephrium stiriacum* (UNGER) E. KNOBLOCH et KVAČEK, p. 12, pl. 1, fig. 1.  
2002a *Pronephrium stiriacum* (UNGER) E. KNOBLOCH et KVAČEK; Kvaček, p. 221, pl. 4, fig. 7.

Incomplete sterile pinnae more than 50 mm long and 14 mm wide with a stout midrib, crenate on sides according to almost fused pinnules, incisions between pinnules 2–3 mm, pinnules max. 7 mm long, at angles of 55–60°, at the apex rounded and slightly turned upwards, midrib of pinnules almost the same thickness as secondaries, straight to slightly bent on very end, secondaries in 6 pairs on each side, the basal united between adjacent pinnules (goniopterid), higher slightly bent, merging the margin.

**Discussion:** Leaf fragments of this common Tertiary swamp fern, showing a goniopterid venation (pl. 4, fig. 7), were wrongly assigned to *Aspidium* due to compression of the specimens and poor preservation at Kučlín by Ettingshausen (1866) and assigned to a different morphotype. In one of the specimens (BP. 55.2319.1, not illustrated by Ettingshausen) and a new material, the goniopterid venation is clearly seen. The specimens from Kučlín are very rare and indeed more delicate than the type material from the Miocene of Styria (Schöneck, Unger 1847, pl. 36, figs 1-4) and other places in the European Tertiary (e.g., Barthel 1976), probably due to different non-swampy environments. *Pronephrium penangianum* (HOOK.) HOLTUM (syn. *Abacopteris penangiana* (HOOK.) CHING) from the Himalayas is

considered according to several authors (e.g., Ching 1963) as the nearest living relative.

**Material studied:** BP 55.2319.1, BP 55.2353.1 (two specimens on the same slab), DB KUC 234.

## ? Lomariopsidaceae

### ? *Lomariopsis* FÉE

#### *Lomariopsis* (?) *bilinica* ETTINGSHAUSEN

Pl. 1, figs 7-8

- 1866 *Lomariopsis bilinica* ETTINGSHAUSEN, p. 13, pl. 3, fig. 13.  
2001 *Blechnum dentatum* (GÖPP.) HEER; Hably in Hably et al., p. 27, pl. 20, fig. 1.

Fragmentary sterile pinna (or complete frond?) ribbon-shaped, parallel-sided, exceeding 100 mm in length, max. 20 mm in width, margin sub-entire, with rare widely spaced widely triangular sharp teeth corresponding to single craspedodromous secondaries, midrib straight, medium thickened, secondaries straight, simple, or occasionally simple forked at base or exceptionally higher, max. in half the distance to the margin, at an angle of 70–80°, in 1–1.5 mm spacing, either gently joining the margin or straight entering the teeth.

Because of its larger width, Ettingshausen (1866) compared this single fern fragment from Kučlín with acrostichoid ferns of the genus *Lomariopsis* FÉE (Lomariopsidaceae). Hably (in Hably et al. 2001, p. 27) transferred this record into the synonymy of *Blechnum dentatum* (Blechnaceae). Indeed, larger pinnae of *Blechnum dentatum* (see, e.g., Kvaček and Hably 1991, pl. 2, fig. 3) are superficially similar to the Kučlín specimen. However, its pinnae are regularly crenulate and the secondaries mostly twice forked. The pantropical genus *Lomariopsis* recalls more the fossil fragment but has a typical heterophylly. Fertile pinnae show acrostichoid sori and sterile foliage is more variable in its morphology, mostly entire-margined or densely finely toothed (Holttum 1978, Moran 2000). By the irregularly toothed margins *Cyclopeltis jani* Barthel (1976) from the Upper Eocene of the Geiseltal matches superficially the Kučlín sterile pinna. Its systematic affinity is corroborated by the position of sori and character of spores *in situ* (Barthel 1976, p. 464, pl. 85, 86, figs 9a-d, text-figs 8 a-b). Although it shows a very similar venation and marginal morphology, its pinnae are much narrower (8 mm). A similar sterile pinna from the Middle Eocene of Eckfeld (Frankenhäuser and Wilde 1993) differs still more in denser and more dichotomizing secondaries. After consulting pteridological monographs and herbarium specimens it becomes clear that such fragments of sterile fern foliage with free secondary veins are hardly determinable to a genus (Barthel 1976, Frankenhäuser and Wilde 1993).

**Material:** BP 55.2489.1

## Blechnaceae

### *Acrostichum* L.

#### *Acrostichum* sp.

Pl. 1, fig. 9

- 2002a *Acrostichum lanzeanum* (VISIANI) CHANDLER; Kvaček, p. 221, pl. 4, fig. 9.

Fragmentary slightly ovate (?) pinnae with entire margin, showing straight midvein and dense simple secondaries at almost right angle, occasionally dichotomizing near the midrib.

**D i s c u s s i o n :** Bůžek et al. (1990, fig. 3) mentioned the occurrence of *Acrostichum* and illustrated a detail with anastomosing venation. The specimens (Kvaček 2002a, pl. 4, fig. 9) do not show anastomoses very distinctly and correspond in this respect with some records from the Eocene of England (Gardner and Ettingshausen, 1879–1882, pl. 1). These poorly and incompletely preserved fragments may represent *Acrostichum lanzeanum*, of which both sterile and fertile pinnae were recorded in other Eocene floras of the Northern Hemisphere (in Europe e.g., Eckfeld, Geiseltal, Célas, Bembridge) but also in the Oligocene (e.g., at Eger-Kiseged, Hungary – Andreánszky 1954). Its nearest living relative, *Acrostichum aureum*, is a common mangrove fern with the cosmopolite distribution in tropical and subtropical areas.

**M a t e r i a l :** CGS sine num., NM G 7896a, b.

## Dryopteridaceae

### *Rumohra* RADDI

#### *Rumohra recentior* (UNGER) BARTHEL

Pl. 1, figs 11–13.

- 1847 *Sphenopteris recentior* UNGER, p. 124, pl. 37, fig. 5.  
1870 *Phegopteris recentior* (UNGER) STUR, p. 9, pl. 1, fig. 7.  
1976 *Rumohra recentior* (UNGER) BARTHEL, p. 457, pls. 80, 81, text-figs 6a–d.

One larger fern frond with its counterpart and several fragments show irregularly dentate margin and venation typical of this fern.

**D i s c u s s i o n :** We follow Barthel (1976) and assign even sterile fern fronds of this kind to *Rumohra*. This fern was well represented in the European Palaeogene (also at Bechlejovice in ČSM – Kvaček and Walther 2004). For more detailed analysis of morphology and affinities see Barthel (1976).

**M a t e r i a l :** NM G 416, KUC 37A, B?

## Conifers

### Cupressaceae

#### *Tetraclinis* MASTERS

#### *Tetraclinis salicornioides* (UNGER) KVAČEK

Pl. 1, figs 17–18

- 1847 *Thuites salicornioides* UNGER, p. 11, pl. 2, figs 1–4, pl. 20, fig. 8.  
1866 *Libocedrus salicornioides* ENDL. sp.; Ettingshausen, p. 33, pl. 10, fig. 5 (non fig. 14).  
1989 *Tetraclinis salicornioides* (UNGER) KVAČEK, p. 48, pl. 1, fig. 11, pl. 2, figs 2–14, pl. 3, figs 1–4, text-fig. 1.  
1990 *Tetraclinis salicornioides* (UNGER) KVAČEK; Bůžek, Fejfar, Konzalová, Kvaček, p. 172, fig. 3.3.

Branches fragmentary, (bi-)pinnately and oppositely branched in flat sprays without overlapping of branches.

Branchlets flattened, with four-ranked dimorphic scale leaves borne in pseudo-whorls. Ultimate twigs diverging from each node of penultimate twigs in opposite pinnate arrangement; ultimate twigs often with two ranks of dimorphic scale leaves, dimorphic; facial and lateral leaves with rounded to bluntly mucronate apices, in each pseudo-whorl fused most of their length to form a dorsoventrally flattened phylloclade-like segments, simple pseudo-whorls oval, tri-veined in surface view or wider, compressed pseudo-whorls at nodes of branching, expanded apically, showing five (to seven) prominent longitudinal lines on the either surface. Apices of the leaves of one node slightly overlapping the leaf bases of the supradjacent node. Facial leaves appressed, ob-triangular, with obvious central midvein; lateral leaves lanceolate to falcate, each folded along its midvein in the plane of compression, shorter than the facial, closely imbricate, more commonly fused to the margins of the facial leaves, base cuneate, apex acute. Seed double winged, seed body ovate, 4 mm long, 2.3 mm wide, wings basally oriented, attached laterally, at the seed base rounded, 2.5 mm wide. Seed cones not recorded in the Kučlín material.

**D i s c u s s i o n :** The cladode-like twigs and seeds of *T. salicornioides* occur extremely rarely in the Kučlín diatomite. This conifer became more spread only in younger strata of the České středohoří Mountains and was widely distributed in the European Oligocene and Neogene (Kvaček 1989). This conifer is, contrary to its extant and fossil subxerophytic relatives *T. verticillata* and *T. brachyodon*, a humid subtropical element avoiding azonal vegetation. Its earliest record was documented in Europe in the Middle Eocene (Eckfeld maar – Wilde and Frankenhäuser 1998, as *Libocedrites*) and in North America in the Oligocene (Kvaček et al. 2000). Its last remnants are known from the Pliocene of Germany, Italy and the Caucasus area (Mai 1995 – as *Tetraclinis brachyodon*).

Impressions of sterile foliage of *Tetraclinis salicornioides* are almost indistinguishable from a related extinct conifer *Ditaxocladus* S. X. GUO et Z. H. SUN occurring in the Late Cretaceous and the Paleocene in the Northern Hemisphere (Guo et al. in press). The sprays of both conifers are composed of cladode-like regularly oppositely branched dorsiventrally flattened twigs. The only difference is in the general form of the sprays, which is slender elongate in *Ditaxocladus* and widely spread in *Tetraclinis salicornioides*. More pronounced differences are in the seed cones (subglobose in racemose fertile branches in *Ditaxocladus* vs quadrivalvate solitary or paired in *Tetraclinis*) and leaf anatomy (non-papillate straight-walled stomatal zones with thin Florin rings in *Ditaxocladus* vs thick and papillate cuticles with undulate anticlines in *Tetraclinis*).

**M a t e r i a l :** KUC 402B, NM G 8598, G 8599.

### Doliosrobaceae Kvaček (2002b)

The family is comprised of the type-bringing genus *Doliosrobos* MARION (1888) and two fossil genera *Araucariacites* KRUTZSCH (type *A. europaeus* KRUTZSCH 1971) for dispersed pollen and *Doliosrobosylon* DOLEZYCH in Junge et al. (2005) for wood. The latter taxon requires validation (no type designated – ICBN Art. 7.9, 7.11).

## ***Doliosobus* MARION, nom. cons.**

Type: *Doliosobus sternbergii* MARION, *type cons.* (= *Doliosobus taxiformis* (STERNBERG) KVAČEK var. *sternbergii* MAI et WALTHER ex KVAČEK) selected by Kvaček (2002c).

The recent characterization and discussion on this genus by Kunzmann (1999: 87-89) requires additional rectifications. The so far known specimens of fertile cone scales show unequivocally only one single seed per scale, with one basal-lateral wing, only exceptionally with a double wing (Kvaček 2002c, pl. 3, fig. 1). The wood structure of twigs corresponds to the *Doliosoboxylon*-type (Rüffle and Süss 2001, Dolezych in Junge et al. 2005).

The comprehensive study of all records (Kunzmann 1999) shows only one variable species of *Doliosobus* in the Palaeogene of Europe, *Doliosobus taxiformis* (STERNBERG) KVAČEK (1971). According to the leaf morphology, the population from Kučlín belongs to the variety with shorter dimorphic needle leaves as defined by Mai and Walther (1985).

### ***Doliosobus taxiformis* (STERNBERG) KVAČEK var. *sternbergii* MAI et WALTHER ex KVAČEK**

Pl.1, figs 14-16, 19

- 1868 *Sequoia sternbergii* HEER; Ettingshausen, p. 40, pl. 13, figs 3-8.
- 1868 *Embothrites cuneatus* ETTINGSHAUSEN, p. 15, pl. 35, fig. 13.
- 1881 *Carpolithes carpini cuiusdam* ? Sieber, p. 92, pl. 3, fig. 18.
- 1926 *Araucarites gurnardii* FLORIN in E.M. REID et CHANDLER, p. 48, pl. 2, figs 6-16.
- 1968b *Doliosobus gurnardii* (FLORIN in E.M. REID et CHANDLER) BŮŽEK, HOLÝ et KVAČEK, p. 154.
- 1968b *Doliosobus certus* BŮŽEK, HOLÝ et KVAČEK, pp. 160-168, pl. 32, figs 1-11, pl. 33, figs 1-17, pl. 34, figs 1-7, pl. 35, figs 1, 2, 5-7, text-tables 1-7.
- 1985 *Doliosobus taxiformis* (STERNBERG) KVAČEK var. *sternbergii* MAI et WALTHER, p. 25, pl. 3, figs 14-16, pl. 6, figs 1-11 (non pl. 5, figs 18-20).
- 1990 *Doliosobus certus* BŮŽEK, HOLÝ et KVAČEK; Bůžek, Fejfar, Konzalová, Kvaček. 172, figs 3.1-2.
- 2001 *Sequoia sternbergii* HEER; Hably et al., p. 61, pl. 79, fig. 3, pl. 80, figs 1-2, 5.
- 2002c *Doliosobus taxiformis* (STERNBERG) KVAČEK var. *sternbergii* (MARION) MAI et WALTHER; Kvaček, p. 221, pl. 1, fig. 6b, pl. 2, fig. 7 (Mrtvý vrch).
- 2007 *Doliosobus taxiformis* (STERNBERG) KVAČEK; Kvaček and Teodoridis, p. 384, fig. 2.N.
- 2008 *Doliosobus taxiformis* (STERNBERG) KVAČEK; Kvaček, p. 4, pl. 2, fig. 10.

Large foliage branches of helically disposed partly appressed needle leaves well decurrent on the axis. Free parts of the needles never exceed half of the needle length (contrary to var. *taxiformis* from Häring). Epidermal anatomy not preserved. Detached cone scales characteristically longitudinally striated, with a long apical mucro. Detached seed laterally one-winged, seed body rounded ovoid, wing obovate slightly oblique, longer than the seed body. For more detailed morphology of the material from Kučlín see previous monographic treatment by Bůžek et al. 1998, Kunzmann 1999 and Kvaček 2002c).

**Discussion:** This extinct conifer, which shares some features with araucarians (pollen morphology, a single seed per scale) and cupressoids (abietoid pitting), is a

common element of the Eocene of Kučlín and occurs also in the Eocene of Germany (Mai and Walther 1985, Europe (see Kunzmann 1999, Kvaček 2002c). According to its characteristic leaf morphology (shorter dimorphic foliage helically arranged) it was long known as *Sequoia sternbergii* but sometimes mistaken for true taxodioid Cupressaceae (Heer 1868). Cone scales and twigs of *Doliosobus* occur besides Kučlín also at other late Eocene localities in North Bohemia, e.g., Mrtvý vrch, the cores at Hlinná and Lbín, Kostomlaty / Roudný, and in the Skalice quartzite (Kvaček 2002c). *Doliosobus* is rarely represented in the Staré Sedlo Fm. in the Cheb Basin. This conifer is typical of the Zeitz flora (Mai and Walther 1985).

A recent xylotomical study in the German Late Eocene locality Grotzsch Dreick in the Weissester Basin (Dolezych in Lange et al. 2005) recovered whole trunks more than 8 m long with unusual surface and characteristic pitting confirming the assumption that *D. taxiformis* is a large tree. Konzalová reports tentatively on the araucarioid pollen which may belong to *Doliosobus* from the Kučlín cores V 2 and V 3 (Mazancová in Horácková et al. 1967), and at Lbín and Hlinná (Konzalová 1981).

A silicified trunk, which was described from Kučlín as *Podocarpoxydon helmstaedianum* by Březinová et al. (1994), does not belong to *Doliosoboxylon*, although it was at first believed to represent a trunk of *Doliosobus*. It was reinterpreted to belong to *Tetraclinoxydon* (Sakala 2003, Dolezych and Sakala 2007), another conifer present in the Kučlín flora (see below).

**Material studied:** BP 55.2348.1, 55.2443.1, 55.2455.1, 55.497.1., NM G 2342a,b, G 2433-36, G 2439a,b, G 4832, G 5572-74.

## **Angiosperms**

### **Nymphaeaceae s. l.**

Various fossils belonging to Water Lilies are well represented in the Kučlín flora (Ettingshausen 1869, Bůžek et al. 1990, Kvaček 2002a), as impressions of leaves, attachment traces of petioles and seeds. Ettingshausen (1869) recognized in this category of Nymphaeaceae fossils several taxa on mere superficial traits. Most are not really identifiable because necessary diagnostic characters are not visible on the impression material. Nevertheless, the presented documentation shows a quite large diversity of this group of aquatic plants and may help to characterize environment of the Kučlín lake, because these remains belong to autochthonous plants.

#### ***Sabrenia vel Dusembaya* sp.**

Pl. 2, fig. 9

- 1881 *Sapindus falcifolius* A. BRAUN; Sieber, p. 86 pro parte, pl. 2, fig. 11.
- ?1881 *Carpolithes amygdaliformis* SIEBER, p. 92, pl. 4, fig. 25.
- 1990 *Brasenia vel Dusembaya* sp.; Bůžek et al, p. 172, fig. 3.14.

Seeds well compressed, in fossil state disc-shaped and variously damaged, 3–20 mm in diameter.

**Discussion:** In the present treatment the seeds of Nymphaeaceae s. l. are not differentiated awaiting future more thorough study. A more precise identification requires details of testa and other anatomical traits (Collinson 1980).

***Anoetomeria brongniartii* SAPORTA**

Pl. 1, fig. 20; Pl. 2, figs 1-3

- 1865 *Anoetomeria brongniartii* SAPORTA; p. 125, pl. 7, fig. 1.  
1869 *Anoetomeria brongniartii* SAPORTA; Ettingshausen, p. 10, pl. 41, figs 11, 12, 13, 14.  
2001 *Anoetomeria brongniartii* SAPORTA; Hably et al. p. 42-43, pl. 43, fig. 4, pl. 44, figs 1, 2, 3.

Rounded bodies consisting of groups of small rhizome traces (or seeds?) ca.2 mm in diameter.

**D i s c u s s i o n :** The true affinities of such fossils have not been verified, although Ettingshausen (1869) agreed with the treatment by Saporta (1865) who believed that they should represent rhizome fragments. In our case these bodies may represent compressed groups of seeds (Pl. 1, fig. 20; Pl. 2, figs 1-3, 9), in contrast with the rhizome fragments treated here as *N. polyrrhiza* (Pl. 2, figs 6-8).

**M a t e r i a l :** BP 55.2334.1, 55.2336.1, 55.2428.1, 55.2454.1, KUC457A.

***Nymphaea polyrrhiza* SAPORTA**

Pl. 2, figs 6-8

- 1862 *Nymphaea polyrrhiza* SAPORTA; p. 177, 236, pl. 10, fig. 1.  
1869 *Nymphaea polyrrhiza* SAPORTA; Ettingshausen, p. 11, pl. 41, figs 16, 17.  
1869 *Nymphaea gypsorum* SAPORTA; Ettingshausen, p. 11, pl. 41, fig. 15.  
2001 *Nymphaea polyrrhiza* SAPORTA; Hably et al., p.56, pl. 69, figs 6-7.

Rounded to polygonal irregularly shaped traces of attachments of petioles to rhizomes leaving characteristic grouping of rounded variously sized traces on the surface.

**D i s c u s s i o n :** The affinity to the Nymphaeaceae is most probable but the remains can hardly characterize individual natural species. Similar petiole outlines with vascular bundle marks have been attributed to *Nuphar* from the Oligocene of Montana and Oregon (Becker 1969; Meyer and Manchester 1997).

**M a t e r i a l :** BP 55.2345.1, 56.1236.1, NM G 8635, NM G 8657a, G 4836.

**Nymphaeaceae gen.**

Pl. 2, figs 4-5

- 2002a Nymphaeaceae gen.; Kvaček, p. 222, pl. 1, fig. 2, pl. 4, fig. 2

Imperfectly preserved rounded leaves up to 5 cm in diameter with actinodromous venation.

**D i s c u s s i o n :** Such fossils have been usually referred to *Nelumbo* on account of seemingly peltate attachment of the lamina to the petiole. They apparently belong to the same plants at Kučlín that left various seeds and rhizome remains as described above, in which case they should be removed from Nelumbaceae to the Nymphaeaceae. The bilateral symmetry of the veins within the lamina (Pl. 2, fig. 4) is consistent with Nymphaeaceae, and readily distinguished from *Nuphar* which has more strictly radial venation. The preservation of the venation and overall morphology is very poor due to long time of decay in the sediment. We do not attempt any detailed comparisons to better preserved fossils

of this kind previously described from the Tertiary of Europe.

**M a t e r i a l :** NM G 8638, G 8639.

**Magnoliaceae**

***Magnolia* L.**

***Magnolia longipetiolata* ETTINGSHAUSEN**

Pl. 3, fig. 2, pl. 4, fig. 1, ? pl. 9, figs 1-2.

- ? 1866 *Ficus hercules* ETTINGSHAUSEN, p. 74, pl. 21, fig. 1.  
? 1868 *Rhododendron haueri* ETTINGSHAUSEN, p. 50, pl.39, fig. 19.  
1869 *Magnolia longipetiolata* ETTINGSHAUSEN, p. 9, pl. 41, fig. 8-9.  
1990 *Magnolia longipetiolata* ETTINGSHAUSEN; Bůžek et al., p. 172, fig. 3.21.  
? 2001 *Rhododendron haueri* ETTINGSHAUSEN; Hably et al., p.33, pl. 28, fig. 1.  
? 2001 *Ficus hercules* ETTINGSHAUSEN; Hably et al., p. 23, pl. 15, fig. 3.

Leaves simple, petiole stout, long, exceeding the length of 25 mm, lamina lanceolate, more than 25 cm. Venation eucamptodromous. Midrib stout, straight, secondaries quite dense, much thinner and steep, venation of higher order reticulate, not well discernible.

**D i s c u s s i o n :** These slender and long petiolate leaves ascribed by Ettingshausen to this morphotype are typical elements of the Kučlín flora and may indeed belong to the magnolias. Unfortunately, there is no evidence by epidermal anatomy to verify this identification..

**M a t e r i a l :** BP 59.1113.1, BP 55.2367.1, KUC 442, NM G 8640a,b, G 8672a.

***Liriodendron* L.**

***Liriodendron* sp.**

Pl. 4, figs 6-7

An incomplete bilobate leaf, lobes entire, venation camptodromous.

**D i s c u s s i o n :** Morphology of *Liriodendron* leaves is typically developed in one of the impressions from Kučlín. This genus is well documented from the České středohoří Mounains both by fruitlets and foliage mainly from Oligocene sites, e.g., Hrazený, Markvartice (Knobloch 1961, Bůžek et al. 1976), exceptionally also from the Late Eocene flora of Roudníky (Z. Kvaček, own observation).

**M a t e r i a l :** NM G 8655.

**Magnoliaceae gen.**

Pl. 4, figs 2-5

- 1869 *Magnolia crassifolia* GÖPPERT; Ettingshausen, p. 8.  
1869 *Magolia primigenia* UNGER; Ettingshausen, p.8, pl. 41, fig. 7.

Leaves elliptical, entire-margined, without petiole preserved, venation eucamptodromous, midrib straight, medium thick, secondaries very delicate, hardly visible.

**D i s c u s s i o n :** The Budapest collection contains also nonillustrated specimens identified by Ettingshausen as *Magnolia crassifolia* GÖPP. All specimens are quite deli-



cate, suggesting deciduous nature, contrary to the opinion of Ettingshausen. The lack of epidermal structure prevents us to express our opinion as to the affinities. The texture indeed may suggest deciduous magnolias, laurels etc.

**Material:** BP 55.2382.1, 55.2343, 59.1156.1.

## Lauraceae

### *Laurophyllum* GÖPPERT

#### *Laurophyllum* sp. 1

Pl. 4, figs 13-14

- 1868 *Nectandra arcinervia* ETTINGSHAUSEN, pp. 8-9, pl. 33, figs 1-3.

Narrow-leaved lauroid leaf with a prominent venation.

**Discussion:** See under *Laurophyllum* sp. 2

**Material:** BP 55.2413.1.

#### *Laurophyllum* sp. 2

Pl. 4, figs 15, pl. 5, figs 1-4

- 1868 *Cinnamomum laurifolium* ETTINGSHAUSEN, p. 11, pl. 34, fig. 13.  
1868 *Laurus primigenia* UNGER; Ettingshausen, p. 4 (s.ic.).  
1868 *Laurus ocoteaefolia* ETTINGSHAUSEN, p. 4, pl. 31, figs 11, 12.  
1868 *Laurus reussii* ETTINGSHAUSEN, p. 5, pl. 30, figs 5, 11.  
1868 *Laurus princeps* HEER; Ettingshausen, p. 4 (s.ic.).  
1868 *Laurus tetrantheroides* ETTINGSHAUSEN; Ettingshausen, p. 5 (s.ic.).  
1868 *Laurus lalages* UNG.; Ettingshausen, p. 4 (s.ic.).  
1868 *Laurus nectandroides* ETTINGSHAUSEN, p. 6, pl. 31, figs 10, 10b.  
1868 *Laurus brocchiana* MASSAL.; Ettingshausen, p. 7 (s.ic.).  
1868 *Laurus protodaphne* WEBER; Ettingshausen, p. 7 (s.ic.).  
1868 *Cinchonidium bilinicum* ETTINGSHAUSEN, p. 19-20, pl. 35, figs 28, 29.  
1868 *Cinchonidium randiaefolium* ETTINGSHAUSEN, p. 20, pl. 36, fig. 1.  
1868 *Heliotropites acuminatus* ETTINGSHAUSEN, p. 34, pl. 37, fig. 30.  
1869 *Dodonea apocynophyllum* ETTINGSHAUSEN, p. 28, pl. 46, figs 19-20.  
1869 *Dodonea antiqua* ETTINGSHAUSEN, p. 28, pl. 46, fig. 18.  
? 1869 *Celastrus elaeanus* UNG.; Ettingshausen, p. 34, pl. 48, fig. 29.  
1869 *Rhamnus heerii* ETTINGSHAUSEN, p. 43, pl. 50, fig. 20.  
1869 *Rhamnus paucinervia* ETTINGSHAUSEN, p. 43, pl. 50, fig. 19.  
1869 *Pomadereis acuminata* ETTINGSHAUSEN, p. 43, pl. 50, fig. 21.  
1869 *Adenopeltis protogaea* ETTINGSHAUSEN, p. 44, pl. 50, figs 23-24.  
1881 *Laurus haidingeri* ETTINGSHAUSEN; Sieber, p. 79, pl. 4, fig. 33.  
1990 cf. Lauraceae; Bůžek, Fejfar, Konzalová, Kvaček, p. 172, fig. 3.10.  
2001 *Cinnamomum laurifolium* ETTINGSHAUSEN; Hably et al., p. 19, pl. 9, fig. 5.  
2001 *Nectandra arcinervia* ETTINGSHAUSEN; Hably et al., p. 30, pl. 23, figs 4, 5.  
2001 *Laurus nectandroides* ETTINGSHAUSEN; Hably et al., p. 27, pl. 19, fig. 1.  
2001 *Rhamnus paucinervia* ETTINGSHAUSEN; Hably et al., p. 33, pl. 27, fig. 2.  
2001 *Cinchonidium bilinicum* ETTINGSHAUSEN; Hably et al., p. 18, pl. 9, figs 1, 2.  
2001 *Cinchonidium randiaefolium* ETTINGSHAUSEN; Hably et al., p. 19, pl. 9, fig. 6.

Elongate entire-margined leaves of various outlines with typically brochidodromous lauroid venation with mostly irregularly disposed secundaries.

**Discussion:** In spite of the different morphotypes of lauroid foliage recognized by Ettingshausen (1868), it is difficult to judge the number of natural representatives of the Lauraceae in the Kučlín flora. For such an analysis it would be necessary to employ leaf epidermal characteristics, which are lacking in the material studied. Therefore we do not attempt any precise synonymy of the lauroids described by Ettingshausen (1868, 1869) and the above listed synonyms include only some more typical examples of the lauroid foliage.

**Material:** BP 55.2312, 55.2364.1, 55.2397, 55.2479.1, NM G 8479ab, others at NM, DB.

### *Daphnogene* UNGER

#### *Daphnogene cinnamomifolia* (BRONGNIART) UNGER

Pl. 4, figs 8-9

- 1868 *Cinnamomum polymorphum* (A. BRAUN) HEER; Ettingshausen, p. 198, pl. 33, figs 14, 15, 17-22.  
1868 *Daphnogene kutschlinica* ETTINGSHAUSEN, p. 199, pl. 34, fig. 12, fig. 14.  
1868 *Cinnamomum lanceolatum* (UNGER) HEER; Ettingshausen, p. 10, pl. 33, figs 7, 8, 9, 13, 16.  
1868 *Cinnamomum polymorphum* (A. BR.) HEER; Ettingshausen, p. 10, pl. 33, figs 17, 18, 20, 21.  
1868 *Cinnamomum rosmässleri* HEER; Ettingshausen, p. 9, pl. 32, figs 11, 12, 13.  
1868 *Cinnamomum scheuchzeri* HEER; Ettingshausen, p. 10, pl. 32, figs 2, 7.  
1868 *Cinnamomum spectabile* HEER; Ettingshausen, p. 11, pl. 34, fig. 15.  
1990 *Daphnogene cinnamomifolia* (BRONGNIART) UNGER; Bůžek, Fejfar, Konzalová, Kvaček, p. 172, fig. 3.16.  
2001 *Cinnamomum buchii* HEER; Hably et al., p. 47, pl. 52, fig. 2;  
2001 *Cinnamomum spectabile* HEER; Hably et al., p. 49, pl. 56, fig. 2.  
2001 *Cinnamomum rosmässleri* HEER; Hably et al., p. 48-49, pl. 53, fig. 5; pl. 54, figs 4, 5.  
2001 *Cinnamomum lanceolatum* (UNGER) HEER; Hably et al., p. 48, pl. 53, figs 2, 3.  
2001 *Cinnamomum polymorphum* (A. BR.) HEER; Hably et al., p. 48, pl. 53, fig. 3; pl. 54, figs 1, 2, pl. 55, fig. 1.  
2001 *Cinnamomum scheuchzeri* HEER; Hably et al. p. 49, pl. 55, figs 2, 3, pl. 33, figs 5, 6.  
2001 *Daphnogene kutschlinica* ETTINGSHAUSEN; Hably et al., p. 219, pl. 11, fig. 2.

Leaves simple, short petiolate, lamina lanceolate to broadly oval, entire-margined, of variable form, triveined, with acrodromous venation.

**Discussion:** Slender cinnamomoid leaves are among the commonest woody elements of the Kučlín flora. *Daphnogene cinnamomifolia* is common also in mesophytic sites of the Oligocene elsewhere in the České středohoří Mountains. Not all triveined leaves are here assigned to this unit because broader forms described below may show differences in the epidermal structure judging according studies in the floras of Eocene age, in particular in Messel (see Wilde 1989)

**Material:** BP 55.2318.1, 55.2323.1, 55.2328.1, 55.2335.1, 55.2346.1, 55.2403.1, 55.2425.1, 55.2436.1,

55.2464.1, 55.2482.1., 59.871.1, 59.1100.1, NM G 425, G 426, G 435, G 8427, G 8479, G 8646, G 8671 others at NM, DB.

### ***Daphnogene* sp.**

Pl. 4, figs 10-12

1868 *Sassafras aesculapi* HEER; Ettingshausen, p. 8, pl. 31, fig. 12.  
2001 *Sassafras aesculapi* HEER; Hably et al., p. 60, pl. 79, fig. 4.  
? 2002a *Matudaea* sp. sensu Kvaček, p. 222, pl. 1, fig. 3.

Oval entire-margined leaves with triveined acrodromous venation

**D i s c u s s i o n :** Wide ovate, triveined leaves do not always belong to the Lauraceae. Hably and Kvaček (1998) interpreted such leaf forms from the Lower Oligocene of Eger-Kiseged as representatives of Hamamelidaceae (*Matudaea*). Similar leaves occur also at Kučlín (pl. 1, fig. 3) and Staré Sedlo Fm. (*Daphnogene pseudopolymorpha* E. KNOBLOCH et KVAČEK in Knobloch et al. 1996). Epidermal anatomy is necessary to prove their affinities.

**M a t e r i a l :** BP 55.1171.1.

## **Araceae**

### ***Nitophyllites* ILJINSKAYA**

#### ***Nitophyllites bohemicus* WILDE, KVAČEK et BOGNER**

Pl. 3, figs 4, 11

2005 *Nitophyllites bohemicus* WILDE, KVAČEK et BOGNER, p. 170, fig. 10.

Fragments of large cordate leaves and rounded apices with characteristic parallel venation (for more details together with comparison with similar fossils from Messel and extant representatives see Wilde et al. (2005).

**D i s c u s s i o n :** Leaves of the Araceae left delicate remains in many cases disintegrated into small pieces as the thin lamina folded and vent into pieces. The same preservation mode is seen in the generitype (Iljinskaya 1960, 1963) which was originally interpreted as remains of algae. Additional material found at Kučlín confirms that such remains are large pieces of the Araceae foliage recognizable according to characteristic pattern of higher-order venation. Because of overlapping morphology among different extant genera, the affinity of this morphotype to particular living genera has not been recognized even in cases of much better preservation of Messel material (Wilde et al. 2005).

The occurrence of *Nitophyllites* at Kučlín documents helophytic araceous plants typical of warm climate today. Other fossil occurrences of this group are extremely rare, in the Eocene of North America, and in the Palaeocene–Eocene of Kazakhstan and Far East. The Araceae are also well represented by foliage at the Middle Eocene site Messel in Germany, but by different representatives of this family.

**M a t e r i a l :** KUC 431, NM G 7778.

### **cf. *Orontium* sp.**

Pl. 3, figs 5-6

Leaf simple, oblong, ca 10 mm wide, length incomplete, margin entire, venation subparallel, ca 3 parallel veins run

on either side of the thin midrib and fuse with it. Venation of higher order not preserved.

**D i s c u s s i o n :** *Orontium* belongs to very ancient simple-leaved Araceae (Bogner et al. 2007) and has not been recognized so far in the Tertiary of Europe. Although the available leaf fragment is very incomplete, it matches in the main venation pattern with the representatives of this genus from the Late Cretaceous and Early Paleogene of North America (Bogner et al. 2007).

**M a t e r i a l :** KUC230.

## **Smilacaceae**

### ***Smilax* L.**

#### ***Smilax* sp.**

Pl. 3, fig. 3

Incomplete shortly petiolate leaf lamina, at base rounded, ovate, margin entire, venation acrodromous, of which only three centrally positioned primaries visible.

**D i s c u s s i o n :** Similar but much better preserved leaves of the Smilacaceae were described from the Staré Sedlo formation (Knobloch et al. 1996).

**M a t e r i a l :** NM G 8634a.

## **Dioscoreaceae**

### **cf. *Dioscorea* L.**

#### **? *Dioscorea* sp.**

Pl. 3, figs 1-2

A fragment of cordate leaf with 5 primaries radiating from the incomplete leaf base. Venation of higher order very thin, hardly visible. Individual half-moon shaped fruitlets ca. 6 mm long and 4.5 mm in diameter, well flattened

**D i s c u s s i o n :** Besides a fragment possibly representing *Dioscorea* foliage, two *Dioscorea*-like fruitlets were recovered at Kučlín so far. One of the first documents was recognised by S.R. Manchester (in Kvaček 2002a) as possibly belonging to the Dioscoreaceae. We have not seen the persistent apical tepals that should be expected, however (Manchester and O'leary 2010). More complete fruits of this plant group were recovered in the Hungarian Early Oligocene site Eger-Kiseged (Andreánszky 1959, as *Dioscoreocarpum*). This element is certainly a liana like thermophilous plant typical of tropical–subtropical areas.

**M a t e r i a l :** KIN 448-2, KUC 216.

## **Arcaceae**

Palm remains are very scanty at Kučlín and mostly preserved as isolated leaf segments.

### ***Sabal* ADANSON**

#### ***Sabal raphifolia* (STERNBERG) E. KNOBLOCH et KVAČEK**

Pl. 2, fig. 14, pl. 3, fig. 9, pl. 18, fig. 1

1866 *Cyperus chavannesi* HEER; Ettingshausen, p. 26, pl. 6, fig. 3.  
2009 *Sabal raphifolia* (STERNBERG) E. KNOBLOCH et KVAČEK; Akhmetiev et al., p. 81, pl. 8, fig. 11.

Large portions of palm segments over 30 cm long, belonging most probably to a sabaloid palm, basal parts not preserved, apical parts split. Smaller parts showing V-shaped venation of leaf lamina.

**D i s c u s s i o n :** A more precise identification of leaf segments is difficult due to the lack of important parts, in particular the attachment of the petiole to the leaf.

**M a t e r i a l :** BP 55.1151.1, KUC 458.

#### **cf. Arecaceae indet.**

Pl. 3, fig. 10

1868 *Leptomeria bilinica* ETTINGSHAUSEN, p. 12, pl. 34, fig. 7.

Small partly branched portions of an inflorescence/ fructescence devoid of flowers.

**D i s c u s s i o n :** The fossils at hand may represent fragments of palm infructescences rather than branches of the Proteaceae assigned to *Leptomeria*, contrary to the opinion of Ettingshausen (1868). The incomplete preservation makes it difficult to be sure of the nature of such fossils at all.

**M a t e r i a l :** BP 59 1144.1, 55 1136.2.

#### **Poaceae (vel Cyperaceae)**

We unite under this heading mostly impressions of grass-like foliage. The preservation of the venation does not allow more precise comparisons.

##### ***Poacites acuminatus* ETTINGSHAUSEN**

Pl. 2, fig. 15

1866 *Poacites acuminatus* ETTINGSHAUSEN, p. 24, pl. 6, fig. 6.

2001 *Poacites acuminatus* ETTINGSHAUSEN, Hably et al., p. 91, pl.25, fig. 6.

Grass-like foliage without diagnostic traits.

**M a t e r i a l :** BP 55 1142.1 and many others.

#### **Musaceae**

##### ***Musa* L.**

##### ***Musa bilinica* ETTINGSHAUSEN**

Pl. 2, figs 12-13

1866 *Musa bilinica* ETTINGSHAUSEN, p. 28, pl. 7, fig. 4.

Large portions of entire banana-like leaves with a midrib and very dense secondaries at about 50°.

**D i s c u s s i o n :** This type of monocot foliage has been recently treated in detail and transferred from Zingiberaceae to Musaceae (Fischer et al. 2009).

**M a t e r i a l :** BP 55.1145.1.

#### **Monocot inc. sed.**

##### ***“Chamaerops” kutschlinica* ETTINGSHAUSEN**

Pl. 3, figs 7-8

1866 *Chamaerops kutschlinica* ETTINGSHAUSEN (*Flabellaria kutschlinica* ETTINGSHAUSEN in figure captions), p. 32, pl., 8, fig. 5.

1990 *Chamaerops kutschlinica* ETTINGSHAUSEN; Bůžek et al., p. 172, fig. 3.23.

Poorly preserved impression of ca. 3 cm large tuber-like rhizome with radiating narrow segments.

**D i s c u s s i o n :** The fossil described as *Chamaerops kutschlinica* by Ettingshausen (1866) represents in fact a nodular rhizome with radiating rootlets resembling leaf segments

The holotype of this species is clearly not a foliar fossil. The segments radiating from the rhizome are very doubtful, probably rootlets. No similar fossils have been recovered to bring further evidence that *Chamaerops*-like palms existed in the Kučlín flora.

**M a t e r i a l :** BP 59.1179.1.

##### ***“Butomus” heerii* ETTINGSHAUSEN**

Pl. 2, figs 10-11.

1866 *Butomus heerii* ETTINGSHAUSEN, p. 27, pl. 6, figs 12-14.

Infructescence impression joining in an umbel several longly stalked bicarpellate fruitlets.

**D i s c u s s i o n :** This fruit remain is certainly interesting, recalling *Butomus* fruits because of the umbellate infructescence structure. However, this kind of infructescence also occurs in the Araliaceae. The individual fruit organization, consisting of D-shaped wedges topped by persistent divergent styles, resembles more closely the Araliaceae (S.R. Manchester, personal communication), but we have not done more detailed comparative work to clearly resolve its affinities.

**M a t e r i a l :** BP59.1103.1, NM G 8647b.

##### ***“Arundo” heerii* ETTINGSHAUSEN**

Pl. 2, fig. 16

1866 *Arundo heerii* ETTINGSHAUSEN, p. 20, pl. 4, fig. 5

Rhizome with several roundish differently sized traces of secondary roots, or perhaps seed impressions, in a vertical line.

**D i s c u s s i o n :** A very incomplete fossil presumed to be *Arundo*, but for a definite proof it is very insufficient and doubtful.

**M a t e r i a l :** BP 59.1346.1.

#### **Berberidaceae**

##### ***Berberis* L.**

##### ***Berberis* sp.**

Pl. 5, fig. 5

Leaf simple, obovate, sessile, apex rounded, base arrow cuneate, margin simple, finely and sharply serrate in the upper part of the lamina, venation semicraspedodromous, midrib straight, secondaries densely spaced, subparallel, at angles of 40–60 °, looping along the margin.

**D i s c u s s i o n :** Contrary to *Berberis berberidifolia* (HEER) PALAMAREV et PETKOVA from the European Miocene, this species does not form broader meshes of secondaries inside the lamina. The affinity to *Berberis* is based only on the sharp serration and the form of the lamina. Similar foliage can be seen in many Asiatic species today.

**M a t e r i a l :** KUC 76, KUC 215.

? *Mahonia* NUTT.

cf. *Mahonia* sp.

Pl. 5, fig. 6

Leaflet incomplete, slightly asymmetrical, broadly ovate, 24 mm wide, 39 mm long, sessile, margin sharply simple dentate, venation semicrapedodromous (?), midrib straight, basal secondaries opposite, higher at an angle of 45°, entering the marginal teeth.

**D i s c u s s i o n :** This quite incomplete impression is assigned to *Mahonia* an account of sharply tooth margin. A closer comparison is difficult because of the inadequately preserved material.

**M a t e r i a l :** KUC 446.

**Platanaceae**

***Platanus* subgen. *Glandulosa* KVAČEK et MANCHESTER**

***Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK**

Pl. 5, figs 7-11

- 1866 *Sparganium neptuni* ETTINGSHAUSEN, p. 31, pl. 7, figs 10, 11, 12, 13, 17, 18.
- 1866 *Myrica reussii* ETTINGSHAUSEN, p. 44, pl. 14, fig. 4.
- 1868 *Hedycarya europaea* ETTINGSHAUSEN, p. 3, partim, pl. 30, fig. 4.
- 1868? *Banksia ungeri* ETTINGSHAUSEN; Ettingshausen, p. 16 (s.ic.).
- 1869 *Ceratopetalum bilanicum* ETTINGSHAUSEN, p. 6, pl. 40, figs 26, 30, 31.
- 1869 *Bombax chorisiaefolium* ETTINGSHAUSEN, p. 11, pl. 42, figs 2, 4, 5.
- 1869 *Celastrus deucalionis* ETTINGSHAUSEN, p. 33, pl. 48, fig. 15.
- 1869? *Celastrus acherontis* ETTINGSHAUSEN, p. 33, pl. 48, fig. 9.
- 1869 *Cunonia bilinica* ETTINGSHAUSEN, p. 64, pl. 55, fig. 21.
- 1869 *Ternstroemia bilinica* ETTINGSHAUSEN, p. 17, pl. 47, figs 8, 9, 10.
- 1869 ? *Elaeodendron persei* UNGER; Ettingshausen, p. 36, pl. 48, fig. 25, pl. 49, fig. 11.
- ? 1869 *Elaeodendron degener* (UNGER) ETTINGSHAUSEN; Ettingshausen, p. 37, pl. 49, figs 5, 7, 8, 9, 10.
- ? 1869 *Ceratopetalum haeringianum* ETTINGSHAUSEN; Ettingshausen, p. 6, pl. 40, figs 27, 28, pl. 41, figs 4, 5.
- 1869 *Maytenus europaea* ETTINGSHAUSEN, p. 31, pl. 48, figs 10, 11, 13.
- ? 1869 *Sapindus fraxinifolius* ETTINGSHAUSEN, p. 26, pl. 46, figs 24, 25, 26, pl. 47, fig. 12.
- 1869 *Hippocratea bilinica* ETTINGSHAUSEN, p. 38 pro parte, pl. 49, fig. 14.
- 1869 *Rhus hydrophila* (UNGER) ETTINGSHAUSEN; Ettingshausen, p. 49, pl. 51, fig. 3 (*Platanus neptuni* mf. *fraxinifolia*).
- 1967 *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK, p. 205, pl. 1, figs 1-4, 6 (non 5 – *Sloanea artocarpites*), pls 2-4.
- 1990 *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK; Bůžek, Fejfar, Konzalová, Kvaček, p. 172, figs 3.4-7.
- 2001 *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK; Hably et al. p. 12, pl. 3, fig. 4; p. 14, pl. 5, figs 1-2, p. 17, pl. 8, fig. 1, p. 25, pl. 17, fig. 2; p. 28, pl. 21, figs 2, 4, 5; p. 36, pl. 32, figs 2, 6; pp. 37-38, pl. 33, figs 4, 5, pl. 34, figs 2, 3, 5, pl. 35, figs 1, 2; p. 39, pl. 38, fig. 2; p. 47, pl. 51, figs 3, 4; p. 52, pl. 60, fig. 3.
- 2002a *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK; Kvaček, p. 222, pl. 3, fig. 7.

- 2004 *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK mf. *neptuni*, p. 19, figs 2g, h, 3b; *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK mf. *reussii* (ETTINGSHAUSEN) KVAČEK et MANCHESTER p. 19, figs. 5a, b, c, f; *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK mf. *fraxinifolia* (JOHNSON et GILMORE) KVAČEK et MANCHESTER, p. 19, figs 7b, c.
- 2007 *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK; Kvaček and Teodoridis, p. 384, figs 2. G, H.
- 2008 *Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK; Kvaček, 94, pl. 1, figs 5-7.

Globular male inflorescences and female infructescences on single stalks. Foliage twigs with alternate leaves attached to the twig by an enlarged petiole enveloping the axillary bud. Leaves simple or trifoliolate (quiquefoliolate outside Kučlín), usually crenate to creanulate, rarely entire. Stipules only decayed on the top, strap-like (for more detailed description see Kvaček and Manchester 2004).

**D i s c u s s i o n :** Kučlín is the type locality of this unusual plane with oblanceolate leaves common and distinctive inflorescences in the Eocene to Miocene of Europe (Walther 1985). One of the Kučlín specimens is important in showing the alternate phylotaxy of unifoliolate leaves on a branching twig (Kvaček et al. 2001). This species is a successor of the still more ancient compound-leaved *P. bella* (HEER) KVAČEK, MANCHESTER et GUO (2001) known from the Palaeocene–Eocene of North America, Greenland and East Asia. Besides Kučlín, *P. neptuni* has been documented by its typical cuticular structure in various floras of Europe. In the Zeitz floras, it is known more often in the trifoliolate-quiquefoliolate form (Mai and Walther 1985, as *Platanus fraxinifolia*). This ancient plane thrived abundantly on fertile volcanic soils (Markvartice, Ipolytarnóc) and mostly avoided fluvial environment, contrary to the extant plane trees growing often at streams.

**M a t e r i a l :** BP 55.2321.1, 55.2337.1, 55.2349.1, 55.2427.1, 55.2423.1, 55.2437.1, 55.2445.1, 55.2484.1, 55.2494.1, 55.2491.1, 55.2498.1, 56.1220.1, 59.119.1, 59.1144.1, 59.1148.1; NM G 427, G 432-4, G 417, G 418, G 4635, G 4837, G 5061, G 7565, G 8114, G 8478, G 8665-71.

**Vitaceae**

? *Ampelopsis* MICHX.

cf. *Ampelopsis* sp.

Pl. 5, fig. 12

Leaflet symmetrical, petiolule short, incomplete, lamina lanceolate, 17 mm wide, 34 mm long, margin widely toothed, with 2 teeth on either side, blunt, apex elongate blunt, venation craspedodromous, midrib straight, thick, secondaries widely spreading, the lowermost subopposite, reaching the lower teeth, higher veins not well visible, steeply ending into the marginal teeth.

**D i s c u s s i o n :** The unique specimen of this morphotype is similar but much slender than *Ampelopsis* sp. from Bechlejšovice (Kvaček and Walther 2004, pl. 3, fig. 3) recalling leaflets of the living *A. arborea* and *A. orientalis*.

An affinity to another genus of the Vitaceae, e.g., *Parthenocissus*, cannot be ruled out.

**Material:** KIN 363. 1.2.

## Elaeocarpaceae

### *Sloanea* L.

*Sloanea* belongs to tropical–subtropical elements spread in Asia to Australia, Madagascar and tropical America today, which was recognized by its characteristic fruits also in Cenozoic deposits in North America (Manchester and Kvaček 2009), Greenland and Europe (Reid and Chandler 1933, Rasky 1962, Kvaček et al. 2001). More than 120 extant species have been reported and the modern affinities at the species level are still under discussion. Similarly representatives of fossil species, particularly the whole plants based on fruits and foliage, are difficult to delimit and recognize. In the Bohemian Palaeogene two species have been described based on foliage and both occur in the Kučlín flora. *Sloanea nimrodi* and *S. artocarpites*. Besides, two kinds of fruits are associated there, which are newly characterized below.

#### *Sloanea nimrodi* (ETTINGSHAUSEN) KVAČEK et HABLY

Pl. 6, figs 3, 6

- 1869 *Cissus nimrodi* ETTINGSHAUSEN, p. 3, pl. 40, figs 3-4, 6-10.  
1869 *Celastrus cassinefolius* UNGER; Ettingshausen, p. 31, pl. 48, figs 17-18.  
1869 *Cassine palaeogea* ETTINGSHAUSEN; Ettingshausen, p. 38, pro parte pl. 46, fig. 13.  
1869 *Crataegus bilinica* ETTINGSHAUSEN, p. 54, pl. 53, fig. 17.  
1985 *Dicotylophyllum sparsidentatum* BŮŽEK, HOLÝ et KVAČEK; Mai and Walther, p. 117, pl. 9, figs 1-3, text-figs 1/16-17, 2/17-19.  
1995 *Icaciniophyllum nimrodi* (ETTINGSHAUSEN) KVAČEK et BŮŽEK, p. 134, pl. 4, figs 1-6, text-fig. 2.  
2001 *Sloanea nimrodi* (ETTINGSHAUSEN) KVAČEK et HABLY in Kvaček et al., p. 117.

Leaves simple, broadly elliptic to obovate, 30–52 mm long and 18–32 wide (L/W ratio < 2), petiole short, margin coarsely crenulate to double crenulate to sub-entire, venation craspedodromous to eucamptodromous, midrib stout, straight, secondaries in mostly in 5 pairs, basal pair slightly more prominent, opposite, tertiaries much thinner, percurrent and oblique to the secondaries, forming lops along the margin.

**Lectotype** established here: BP 55.2324.1 (Ettingshausen 1869, pl. 40, fig. 6) refigured in pl. 6, fig. 6.

**Discussion:** The leaves of *S. nimrodi* were at first misinterpreted for the Icacinaceae foliage (Kvaček and Bůžek 1995) or merged with a large-leaved *S. olmediaefolia* (UNG.) KVAČEK et HABLY (as *Icaciniophyllum artocarpites* – Mai and Walther 2000), which is similar in its epidermal structure. The co-occurring fruit at Kučlín, described below as *Sloanea manchesteri* sp. n. reveals further traits of this late Eocene small-leaved representative, whose capsules bear longer and coarser spines. On the contrary, the Oligocene *S. olmediaefolia* has been accompanied by finely and shortly spiny fruits of *Sloanea engelhardtii* sp. n. (see below). *S. elliptica* (ANDREÁNSZKY) KVAČEK et HABLY from the Hungarian Oligocene is another species

with robust, variable foliage and very large fruits covered by long spines (Kvaček et al. 2001).

*S. nimrodi* occurs, besides Kučlín, also in the core Úc 9 of the North Bohemian Eocene and is common also in the Late Eocene Zeitz Floral Assemblage of the Weissenster Basin (Mai and Walther 1985 – as *Dicotylophyllum sparsidentatum*; Mai and Walther 2000, pl. 5, fig. 6 – as *Icaciniophyllum artocarpites*). It obviously preferred mesic habitats, as its extant relatives, but occasionally appeared also in the fluvial facies in the mine Haselbach and the sand pit Klaus, as well as in the coal facies in the mine Profen (Mai and Walther 2000). In the Kučlín flora *S. nimrodi* is accompanied by a large-leaved *S. olmediaefolia*, which is very rare there but spread to other localities during the Oligocene (Kvaček et al. 2001, Hably 2010).

**Material:** BP 55.1151.1 (paratype), BP 55.2313.1 (paratype), BP 55.2324.1 (lectotype), BP 55.2330.1, BP 2432.1 (paratypes), NM G 5033, G 7677, G 7895, G 7900a,b, G 8673, G 8674, Olomouc Univ. 204, MMG KIN 266.

#### *Sloanea manchesteri* KVAČEK et TEODORIDIS sp. n.

Pl. 6, fig. 7

2002a *Sloanea* sp.; Kvaček, p. 231, pl. 4, fig. 8.

Compression of the indehiscent spiny capsule, fruit body almost globular, well flattened, ca. 12 mm in diameter, inside smooth, outside with spines 8 mm long and 0.2 mm thick, blunt, subparallel, well separated during the whole length, densely covering the capsule valves.

**Holotype** established here: NM G 7895 – pl. 6, fig. 6.

**Etymology:** Appreciating help extended by our colleague Steven R. Manchester towards better understanding of the Cenozoic floras of North Bohemia.

**Type locality:** Kučlín in North Bohemian České středohoří Mountains, late Eocene.

**Remarks:** The only available specimen differs from similar long spiny capsules of *S. eocenica* (RÁSKY) KVAČEK, HABLY et MANCHESTER (2001) in a more globular form and smaller dimensions.

**Material:** NM G 7895.

#### *Sloanea olmediifolia* (UNGER) HABLY et KVAČEK

Pl 6, fig. 4

- 1850b *Artocarpidium olmediaefolium* UNGER, p. 36, pl. 14, figs 1-2.  
1853 *Quercus goeppertii* ETTINGSHAUSEN, p. 40, pl. 31, figs 17-18.  
1869 *Quercus artocarpites* ETTINGSHAUSEN, p. 63, pl. 55, figs 19-19b.  
1898 *Viburnum oligocainicum* ENGELHARDT, p. 22, pl. 1, fig. 61.  
1898 *Ampelopsis (Cissus) bohémica* ENGELHARDT, p. 27, pl. 2, figs 23-26.  
1898 *Elaedendron grandifolium* ENGELHARDT, p. 33, pl. 2, fig. 32.  
1898 *Euonymus heeri* ENGELHARDT, p. 33, pl. 2, fig. 32.  
1898 *Phyllites quercoides* ENGELHARDT, p. 42, pl. 3, fig. 38.  
1898 *Phyllites amphirocifolius* ENGELHARDT, p. 42, pl. 3, figs 47, 68, 75.  
1976 *Dicotylophyllum sparsidentatum* BŮŽEK, HOLÝ et KVAČEK, p. 105, pl. 10, figs 1-7, pl. 20, figs 5-6, pl. 21, figs 1-6, text-fig. 8.igs. 1-5, pl. 4, figs 1-5, pl. 6, figs 1-7.  
1995 *Icaciniophyllum artocarpites* (ETTINGSHAUSEN) KVAČEK et BŮŽEK, p. 132, pl. 3, figs 1-4, pl. 4, figs 7-9, pl. 6, figs 1-5, text-fig. 1.

- 2001 *Sloanea elliptica* (ANDREÁNSZKY) KVAČEK et HABLY in Kvaček et al., p.117, pl. 2, figs 1-5, pl. 3, figs 1-5, pl. 4, figs 1-5, pl. 6, figs 1-7.  
 2008 *Sloanea olmediaefolia* (UNGER) KVAČEK et HABLY in Hably and Kvaček, p. 140, fig. 1.

**Type:** 1851/03/23 GBA, designated by Hably and Kvaček (2008).

Leaves simple, lamina up to 10 cm long, ovate, base cuneate, apex acute, margin finely widely (to coarsely in Suletice-Berand) dentate, venation craspedodromous / semicraspedodromous, midrib straight, secondaries widely spaced, looping along the margin, partly entering the teeth

**Remarks:** The typical leaf morphotypes assigned to *Sloanea olmediaefolia* are quite rare in the Kučlín flora while certain morphotypes may dominate in other plant assemblages, e.g., at Suletice-Berand (Kvaček and Walther 1995), probably due to microclimatic conditions. This type of foliage is accompanied either by narrow ellipsoidal fruits with shorter spines described below as *Sloanea engelhardtii* sp. n. (at Markvartice, Holý Kluk Hill, Kunderatice) or larger fruits of the same type described as *Sloanea elliptica* (ANDREÁNSZKY) KVAČEK, HABLY et MANCHESTER (2001) (Tard Clay).

**Material:** ČB 4b.

***Sloanea engelhardtii* KVAČEK et TEODORIDIS sp. n.**

Pl. 6, fig. 5

- 1898 *Castanea kubinyi* KOVÁTS; Engelhardt, p. 15, pl. 1, figs 21-23, 25.  
 1976 *Carpolithes* sp. 7; Bůžek et al., p. 118, pl. 9, figs 9-10.  
 1995 *Carpolithes* sp.; Kvaček and Walther, p. 30, fig. 3.  
 2001 *Carpolithes* sp.; Kvaček, Hably and Manchester, p. 115, pl. 1, figs 6-7.

Compressions of the isolated narrow elliptical capsule valves, partly in pairs, 15–20 mm wide and 8 mm wide, inside smooth, outside densely covered with 3–5 mm long blunt spines, subparallel, separated during the whole length.

**Holotype established here:** MMG Su-Be 284 (illustrated by Engelhardt 1898, pl. 1, fig. 2, Kvaček et al. 2001, pl. 1, figs 6-7).

**Etymology:** Appreciating contribution of Herman Engelhardt, to the Tertiary palaeobotany in North Bohemia.

**Type locality:** Suletice-Berand, North Bohemian České středohoří Mountains, Oligocene.

**Remarks:** Rare specimens of these fruits similar in morphology to the designated type from Suletice-Berand regularly accompany the large-leaved morphotype of *Sloanea* in the Oligocene of ČSM (Kvaček et al. 2001, as *Sloanea* sp.), newly also in the late Eocene flora at Kučlín.

**Material:** MMG KIN 398.

**Fabaceae**

***Podocarpium* A. BRAUN ex STITZENBERGER**

***Podocarpium hirsutum* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS comb. n.**

Pl. 5, figs 16-18

- 1869 *Podogonium hirsutum* ETTINGSHAUSEN, p. 60, pl. 55, fig. 11 (basionym).

A pod one-seeded, broadly oval, 23 mm long and 14 mm wide, on the surface finely hairy, leaflet narrow elongate, subsessile, rounded on the apex, slightly asymmetrical and cuneate at the base, venation eucaptodromous, midrib straight, thin, secondaries hardly visible, dense and steep.

**Discussion:** The fruit is similar to the common species of *Podocarpium podocarpum* spread in Eurasian Miocene, although the dense hairiness on the surface clearly differentiate the Kučlín record from the rest of *Podocarpium* fossils. The foliage, which we assign to this unique pod does not differ from the Miocene records.

**Material:** BP 59.1106.2 (fruit and its counterpart), KUC 414A.

***Leguminocarpon* GÖPPERT**

***Leguminocarpon* sp.**

Pl. 5, fig. 15

A fragment of a stout pod showing several traces of rounded seeds up to 7 mm in diameter, densely attached to the ventral side.

**Discussion:** The exact affinity of this fruit is not quite clear, also some of similar forms can be detected in the Hungarian Oligocene (Hably 1992).

**Material:** NM G 8648a, b.

***Leguminosites* BOWERBANK emend. SCHIMPER**

***Leguminosites* sp. 1**

Pl. 5, figs 19-20

Detached leaflets sessile, entire-margined, 20–25 mm wide and ca. 50 mm long elliptic, midrib straight, medium thick, secondaries very delicate eucaptodromous, dense, with intersecondaries.

**Material:** KUC 423, KIN 358.

***Leguminosites* sp. 2**

Pl. 6, figs 1-2

Compound leaves fragmentary, consisting of a few pairs of opposite leaflets, most leaflets detached, sessile, entire-margined, elliptical or narrow elongate, venation eucamptodromous, midrib straight, secondaries very thin, dense, at an angle of ca. 60°.

**Discussion:** Legume leaflets are not rare in the Kučlín flora and may represent several morphotypes with variously shaped laminas. In the present treatment only two are recognized. Closer affinities are difficult to judge merely on the morphology of foliage.

**Material:** KIN 209.1, KIN 388.

**Rhamnaceae**

***Ziziphus* MILLER**

***Ziziphus bilinica* ETTINGSHAUSEN**

Pl. 16, figs 3-5

- 1869 *Ziziphus bilinicus* ETTINGSHAUSEN, p. 40, pl. 51, fig. 1.  
 1990 *Ziziphus ungeri* HEER; Bůžek et al., p. 172, fig. 3.20.  
 2001 *Ziziphus bilinicus* ETTINGSHAUSEN; Hably et al., p. 41, pl. 37, fig. 3.

Twig with attached alternate leaves, detached leaves short petiolate, lamina ovate to broadly ovate, asymmetrical, base rounded, margin serrate to fine serrate, apex missing, venation triveined, acrodromous, midrib slightly bent, basal veins reaching well above half of the lamina or almost into the apex, higher secondaries very few, thin, tertiaries perpendicular to the midrib, dense.

**Discussion:** This species is often merged with *Ziziphus ziziphoides* (UNGER) WEYLAND, a common Oligocene plant in Europe. We maintain the Kučlín population separate because *Ziziphus*-like morphotypes require a more detailed revision in Europe, which is beyond the scope of the present study.

**Material:** BP 59.1139.1 (holotype), KUC 141A.

## Ulmaceae

### *Cedrelospermum* SAPORTA emend. Manchester

This morphogenus of the extinct Ulmaceae is based on a detached fruit of *Cedrelospermum aquense* (SAPORTA) SAPORTA, 1889 (?? *Embothrites aquensis* SAPORTA, 1865 refigured in Manchester 1987a, b, pl. 1, fig. 4) from the Oligocene of France (Aix-en-Provence). In the genus *Cedrelospermum*, Saporta (1889) originally included several kinds of mesofossils, which he believed to represent seeds. In his concept he included as a synonym *Embothrites* UNGER arguing that such fossils do not belong to the Proteaceae.

Manchester (1987a, b: 120) firstly emended *Cedrelospermum* for detached fruits only and incorrectly suggested as the lectotype *C. leptospermum* (ETTINGSHAUSEN) MANCHESTER (= *Embothrites leptospermus* ETTINGSHAUSEN, 1853) from Häring stressing the differences from the similar type specimen of *Embothrites borealis* UNGER from Socka, Slovenia (Unger 1850b). He subsequently newly corrected his previous typification (Manchester 1989: 261-262). He suggested *Cedrelospermum aquense* as a type of *Cedrelospermum* and offered a new emendation to include detached fruits as well as fertile foliage twigs on the basis of more complete material from the Paleogene of the USA (*Cedrelospermum lineatum* (LESQUEREUX) MANCHESTER (= *Banksites lineatus* LESQUEREUX, 1883), Florissant, *C. nervosum* (NEWBERRY) MANCHESTER (= *Planera nervosa* NEWBERRY, 1883) as well the fruits from Europe. Manchester (1987a: 262) merged at this occasion *C. aquense* with the previously treated species *C. leptospermum* leaving the species taxonomy open. However, he noticed the size differences among European Tertiary populations (Manchester 1987a: 262, footnote).

After more material from Europe has become available (Wilde and Manchester 2003) Manchester's suspicion can be confirmed. The differences in the fruit size go along with changes in co-occurring leaf morphology. At least two species of *Cedrelospermum* are recognizable in Europe (Wilde and Manchester 2003), one with small fruits and narrower leaves (Häring, Messel, Kučlín) and others with larger fruits and variable foliage (see also Kovar-Eder et al. 2004, Hably and Thiébaud 2002). From the late Eocene diatomite at Kučlín, Kvaček (2002a) first announced such fruits and foliage but treated both organs under the same headings. In the present treatment, a traditional separa-

tion of the fruits and foliage morphogenera is preferred in spite of the interconnection between fruits and foliage both in North America and Europe (Wilde and Manchester 2002).

### *Cedrelospermum leptospermum* (ETTINGSHAUSEN) MANCHESTER

Pl. 6, figs 14-15.

- 1853 *Embothrites leptospermus* ETTINGSHAUSEN, p. 51, pl. 14, figs 15-25.  
 1987a *Cedrelospermum leptospermum* (ETTINGSHAUSEN) MANCHESTER, p. 122, pro parte (non pl. 1, figs 1-4, pl. 2, fig. 11).  
 1989 *Cedrelospermum aquense* (SAPORTA) SAPORTA; Manchester, p. 270, pro parte, only fig. 41 (refigured type of *Embothrites leptospermus* ETTINGSHAUSEN, p. 51, pl. 14, fig. 21).  
 2002a *Cedrelospermum leptospermum* (ETTINGSHAUSEN) MANCHESTER; Kvaček, p. 223, pro parte, only pl. 2, fig. 10.  
 2003 *Cedrelospermum leptospermum* (ETTINGSHAUSEN) MANCHESTER emend. Wilde and Manchester, p. 148, pl. 1, figs 1-2.

**Lectotype:** NHMV Ett. 13, Häring, Ettingshausen 1853, pl. 14, fig. 21, Manchester 1989, fig. 45 (selected by Wilde and Manchester 2003).

Samaras 9–11 mm long and 4–5 mm wide containing a flattened elliptical endocarp 1.5–2 x 2.5 mm in size basally and a slightly oblique oblong wing laterally attached to the fruit body. The wing shows distally a minute stigmatic cleft. Venation of the wing is not apparent due to poor preservation.

**Discussion:** The three specimens from Kučlín match in size and form the more numerous fruits from Häring (late Eocene) and do not differ from incomplete samaras found in the middle Eocene of Messel (Wilde and Manchester 2003, Collinson et al, in prep.). The Oligocene fruits from Aix-en-Provence (Saporta 1889), Rott (Manchester 1987a) and the Lower–Middle Miocene from Randeck (Rüffle 1963) and Parschlug (Kovar-Eder et al. 2004) exceed in size of fruits all three Eocene populations and are attributed to different species (Kovar-Eder et al 2004).

**Material:** MMG KIN 192, NM G 7894, DB KUC 116.

### *Tremophyllum* RÜFFLE

On the basis of *Quercus tremophylla* WEBER from Rott Rüffle (1963) installed a fossil genus of foliage now known to correspond with the fruits of *Cedrelospermum*. At least for Europe different species better show differentiation of this extinct ulmoid through its evolution from the Eocene to the Miocene in Europe.

### *Tremophyllum microphyllum* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS comb. n.

Pl. 6, figs 11-13, 16, 18-21.

- 1868 *Banksia longifolia* ETTINGSHAUSEN; Ettingshausen, p. 15, pl. 35, figs 11-12.  
 1869 *Callicoma microphylla* ETTINGSHAUSEN; pp. 5-6, pl. 40, figs 17, 18, 21, 22 (Basionym).  
 2001 *Callicoma microphylla* ETTINGSHAUSEN; Hably et al, p. 16, pl. 6, figs 3, 4, 5, 6, 8, 9, 10.  
 2002a *Cedrelospermum* sp. Kvaček, p. 221, pl. 2, fig. 3.

Leaves simple, petiole short, stout, lamina narrow, falcate, uniform in form, from linear to narrow elliptic to narrow lanceolate, margin finely simple toothed, venation craspedodromous, midrib thick, usually curved, secondaries dense, the number of pairs corresponding to the marginal teeth, higher-order venation reticulate.

**D i s c u s s i o n :** *Tremophyllum microphyllum* is similar to slender leaves attached to a fertile twig of *Cedrelospermum* from Messel (Wilde and Manchester 2003). The Kučlín population is much more variable in size and is one of the most frequent morphotypes in the Kučlín flora.

**M a t e r i a l :** BP55.2394.1, 55.2304.1, 55 2421.1, 55.2431.1, 55.2482.1, 55.2492.1, 56.1144.1, at KUC, NM G 7894, G 7897a,b, G 8641-44, G 8659, G 8664, G 8665 and many other specimens.

#### **Ulmites KVAČEK, MANUM et BOULTER**

##### ***Ulmites* sp.**

Pl. 6, fig. 17

1869 *Rhamnus bilinicus* UNGER; Ettingshausen, p. 41, pl. 50, fig. 19.  
2001 *Rhamnus bilinicus* UNGER; Hably, p. 59, pl. 73, fig. 4.

Leaf simple, sessile, lamina minute, elliptical, regularly serrate on margin.

**D i s c u s s i o n :** The unique specimen recalls ulmoid foliage which is in larger specimens spread in various Palaeogene sites, e.g., Messel and also at Spitsbergen (Budantsev and Golovneva 2010, as *Ulmus*). Kvaček, Manum and Boulter (1994) suggested a non-committal name *Ulmites* for such morphotypes that may not unequivocally belong to the genus *Ulmus*. Fertile remains of *Ulmus* were recorded in the Eocene of North America (for review see Denk and Dillhof 2005).

**M a t e r i a l :** BP 59.1072.1.

#### **Fagaceae**

##### ***Eotrigonobalanus* WALTHER et KVAČEK**

##### ***Eotrigonobalanus furcinervis* (ROSSMÄSSLER) WALTHER et KVAČEK**

Pl. 7, figs 8-10, pl. 18, figs 2-3

2002a *Eotrigonobalanus furcinervis* (ROSSMÄSSLER) WALTHER et KVAČEK; Kvaček, p. 223, pl. 2, fig. 4.

(For more detailed synonymy see Kvaček and Walther 1989 and Knobloch et al. 1996)

Leaves simple, lamina ovate, up to 160 mm long and 84 mm wide, margin shallowly to coarsely dentate, rarely entire, venation semicraspedodromous (to camptodromous in the entire parts), midrib strong, straight, running directly to the apex region, apex not always fully preserved, secondaries in ten to more pairs, slightly bent, at an angle of 40–50°, in marginal region ending in loops which are connected with the next apical secondary, mostly one intersecondary between successive secondaries, tertiaries percurrent, almost at a right angle to the secondaries, higher order of venation not well preserved.

**D i s c u s s i o n :** Leaves of this extinct fagaceous element are common in the Late Eocene fluviatile sandstones of the Staré Sedlo Fm. and other sites of this kind in Germany, Ukraine and elsewhere in Europe (Kvaček and Walt-

her 1989) but quite rare in volcanic facies. Several leaves have been recovered at Kučlín, of which some of enormous size (pl. 18, figs 2-3). Entire-margined *E. furcinervis* ssp. *flagelliformis* (ROSSM.) E. KNOBLOCH et. KVAČEK occur quite rarely. This tree preferred oligotrophic acidic soils of peat-forming basins but occurred scarcely in mesophytic volcanic assemblages.

**M a t e r i a l :** NM G 8629, G 8630, KUC 1.

##### ***Trigonobalanopsis* KVAČEK et WALTHER**

##### ***Trigonobalanopsis rhamnoides* (ROSSMÄSSLER) KVAČEK et WALTHER**

Pl. 7, fig. 7

1988 *Trigonobalanopsis rhamnoides* (ROSSMÄSSLER) KVAČEK et WALTHER, p. 405, pl. 2, figs 1-8, pls 50-54, pl. 55, figs 2-7, pl. 56, figs 1-4, pl. 57, text-figs 2-4.

Leaves petiolate, incompletely preserved, lamina narrow elliptical, base cuneate, margin entire, venation brochidodromous, midrib straight, secondaries very regularly disposed, bent, subparallel, at an angle of ca. 35°. Higher-order venation not preserved.

**D i s c u s s i o n :** This extinct member of the Fagaceae has been usually recognized mainly according to its rhamnoid venation (*Phyllites rhamnoides* ROSSM.). Its occurrences in the Eocene are rare (Knobloch et al 1996). In the volcanic facies *Trigonobalanopsis* was usually poorly represented (Rott, as *Rhamnus dechenii* WEBER) while it was a dominant element in the Miocene mastixioid floras (Kvaček and Walther 1988). The occurrence of rare specimens at Kučlín is quite exceptional outside the Late Eocene riparian vegetation in the Bohemian Massif.

**M a t e r i a l :** KIN 372.

##### **? *Quercus* L.**

##### **? *Quercus* sp.**

Pl. 7, fig. 11

Oak-like cupule 10 mm in diameter covered densely by minute scales adhering to the surface.

**D i s c u s s i o n :** This is the only evidence of possible oaks in the flora of Kučlín. The only minute specimen is an equivocal proof because similar cupules are developed also in *Lithocarpus*. And it may lead to the question whether some of the leaf impressions determined as *Eotrigonobalanus* could in fact represent *Quercus*. Without preservation of epidermal characters, it may be impossible to distinguish some species of these genera.

In any case, the affinity of the cupule to the Fagaceae is highly probable.

**M a t e r i a l :** KUC 401 B.

#### **Juglandaceae**

##### **? *Carya* NUTT.**

##### **? *Carya fragiliformis* (STERNBERG) KVAČEK et WALTHER**

Pl. 7, fig. 13

? 1825 *Phyllites fragiliformis* STERNBERG, p. 42, index iconum, pl. 50, fig. 1.



1866 *Carya bilinica* UNG. sp.; Ettingshausen, p. 46, pro parte, pl. 52, fig. 7.

? 2007 *Carya fragiliformis* (STERNBERG) WALTHER et KVAČEK, pp. 110-112, pl. 11, figs 1-3, pl. 23, figs 8-10, text-fig. 6b.

**Description:** A single incomplete detached leaflet, sessile, oval, lamina up to 35 mm wide, apex not preserved, base rounded to cuneate, slightly asymmetrical, margin subentire venation eucaptodromous, partly semicraspedodromous, midvein almost straight, secondaries in 7 pairs, opposite in the base of the lamina, then alternate, more or less bent admedially, at angles of about 45°; tertiaries percurrent, almost at right angle.

**Remarks:** This fragmentary leaflet may belong to the foliage of *Carya* widely spread in the Oligocene of the České středohoří Mountains. The specimen is very incomplete and the determination remains equivocal.

**Material studied:** BP 55.2405.1, NM G 428.

### ***Engelhardia* LESCHEN. ex BUME.**

#### ***Engelhardia orsbergensis* (WESSEL et WEBER)**

**JÄHNICHEN, MAI et WALTHER**

Pl. 7, figs 15-18

1856 *Banksia orsbergensis* WESSEL et WEBER, p. 146, pl. 25, figs 9a-d.

? 1868 *Banksia haeringiana* ETTINGSHAUSEN; Ettingshausen, p. 16, pl. 35, figs 16-17.

1869 *Sapindus cassioides* ETTINGSHAUSEN, p. 26, pl. 46, figs 1-2, 3-6, 7.

1869 *Sapindophyllum spinuloso-dentatum* ETTINGSHAUSEN, p. 26, pl. 46, fig. 27.

1869 *Sapindophyllum acuminatum* ETTINGSHAUSEN, p. 27, sine ic.

? 1869 *Dodonea salicites* ETTINGSHAUSEN, p. 28, pl. 47, fig. 11.

1880 *Sapindus cassioides* ETTINGSHAUSEN; Sieber, p. 87, pl. 2, fig. 12.

1977 *Engelhardia orsbergensis* (WESSEL et WEBER) JÄHNICHEN, MAI et WALTHER, pp. 326-346, pls 38-49, text-figs 1-3 (localities and stratigraphy see Jähnichen et al. 1977, pp. 336-337).

1990 *Palaeocarya orsbergensis* (WESSEL et WEBER) JÄHNICHEN, FRIEDRICH et TAKÁČ; Bůžek, Fejfar, Konzalová and Kvaček, p. 172, fig. 3.18.

2001 *Sapindus cassioides* ETTINGSHAUSEN; Hably et al., pp. 35-36, pl. 32, fig. 1, pl. 33, fig. 1.

2001 *Sapindophyllum acuminatum* ETTINGSHAUSEN; Hably et al., p. 35, pl. 30, fig. 6.

2002a *Engelhardia orsbergensis* (WEBER) JÄHNICHEN, MAI et WALTHER; Kvaček, p. 223.

Leaves pinnately compound, leaflets incompletely preserved, sessile, subopposite, lamina narrow oblong, straight to slightly falcate, 40 and more mm long, and 10–20 mm wide, base asymmetrical, cuneate to rounded, apex acute, margin basally entire, higher up widely minutely serrate, tooth tips bluntly acute, partly abmedially oblique, sinus shallow, acute to blunt; venation semicraspedodromous, midrib slightly curved to straight, thick, secondaries delicate, dense, under wide angles, running and looping very near the margin and sending veinlets near the sinus into the tooth, intersecondaries dense, parallel with the secondaries; venation details poorly preserved

**Discussion:** Leaflets of *Engelhardia orsbergensis* occur quite rarely at Kučlín while they are common in the

Oligocene of, e.g., Suletice-Berand (Kvaček and Walther 1995), Holý Kluk hill at Proboštov (Radoň et al. 2006) and Haselbach (Jähnichen et al. 1977, Walther in Mai and Walther 1978). As in other sites, also at Kučlín they are accompanied by fruits of *E. macroptera* (see below). *Engelhardia* belongs certainly to thermophilous and mesophytic elements.

**Material studied:** NM G 360, G 8631, KIN 375, BP 55.2469.1.

### ***Engelhardia macroptera* (BRONGNIART) UNGER**

Pl. 7, fig. 19

1869 *Engelhardia brongniartii* SAPORTA; Ettingshausen, p. 48, pl. 53, figs 3-10.

1977 *Engelhardia macroptera* (BRONGNIART) UNGER; Jähnichen, Mai and Walther, pp. 346-351, pls 54-56, text-figs 7-9 (localities and stratigraphy see Jähnichen et al. 1977, p. 351).

Involucre trilobate, with the nutlet about 6 mm across, basally attached, poorly preserved, medial lobe 30 mm, lateral lobes 25 mm long and about 7 mm wide, widely spread, elongate, at tips rounded, venation not preserved.

**Remarks:** Fruits of *Engelhardia macroptera*, a thermophilic extinct species of the Juglandaceae, do not differ from the other records of the same species in the volcanic floras (e.g., Kvaček and Walther 1995). They are again accompanied by typical leaves and isolated leaflets at Kučlín (*Engelhardia orsbergensis*), inferred to belong to the same plant as in many other sites (e.g., Holý Kluk, Suletice-Berand).

**Material:** BP 55. 2347.1, 55.2372.1, 55.2459.1, KIN 516, NM G 8658.

### ***Hooleya* E. M. REID et CHANDLER**

#### ***Hooleya hermis* (UNGER) E. M. REID et CHANDLER**

Pl. 7, figs 20-21

1926 *Hooleya hermis* (UNGER) E. M. REID et CHANDLER, p. 93, pl. 6, figs 7-9.

2002a *Hooleya hermis* (UNGER) E. M. REID et CHANDLER; Kvaček, p. 223, pl. 7, fig 6 above.

Fruits double winged, nut centrally positioned, ca. 6 mm across, wings reniform, laterally attached in one plane, showing very fine radially disposed venation.

**Discussion:** This extinct member of the Juglandaceae (Wing and Hickey 1984) was described from the Early Oligocene to latest Eocene Bembridge Marl (Reid and Chandler 1926), Socka (Unger 1850b) and from other localities of the European Eocene (e.g., Eckfeld – Frankenhäuser and Wilde 1994, Messel – Manchester et al. 1994), rarely in Early Oligocene (Manchester 1987a). Although the whole plant is not known, typical slender, fine toothed leaflets and complete leaves accompany these juglandaceous fruits at Eckfeld (Wilde and Frankenhäuser 1998). Also at Kučlín, these fruits co-occur with juglandaceous foliage of this kind (see the next heading, specimens Nos BP 55.2380.1, 55.2341.1, KIN 20.1).

**Material:** KIN126, 128, NM G 3724.

### *Juglandiphyllites* BOULTER et KVAČEK

This fossil genus was installed for juglandoid foliage of uncertain affinities (Boulter and Kvaček 1989).

#### *Juglandiphyllites* sp.

Pl. 7, fig. 12, pl. 8, figs 1-2

- 1868 *Dryandroides acuminata* ETTINGSHAUSEN, p. 52 sin. descr., pl. 35, fig. 10.  
1869 *Sapindus basilicus* UNGER; Ettingshausen, p. 25, pl. 47, fig. 13.  
2001 *Dryandroides acuminatus* ETTINGSHAUSEN; Hably et al., p. 51, pl. 59, fig. 9.  
2001 *Sapindus basilicus* UNGER; Hably et al., p. 60, pl. 59, fig. 9.

Leaflets (?) sessile, lamina slightly asymmetrical, subentire, 16 to 36 mm wide, 59 to 114 mm long, apex rounded, if preserved, base cuneate, venation semicraspedodromous, midrib bent, secondaries closely spaced, dense, at narrower angles on one side of the midrib than the other, looping along the margin, intersecondaries partly present, tertiaries not well preserved.

**D i s c u s s i o n :** These rare leaflets of juglandaceous affinity are not assignable to a natural genus. We suspect they may correspond to *Hooleya*.

**M a t e r i a l :** BP 55.2380.1, 55.2341.1, KIN 20.1.

## Malvaceae

### *Byttneriopsis* KVAČEK et WILDE

The detailed circumscription of this morphogenus is mainly based on rich and well preserved material from the Middle Eocene of Messel allowing studies of epidermal characters. Several malvacean leaf morphotypes can be distinguished in this plant taphocoenosis. The critical character supporting malvacean affinities are specific types of trichomes and their bases. Most typical are simple rounded to elliptic bases, on which remains of the barrel-shaped glandular trichomes composed of many segments parallel to the trichome length are occasionally preserved. They correspond to a general form of multicellular glandular trichomes commonly distributed throughout the Malvales (see Kvaček and Wilde 2010). Another kind of pubescence is represented by complex trichome bases as sometimes seen in the material from Messel, which may have carried stellate-multiradiate trichomes. The latter are also characteristic of most members of the malvacean alliance (e.g., *Eriolaena*).

The morphogenus *Byttneriopsis* differs from the two other malvacean foliage morphogenera *Byttneriophyllum* and *Plafkeria* in the symmetry of the basal venation. The distinction from *Dombeyopsis* UNGER also with symmetrical venation, which is accepted in a restricted sense as suggested by Kvaček (2005), viz. to include the only species *D. lobata* typical of trilobate leaves with occasionally undulate to dentate margins is in a different abaxial epidermis with a dense indumentum of stellate trichomes. Other leaves similar to the new morphogenus are those of "*Ficus*" *truncata* HEER *sensu* Bůžek (1971) which are also of malvacean affinity and have recently been discussed as *Laria rueminiiana* (HEER) G. WOROBIEC et KVAČEK possibly related to *Reevesia* (Worobiec et al. 2010). They differ from *Byttneriopsis* in showing a less regular tertiary and higher-

order venation between the primaries (Worobiec 2003; Worobiec et al. 2010).

### *Byttneriopsis daphnogenes* (ETTINGSHAUSEN)

KVAČEK et WILDE

Pl. 8, figs 4-6

- 1866 *Ficus daphnogenes* ETTINGSHAUSEN, p. 77 (basionym), pl. 22, figs 1, 2 (lectotype), 8, 9.  
1866 *Ficus goeppertii* ETTINGSHAUSEN, p. 73, partim, pl. 19, figs 1, 2.  
1866 *Ficus gaudinii* ETTINGSHAUSEN, p. 76, pl. 21, figs 1, 2.  
1866 *Ficus reussii* ETTINGSHAUSEN, p. 79, pl. 22, figs 3, 4, 7, 10.  
1866 *Ficus rueminiianum* HEER *sensu* Ettingshausen (non Heer), p. 76, pl. 22, fig. 5.  
2010 *Byttneriopsis daphnogenes* (ETTINGSHAUSEN) KVAČEK et WILDE, p. 166, figs 2A-J, 3A-E, 7A-H, 8A-B.

For further synonyms see Kvaček and Wilde (2010).

**L e c t o t y p e :** BP 55.2477.1 illustrated by Ettingshausen (1866, pl. 22, fig. 2 as *Ficus daphnogenes*) – Kučlín, North Bohemia, Late Eocene) and reillustrated in Hably et al. (2001).

Leaves alternate, variable in lamina shape and size as well as in epidermal structure, simple, long petiolate, petiole 3–4 cm long, often pulvinate at the attachment to lamina and geniculate; lamina entire margined, hypostomatic, elongate to narrow ovate (length/width mostly more than 1.5), 4 to more than 6 cm long, 2.5–4 cm wide, symmetrical to moderately asymmetrical at the base, rounded, rarely truncate to subcordate, acute to acuminate at the apex, texture chartaceous to coriaceous, venation eucamptodromous, basally triveined, rarely with thin additional outer basal veins, midrib straight or slightly bent, lateral primaries thin, slightly bent, reaching rarely more than half, but usually one third of the lamina length or lower, secondaries irregularly alternate, arising at uneven distances of about 1–3 cm at an angle of 30–45°, bent, tertiaries percurrent or forked, dense, almost perpendicular to the secondaries, areoles mostly quadrangular without veinlets.

**D i s c u s s i o n :** The leaf anatomical characteristics given by Kvaček and Wilde (2010) are based on the material of Messel. The morphological variation of both populations of Messel and Kučlín does not differ in any respect.

**M a t e r i a l :** BP 55.2329.1, 55.2358.1, 55.2477.1.1, 55.2481, DB KUC-53, 160, 199, 200, CGS CB 13 and many others, partly sine numero.

### *Byttneriopsis steuerii* (ENGELHARDT) KVAČEK et WILDE

Pl 8, figs 10-13

- 2010 *Byttneriopsis steuerii* (ENGELHARDT) KVAČEK et WILDE, p. 168, figs 2K, 3F, 4A-D, 5E, 6C-E, 8C-D.

Leaves simple, petiolate, petiole incomplete, often pulvinate, lamina broadly ovate, more than 120 mm long, 100 mm wide, shallowly cordate to truncate at base, apex missing, venation actinodromous–brochidodromous, typically palmately 5 (to 7-veined), ± symmetrical, texture chartaceous.

**D i s c u s s i o n :** The flora of Kučlín yielded only two specimens of this broader morphotype of *Byttneriopsis*, which is much better represented at Messel.

**M a t e r i a l :** BD KUC 51, KUC 218.

**cf. *Acherniaephyllum* RASKY**

**cf. *Acherniaephyllum hydrarchos* (UNGER) HABLY**

Pl. 8, fig. 3

- 1866 *Populus mutabilis* HEER; Ettingshausen, p. 85, pl. 28, fig. 8.  
2001 *Populus mutabilis* HEER; Hably et al., p.58, pl. 72, fig. 2.

Leaf simple, long petiolate, lamina broadly oval, base slightly cordate, apex blunt, missing, venation triveined, midrib straight, basal veins starting at the very base, higher secondaries widely spaced, poorly visible.

**D i s c u s s i o n :** Similar and much more abundant leaves occur in the Oligocene of Hungary and Italy (Hably 2010).

**M a t e r i a l :** BP 559.117.1.

***Saportaspermum* MEYER et MANCHESTER**

***Saportaspermum kovacsiae* KVAČEK et WILDE**

Pl. 8, figs 7-8

- 1959 *Cedrelospermum* sp. type I *sensu* É. Kovács, p. 140, fig. 7 (Lábatlan, MÁFI).  
1959 *Cedrelospermum* sp. type II *sensu* É. Kovács, p. 140, fig. 8 (Lábatlan, MÁFI).  
2010 *Saportaspermum kovacsiae* KVAČEK et WILDE, p. 172, figs 9A-H.

Seeds winged, with an elliptical to subrounded seed body, strengthened at the base and somewhat pointed at the opposite end, with a single narrow elongate membranous wing. Seed body oriented slightly obliquely to the long axis of the wing. One of the lateral margins is straight, the other slightly convex, distal end of wing rounded.

**D i s c u s s i o n :** Several morphotypes connected with transitions can be recognized and assigned to this species: In the opinion of Kvaček and Wilde (2010) they represent mere stages of maturation. Specimens designated *Cedrelospermum* sp. type I *sensu* Kovács (1959, p. 140, fig. 7 – Lábatlan) and most of the material from Messel and Kučlín (Pl. 7, figs 8-9) represent fully mature seeds with a robust seed body, sometimes truncate or with a more acute base, ca. 9 mm long and 4–6 mm high. The wing is almost parallel-sided, slightly narrowed towards the end, 22 to 28 mm long. The dorsal side of the wing is straight, slightly thickened and indistinctly deflected behind the seed body; the ventral side is also straight. The specimens from Lábatlan designated as *Cedrelospermum* sp. type II *sensu* Kovács (1959, p. 140, fig. 8, MAFI BK 3526/L 107 and other not figured material BK 3487/L26, 24) are smaller than the previous morphotype I with the wing 16 mm long, the dorsal side straight or slightly bent, ventral side straight. Not all species of *Cedrelospermum* are assignable to *C. kovacsiae* and are treated in a separate heading below.

**M a t e r i a l s t u d i e d :** KIN 54, KUC 12A.

***Saportaspermum* sp. div.**

Pl. 8, fig. 9

- 2002a *Saportaspermum* sp. div., Kvaček, p. 224, pl. 1, fig. 4.

Winged seeds of smaller size than *S. kovacsiae* with the wing attached obliquely to the seed body.

**D i s c u s s i o n :** Such seeds corresponding in general form to the generitype (Meyer and Manchester 1997) were

originally described as belonging to the same group as *Cedrelospermum* by Saporta (1889), but differ in the seed form and the lack of wing venation. One part of bigger seeds with the dorsal edge of the wing parallel to the seed part was already treated as *Cedrelospermum kovacsiae* above. Some more different and smaller forms are still distributed during Eocene to Miocene times in Europe and only during the Oligocene in North America. Seeds of the *Saportaspermum*-type different from *S. kovacsiae* also occur at Kučlín (Kvaček 2002a) and may belong to other genera of the Malvaceae, e.g., *Reevesia*.

**M a t e r i a l :** KUC 456.

**“*Acer*” *sotzkianum* UNGER**

Pl. 9, figs 8, 10

- 1850b *Acer sotzkianum* UNGER, p. 175, pl. 50, fig. 3.  
1990 *Acer bohemicum sensu* Mai; Bůžek et al., pp. 171-172, fig. 3.17.  
2002a “*Acer*” *sotzkianum* UNGER; Kvaček, p. 224, pl. 2, fig. 1.

Simple samaras of the form of halves of maple samaras. Fruit body narrow oval straight on the dorsal side, slightly rounded ventrally, blunt or shortly broadly stipulate apically, attached to broad wing arising one third of the fruit body on the ventral side and continuing from the dorsal thickened margin of the fruit. Wing very flat and thin almost without any venation visible. On the fruit apex no traces of attachment to a second fruit.

**D i s c u s s i o n :** Affinities of these fruits similar to halves of maple double samara are controversial. These samaras occur rarely at the Late Eocene type locality of Socka (Unger 1850b) and they occur quite occasionally at Kučlín. Unique specimens are known from the Mrtvý vrch Hill and elsewhere in the České středohoří Mountains, e.g., in the Oligocene of Holý Kluk (Radoň, Kvaček and Walther 201). To our mind there are no other occurrences besides those mentioned above and the type locality Socka of Oligocene (? Eocene) age in Slovenia (Mai 1999). The narrowed base of the seed part occasionally with short remains of the stalk suggests that the fruits represent rather single samaras, unlike the typical double samaras of maple. Mai (1999) believes that the fruits of *Acer* subgen. *Negundo* are most similar, but the *Negundo*-like foliage nowhere co-occurs with the mentioned fruits. The much larger fruits of very similar form belonging to the Malvaceae are common in the late Miocene and Pliocene of Europe and assigned to Malphigiaceae by Kräusel (1852) as *Banisteriaecarpum*. We hesitate to use this fossil genus for the fruits from Socka and Kučlín before a connection to the corresponding foliage has been recognized.

**M a t e r i a l :** BP 55.1132.1, 55.2393.1, 55.2395.1, NM G 7893a,b.

***Sterculia* L.**

***Sterculia crassinervia* (ETTINGSHAUSEN) PROCHÁZKA**

Pl. 9, figs 7, 9, 11

- 1868 *Platanus aceroides* GÖPPERT; Ettingshausen, p. 84, pl. 29, fig. 7.  
1869 *Acer crassinervium* ETTINGSHAUSEN, p. 22, pro parte, pl. 45, figs 9-13, 15-16 (non 8, 14 = “*Acer*” *sotzkianum* UNG.).

- 1975 *Sterculia crassinervia* (ETTINGSHAUSEN) PROCHÁZKA in Procházka and Bůžek, p. 59.  
 1990 *Sterculia crassinervia* (ETTINGSHAUSEN) PROCHÁZKA et BŮŽEK, Bůžek et al., p. 172, fig. 3.15.

Leaves simple, trilobate (abnormally bilobate, with one lobe reduced), petiole long, indistinctly geniculate at the attachment with the lamina, lamina broadly ovate to quadrangular, entire-margined or widely, wide and long, lobes short and blunt, directed to the leaf apex, main apical lobe wide triangular, venation tri-palmate, primaries arising directly from the lamina base, secondary veins widely spaced.

Lectotype selected by Procházka and Bůžek (1975) has been illustrated by Ettingshausen (1869, pl. 45, fig. 13) and is housed in Budapest Natural History Museum (BP 55.2416.1) – refigured in pl. 9, fig. 11.

**D i s c u s s i o n :** Such leaves recalling maples already described from Kučlín (Ettingshausen 1869, as *Acer crassinervium*) were originally joined with the fruits of *A. sotzkianum* under the same taxon *Acer crassinervium* by Ettingshausen (1869). When Procházka (in Procházka and Bůžek 1975) made a revision of the Tertiary maples occurring in the Bohemian Massive he rejected Ettingshausen's opinion that the leaves represent true maples and transferred these leaves of *A. crassinervium* to the genus *Sterculia* (Malvaceae sensu lato) on the basis of the venation, large morphological variation and overall comparison with the maples. In our opinion the malvolean affinities of *A. crassinervium* are more probable, even though it may not be appropriate to assign it directly to *Sterculia*. The leaves of this kind are morphologically variable and some recall other malvolean morphotypes described above as *Byttneriopsis*. Neither Procházka nor we are able to suggest any living species of *Sterculia* with leaf morphology that would support the affinity to this genus. The fusion of leaves with quite unusual fruits as suggested by Ettingshausen cannot be supported. The fruits of *A. sotzkianum* occur independently from *S. crassinervia* at Sotzka and Holý Kluk (Radoň et al. 2006), the leaves are not accompanied with the fruits at Bechlejšovice, where *S. crassinervia* occurs at the single locality besides Kučlín (Kvaček and Walther 2004, Manchester 1987).

**M a t e r i a l :** BP 55.2393.1, 55.2416.1, 55.2476.1, NM G 3677.

#### ***Sterculia labrusca* (UNGER) UNGER**

Pl. 9, figs 5-6. pl. 13, figs 6-7

- 1850a *Laurus labrusca* UNGER, p. 433.  
 1850b *Sterculia labrusca* UNGER; Unger, p. 175, pl. 49, figs 1-11.  
 1869 *Sterculia labrusca* UNGER; Ettingshausen, p. 13, pl. 43, figs 4, 5.  
 1990 *Sterculia labrusca* UNGER; Bůžek et al., p. 172, fig. 3.25.

Leaves simple, with thick petiole, lamina trilobate, lobes narrow and partly apically directed, partly patent, margin entire, venation tri-palmate, primaries thick, arising directly from the lamina base, secundaris veins numerous, arising perpendicularly, intersecondaries thin and parallel, venation of higher order poorly preserved.

**D i s c u s s i o n :** These trilobate leaves with slender, almost parallel-sided lobes were rarely recovered at Kučlín (Ettingshausen 1869, pl. 43, figs 4-5). This species varies in

leaf size and lobes. Most of the specimens recovered in the Staré Sedlo Fm. (Knobloch et al. 1996) are smaller, but the leaf described by Engelhardt (1876, pl. 27, fig. 17) from the Žitenice quartzite matches well that from Kučlín. The other occurrences in the European Palaeogene (e.g., Geiseltal – Rufflé et al. 1976) may differ specifically and suggest that this foliage taxon may fall into smaller morphotypes, as already recognized by Ettingshausen (1869).

The affinity of *Sterculia labrusca* is not fully clarified (Knobloch et al. 1996) and the often suggested as *Brachychiton* (Sterculiaceae), is unlikely because of its modern distribution in Australia. In its epidermal anatomy the material from Geiseltal (Rufflé et al. 1976) deviates from the standard pattern of living sterculias (lack of stellate trichomes, paracytic stomata). No other leaf anatomical data are available from other occurrences in Europe, in particular from the type locality Socka in Slovenia.

**M a t e r i a l :** BP 55. 2401.1, NM G 8654.

#### **? *Luheopsis* LANGERON**

##### **? *Luheopsis* sp.**

Pl. 9, figs 3-4

Leaf fragmentary, ? orbicular, on the base shallowly cordate margin coarsely dentate, venation is not visible except for the straight midrib.

**D i s c u s s i o n :** Similar aberrant leaf forms are known from the Palaeocene of France (Menat, Sezanne – Langeron 1900).

**M a t e r i a l :** KUC 226.

### **Trapaceae**

#### ***Hemitrapa* MIKI**

##### ***Hemitrapa* cf. *pomelii* (BOULEY) MAI**

Pl. 7, figs 4-6

- 2003 *Hemitrapa* cf. *pomelii* (BOULEY) MAI; Wójcicki and Kvaček, p. 167, figs 2a-c.

Fruits fully decayed showing only parallel surface strands of epicarps in a form of oval fruit body with only weakly indicated four thorns.

**D i s c u s s i o n :** The objects were designated by Wójcicki (in Wójcicki and Kvaček 2003) as fruits of *Hemitrapa*. They are fully flattened and due to long maceration in water they are devoid of all coal matter. The lateral thorns are preserved only occasionally (Wójcicki and Kvaček 2003, figs 2c). The affinities to *Hemitrapa pomelii* cannot be fully verified pending new better preserved specimens.

**M a t e r i a l :** KIN 25, KIN 449, NM G 8296a, b, G 8650, G 8649.

### **Rutaceae**

#### ***Chaneya* WANG et MANCHESTER**

This type of fossil fruit with persistent corolla was originally referred to the genus *Porana* BURM. (Convolvulaceae) as *Porana oehningensis* HEER. In a recent revision of

this extinct genus Teodoridis and Kvaček (2005) reinterpreted floral morphology, the apocarpous superior gynoecium, the floral disc and oil cells in the petals, and suggested affinities to the Rutales, namely the Simaroubaceae or Rutaceae. The newly recognized species described below differs from the previously described Eurasian representatives of this extinct genus by narrow delicate petals.

***Chaneya palaeogaea* (ETTINGSHAUSEN)**

**KVAČEK et TEODORIDIS comb.n.**

Pl. 10, fig. 4

1868 *Diospyros palaeogaea* ETTINGSHAUSEN, p. 45 (basionym), pro parte, pl. 38, fig. 25 (non pl. 38, fig. 32 leaf, pl. 38, fig. 26 fruit).

**Lectotype:** BP 56.1133.1 refigured in pl. 10, fig. 4 selected here.

Pentamerous corolla with attached fruit in the centre, petals narrow acuminate, up to 17 mm in length, fruit globular, 3 mm in diameter.

**Discussion:** As stated above, the fossil genus *Chaneya* was established on the detached pentamerous persistent corollas previously assigned to *Porana*. The true position of these remains was recognized after a more detailed study of the type collection from the Middle Miocene of Europe (Teodoridis and Kvaček 2005). The genus was also recognized in Palaeogene of Europe and Asia (Wang and Manchester 2000). The new record from Kučlín differs from the previously described species by narrow acuminate sepals and overall smaller dimensions.

**Material:** BP 56.1133.1 (lectotype).

**Simaroubaceae**

***Ailantus* DESF.**

***Ailanthus tardensis* HABLY**

Pl. 10, figs 9-10

2001 *Ailanthus tardensis* HABLY, p. 210, pl. 3, figs 1-7 (Nagybatony brickyard, Obuda).

2002a *Ailanthus* cf. *confucii* UNGER; Kvaček, p. 224, pl. 2, fig. 6.

Mericarps with spindle-shaped entire-margined wing, acute to round at apex, cuneate at base, shortly stipitate, 21 to more than 32 mm long, 6–7 mm wide, with centrally positioned roundish seed 4 mm in diameter, venation poorly preserved except strong intramarginally positioned ventral vein supplying the seed and margin it in the middle of the seed.

**Discussion:** Incomplete fruits of *Ailanthus* recovered in the Kučlín diatomite match by their shape and the position of the seed that from the Upper Eocene of Célas (Laurent 1899) and other similar fruits from the Middle Eocene of Messel (Collinson 1988) and many other Tertiary localities (for the review see Corbet and Manchester 2004). Most of them belong to the *A. confucii* type. Hably (2001) recognized two more species: *A. tardensis* HABLY is distinguished by the ventral vein running intramarginally (contrary to *A. confucii* with marginal position of the ventral vein – Corbett and Manchester 2004) and roundish seed.

*A. gigas* UNGER from Socka (Unger 1850b) exceeds all other fossil fruits by double size. One of the mericarps from Kučlín clearly shows the intramarginal ventral vein suggesting that the population from the Eocene of Kučlín is conspecific with that of the Hungarian Oligocene. It stresses further common features of the two floras containing *Doliosstrobos* and many other common elements.

**Material:** NM G 7898a,b, G 8633a,b, DB KUC 77.

***Ailanthus palaeorhus* (ETTINGSHAUSEN)**

**KVAČEK et TEODORIDIS comb. n.**

Pl. 10, figs 7-8, 11

1869 *Cupania palaeorhus* ETTINGSHAUSEN, p. 27, pl. 46, fig. 12 (basionym).

2001 *Cupania palaeorhus* ETTINGSHAUSEN; Hably et al., p. 20, pl. 10, fig. 7.

Leaflets asymmetrical, long petiolulate, lamina narrow falcate, 42–57 mm long and 9–15 mm wide, margin widely irregularly (?glandular) crenate, venation semicraspedodromous, midrib bent, secondaries irregularly spaced, almost perpendicular to the midrib, tertiaries very thin

**Discussion:** Rare leaflets are assignable to *Ailanthus* on the gross morphology and recall some Early Miocene *Ailanthus* foliage that accompany *Ailanthus* fruits at Parschlug (Kovar-Eder et al. 2004) and elsewhere. The morphotype from the Late Eocene of Kučlín is morphologically quite variable as it is common in leaflets of compound leaves. The glands on the margin considered diagnostic of *Ailanthus* (Corbet and Manchester 2004) are not quite distinctly preserved due to strong compression.

**Material:** BP 55.2496.1 (Holotype of *Cupania palaeorhus* ETTINGSHAUSEN, 1869, p. 27, pl. 46, fig. 12).

**cf. *Ailanthus* sp.**

Pl. 10, figs 1-3, 5-6

Leaflets ?subsessile, lamina narrow elongate, slightly falcate, base rounded, apex acute, margin coarsely widely dentate, venation semicraspedodromous, midrib straight to bent, secondaries very thin, bent, at wide angles, looping well within the lamina with intersecondaries.

**Discussion:** Etingshausen (1869) identified such leaves housed at BP as *Salix varians*. The teeth on the margin differ decidedly from the willows. Additional material suggested that these remains might represent leaflets. Due to coarsely dentate margin an affinity to *Ailanthus* is tentatively suggested.

**Material:** BP s.n., NM G 8633a, b.

**Hydrangeaceae DUMORTIER**

***Hydrangea* L.**

***Hydrangea microcalyx* SIEBER**

Pl. 10, figs 12-13

1881 *Hydrangea microcalyx* SIEBER, p. 16, pro parte, only figs 26, 27, 31.

1963 *Hydrangea microcalyx* SIEBER; Mai, p. 77, pl. 10, figs 7-9, text-fig. 13.

Tetramerous petaloid calyces of sterile flowers 17–31 mm in the diameter, partly attached to straight stalks, showing

scars at intervals of 7–9 mm after fertile flowers, individual sepals obovate to broadly obovate, 6–12 mm long and 4–10 mm broad, in one whorl free, of almost the same size, entire, round to slightly emarginated apically, cuneate, shortly stipitate basally to subsessile. Venation camptodromous–brochidodromous to reticulate, thin wavy main vein gives rise two lateral veins soon radiating from the base, and a few higher secondaries at wide angles, tertiaries very fine, reticulate.

**Discussion:** Sterile persistent calyces of this hydrangea have been rarely found in the Kučlín diatomite, usually isolated. The slab with the illustrated types (Sieber 1881, NM G 337) shows two long stalked sterile flowers and confirms that the fossils came from widely ramified inflorescences of both sterile peripheral and fertile perfect flowers concentrated into dense groups. The latter are difficult to recognize in the impression material. Most other recovered fossils represent sterile florets.

*Hydrangea microcalyx* is the oldest record of this genus in Europe. Similar remains were more frequently reported from the Oligocene (Walther and Kvaček 2007). Specific differences are difficult to recognize according to the morphology of sterile flowers only, which show uniform morphology even comparing impression material from the European and North American records (Meyer and Manchester 1997). Besides Kučlín, the richest sites of fossil hydrangeas in ČSM are connected with thermophilic assemblages at Suletice (Brabenec 1909, Kvaček and Walther 1995) and the Holý Kluk Hill (Radoň et al. 2003). A single flower has been lately recognized in the Late Oligocene flora of Rott, Rhineland (Winterscheid and Kvaček, in prep.). In no case the foliage belonging to the flowers has been suggested leaving the question open, if all records of these flowers belong to a single species.

Tetramerous flowers of *Hydrangea* differ decidedly by the broader form and venation pattern from the extinct genus *Raskya*, which produced similar tetramerous flowers and occurs at Kučlín (see below). The extinct genus *Chaneya* characterized by persistent pentamerous flowers recently reinterpreted as persistent corollas (see above) superficially recalls sterile calyces of *Hydrangea* and can be easily mistaken for such remains. However, some of the type specimens from Sošnica assigned to *Hydrangea* show remains of a pentamerous apocarpic gynoecium typical of *Chaneya* (Manchester and Zastawniak 2007) and differ also in the venation (five basal primaries).

Due to the quite diversified foliage morphology of the living hydrangeas (McClintock 1957) it is a difficult task to suggest one from among the co-occurring morphotypes at Kučlín as belonging to the described flower remains. The stalked sterile flowers remaining on the periphery of variously formed inflorescences are characteristic of many of the ca. 80 living species. Considering the accompanying flora, most cultivated hydrangeas frost hardy are improbable living relatives, namely *H. paniculata* SIEB. et ZUCCARINI (Japan, China), Perhaps *H. aspera* D. DON (Himalayas to Java) or *H. quercifolia* BARTR. (Florida) may come into question.

**Material studied:** NM G 337 (HOLO), NM G 7038a, b, G 75987, G 7892a, b.

## Icacinaceae

### *Palaeohosiea* KVAČEK et BŮŽEK

#### *Palaeohosiea bilinica* (ETTINGSHAUSEN)

KVAČEK et BŮŽEK

Pl. 5, figs 13-14

- 1869 *Amygdalus bilinica* ETTINGSHAUSEN, p. 55, pro parte pl. 53, fig. 22 (non fig. 23).  
 1880 *Amygdalus bilinica* ETTINGSHAUSEN; Sieber, p. 26, pl. 4, fig. 24.  
 1925 *Natsiaum eocenicum* CHANDER, p. 29, pl. 4, fig. 7a-d, text-fig. 11.  
 1963 *Prunus bilinica* (ETTINGSHAUSEN) MAI, p. 75 (non pl. 10, figs 1-2 = *Palaeohosiea suleticensis* KVAČEK et BŮŽEK).  
 1966 *Hosiea eocenica* (CHANDER) TAKHTAJAN, p. 1226.  
 1978 *Hosiea bilinica* (ETTINGSHAUSEN) HOLÝ in Mai and Walther, p. 125 (non pl. 45, figs 4-6).  
 1995 *Palaeohosiea bilinica* (ETTINGSHAUSEN) KVAČEK et BŮŽEK, p. 125, pl. 1, fig. 15, pl. 1, fig. 15.

Casts of fully flattened ovate to rounded endocarps, 3.8 cm long and 2.8 cm wide, with randomly arranged deep longitudinal ridges on the surface and short, shallow horizontal ridges, delimiting ca. 50 polygonal facets. Minute papillation of locule impressions not clearly seen.

**Discussion:** Holý (in Mai and Wather 1978) first recognized the affinity of these fruit remains from Kučlín to Icacinaceae and assigned them to *Hosiea* in line of the previous studies by Chandler (1925 as *Natsiatum*) and Takhtajan (1966 as *Hosiea*). A more detailed study of extant fruits of Icacinaceae (Bůžek and Kvaček 1995) revealed differences from the extant genera and motivated a separation of the fossils into an independent fossil genus *Palaeohosiea*.

Endocarps of this paratropical liana of the Icacinaceae, closely related to *Iodes* (Manchester 1999) have been rarely encountered at Kučlín. Fruits of *Palaeohosiea suleticensis* KVAČEK et BŮŽEK, which may belong to closely related species, occur in the Oligocene of Suletice and Holý Kluk (Kvaček and Bůžek 1995, Radoň et al. 2006). Similar fruits have been described from the Palaeocene and Eocene of England and the Oligocene of Germany (Kvaček and Bůžek 1995). Also newly established *Icacinicaryites corrugatus* (BROWN) PIGG, MANCHESTER et DEVORE (“*corrugata*”) from the Palaeocene of the USA may not taxonomically differ (Pigg et al 2008).

**Material:** KUC 5A, NM G 364.

## Ebenaceae

### ? *Diospyros* L.

#### *Diospyros ? microcalyx* (ETTINGSHAUSEN)

KVAČEK et TEODORIDIS comb. n.

Pl. 13, figs 10-18

- 1868 *Macreightia microcalyx* ETTINGSHAUSEN, p. 46, pl. 39, figs 2-5 (basionym).  
 2001 *Macreightia microcalyx* ETTINGSHAUSEN; Hably et al., p. 28, pl. 19, figs 3, 4, Pl. 20, fig. 3.

Detached tripartite calyces laterally compressed, partly shortly stipitate, joining narrow lanceolate sepals without

any remains of fruits; some may be more than tripartite, like *Chaneya palaeogaea* described above

**D i s c u s s i o n :** The above described remains were interpreted by Ettingshausen (1868) as belonging to *Diospyros* subgen. *Macreightia*. The state of preservation does not allow verifying his view. The leaves we associate with *Diospyros* ? *microcalyx* indeed have similarities to *Diospyros* in general. Calyces of *Diospyros* ? *microcalyx* belong to the frequent fossils at Kučlín.

**M a t e r i a l :** BP 55.2342.1, 55.2500.1, numerous specimens at NM and DB.

## Apocynaceae (vel ? Lythraceae)

### *Apocynophyllum* HEER

Fossil genus of sterile foliage with intramarginal vein, partly assigned to the Lythraceae because of a fruiting twig with seeds of *Decodon* (Kvaček and Sakala 1999), partly used also for foliage of similar morphology widely spread in the Apocynaceae.

### *Apocynophyllum bilanicum* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS comb. n.

Pl. 7, figs 1-2

1868 *Nerium bilanicum* ETTINGSHAUSEN, pp. 30-31, pl. 36, fig. 20 (basonym).

2001 *Nerium bilanicum* ETTINGSHAUSEN; Hably et al., p. 30, pl. 23, fig. 6.

Leaves petiolate, lamina narrow elongate, entire margined, venation eucaptodromous, midrib thick, straight, secondaries numerous, regularly spaced, at wide angles, forming loops along the margin, tertiary veins regularly spaced, dense.

**D i s c u s s i o n :** This type of foliage can be expected with plants producing seeds of Apocynaceae. However, we have no evidence to support the theory that the seeds described below belong to the same plant.

**M a t e r i a l :** BP 55.2447.1, ? 55.2457.1, KUC 411.

## Apocynaceae

### *Apocynospermum* E. M. REID et CHANDLER

### *Apocynospermum striatum* E. M. REID et CHANDLER

Pl. 11, figs 6-9

1926 *Apocynospermum striatum* E. M. REID et CHANDLER, p. 118, Pl. 8, fig. 3.

Detached spindle-shaped seeds distinctly longitudinally striate with a long terminal coma, usually occurring solitarily, exceptionally adhering together or attached to long axis.

**D i s c u s s i o n :** Such seed remains have been recognised as belonging to Apocynaceae–Asclepiadaceae by Reid and Chandler (1926). The fruit bodies, which would contain the seeds, have not been determined. The corresponding foliage may be suspected among *Apocynophyllum*-like morphotypes described above. Occurrences of *Apocynospermum*

*cynospermum* in Europe are from Eocene to Miocene in age (*Echitonium* UNGER p.p. by earlier authors). According to the priority (Manchester, S.R., personal communication) the correct name for such fossils is *Cypselites* HEER (1859). In north Bohemia, similar forms are known besides Kučlín also from Mrtvý Vrch and also from the Oligocene sites, e.g., Kundračice (Kvaček and Walther 1998).

**M a t e r i a l :** KUC 73, 118, 453, 454, G 68675.

## Angiospermae fam. inc.

The following part includes angiosperm elements of the Kučlín flora based on fruits, seeds and foliage without clarified systematic positions. After more precisely defined taxa also an annotated list of enigmatic fossils follows to characterize diversity of the flora. The synonymies of the morphotypes are limited in view of insufficient diagnostic traits and partly poor and fragmentary preservation.

### *Pungiphyllum* FRANKENHÄUSER et WILDE

This genus was originally established for spiny lobed leaves from the middle Eocene site Eckfeld identified as *Pungiphyllum waltheri* FRANKENHÄUSER et WILDE and some larger forms of *Pungiphyllum cruciatum* (A. BRAUN) FRANKENHÄUSER et WILDE, usually referred to “*Quercus*” *cruciata* A. BR. and spread in the European Tertiary. The generitype as well as all known epidermal structures of “*Quercus*” *cruciata* differ in the type of stomata from the Fagaceae (Kvaček and Walther 1981, Frankenhäuser and Wilde 1995). Individual populations of these enigmatic plants vary in the leaf shape and size during the Tertiary. Small and often shallow lobed forms from the Middle Eocene of Eckfeld, which were described as an independent species *Pungiphyllum waltheri* FRANKENHÄUSER et WILDE (1995), differ from the population of Kučlín, formerly compared with the Middle Eocene material (Kvaček 2002a), but it is separated as suggested below.

### *Pungiphyllum heerii* (SIEBER) KVAČEK et TEODORIDIS comb. n.

Pl. 15, figs 1-5

1881 *Ilex heerii* SIEBER, partim p. 87, pl. 4, fig. 23 (missing)(non *Ilex heerii* NATHORST 1888).

1990 “*Quercus*” *cruciata* A. BR; Bůžek et al. p. 170, fig. 3.26

2002a *Pungiphyllum* cf. *waltheri* FRANKENHÄUSER et WILDE; Kvaček, p. 224, pl. 2, fig. 5.

**N e o t y p e :** The originally proposed type specimen of *Ilex heerii* SIEBER from Kučlín has not been recovered in the old collections in Prague or elsewhere. We propose a similar spiny leaf impression from the same locality figured as *Pungiphyllum* cf. *waltheri* FRANKENHÄUSER et WILDE by Kvaček. The specimen is refigured in Kvaček (2002a, pl. 2, fig. 5) and in this paper on pl. 15, figs 4-5, and housed in the collections of DB under the number of KUC 74A, B.

Leaves simple, narrow ovate, petiolate, 10–20 mm long, and 20–40 mm long, at the base cuneate to rounded, on the margin spiny irregularly simple toothed, sinuses rounded, venation, camptodromous to secmicraspedodromous-craspedodromous, midrib thick, straight secondaries numerous,

dense, with intersecondaries, looping along the margin, rarely entering the larger teeth directly, tertiary veins distinct, straight to convex, alternate, percurrent, looping by the margin, venation of the higher orders regular polygonal reticulate; areolation distinct to moderately developed, 3- to 4-sided; veinlets poorly preserved, dichotomous branching.

**D i s c u s s i o n :** Only few similar, slightly larger leaves of this kind have been recovered at Kučlín. The material of Kučlín connects small leaves of *Pungiphyllum waltheri* FRANKENHÄUSER et WILDE from the Middle Eocene of Eckfeld with much larger and typically coarsely dentate morphotypes included so far into *Pungiphyllum cruciatum*, which were commonly reported from the Oligocene to Miocene of central Europe (Kvaček and Walther 1981).

**M a t e r i a l :** KUC 74A, B (neotype), KUC 38, KUC 55 b KUC 213, KUC 214A, B.

#### ***Craspedodromophyllum* CRANE**

This fossil genus was established for detached leaves with craspedodromous venation. The type material is related to extinct Betulaceae (Crane 1981).

#### ***Craspedodromophyllum betuloides***

**KVAČEK et TEODORIDIS sp. n.**

Pl. 13, figs 1-2

**H o l o t y p e :** DB KUC 4 reproduced in pl. 13, fig. 1

Leaf long petiolate with petiole 12 mm long, sideways bent, lamina triangulate broadly ovate, 50 mm wide, 60 mm long, margin double serrate, teeth coarse, weakly differentiated, sharp, moderately spaced, venation craspedodromous, midrib stout, straight, secondaries in 4 pairs, straight, at angles of 40–50°, rarely forked near margin, basal pair starting on the very lamina base, tertiaries weak, irregularly disposed.

**D i s c u s s i o n :** This enigmatic leaf morphotype recalls a foliage of a common birch except marginal wider and coarse teeth.

**M a t e r i a l :** DB KUC 4.

#### ***Camptodromites* BOULTER et KVAČEK**

This fossil genus was established for detached entire-margined leaves with eucamptodromous venation (Boulter and Kvaček 1989). The generitype comes from the Palaeocene of Mull.

#### ***Camptodromites* sp.**

Pl. 12, figs 8-11

1868 *Berchemia multinervis* HEER; Ettingshausen, p. 41, pl. 49, fig. 15.

Leaves simple, subsessile, lamina elliptic, ca 60 mm long and 30 mm wide, margin entire, venation eucamptodromous, midrib straight, secondaries numerous, densely spaced, subparallel, looping with the margin, tertiaries very delicate, dense, almost perpendicular to secondaries.

**D i s c u s s i o n :** Similar leaves ascribed to *Berchemia* and occurring in the European Miocene (Bůžek 1971) differ from the above described morphotype in marginal venation, which in the latter case merges the margin.

**M a t e r i a l :** BP 55.2451.1, NM G8632a, b, KUC 399.

#### ***Majanthemophyllum* WESSEL et WEBER**

#### ***Majanthemophyllum* sp.**

Pl. 14, figs 9-10

Simple leaf narrow elongate, entire-margined, ca 32 mm long and 5 mm wide, apex incomplete, ? acute, base narrow cuneate, inconspicuously narrowed into a petiole, venation steeply acrodromous, consisting of 5 primaries, midrib inconspicuously thickened, higher-order venation probably reticulate, hardly visible.

**D i s c u s s i o n :** Similar leaves of *Majanthemophyllum petiolatum* are larger and much better preserved (Oligocene of Rott). Its preserved epidermal anatomy (see Kvaček and Wilde 2010) is equivocally recalling really enigmatic monocots of the Smilacaceae and some authors assigned it to *Smilax* (Walther in Mai and Walther 1978). The present single specimen from Kučlín is aberrant in its small size and can hardly be assigned without any doubts to *M. petiolatum* typically spread in the Late Oligocene and Miocene in Europe (see Kvaček and Wilde 2010).

**M a t e r i a l :** KUC 191.

#### ***Raskya* MANCHESTER et HABLY**

1997 *Raskya* MANCHESTER et HABLY, p. 236.

**T y p e :** *Raskya vetusta* (ETTINGSHAUSEN) MANCHESTER et HABLY.

This so far monotypic genus was erected for quadrisepalous hypogenous fruits of unknown affinities previously interpreted by Reid and Chandler (1926) as belonging to *Abelia*. Manchester and Hably (1997) recognized the correct position of the ovary/fruit and ruled out the Caprifoliaceae with epigynous persistent calyces as a relative family. In spite of large-scale comparisons they did not find a satisfactory relationship for this genus. An extinct Juglandaceous genus *Cruciptera* MANCHESTER (1991) is distinguished by an inferior differently formed globose fruit, contrary to the superior elongate-fusiform in *Raskya*. The other similar genera with fruits subtended by wings radiating in a propeller manner, e.g., *Asterocarpinus* MANCHESTER et CRANE, are distinguished by fruit morphology and venation of sepals (Manchester and Hably 1997). Only a single species of *Raskya* has been known so far and its all occurrences are confined to the Upper Eocene to Oligocene of Europe.

#### ***Raskya vetusta* (ETTINGSHAUSEN) MANCHESTER et HABLY**

Pl. 15, figs 10-11

1869 *Ononis vetusta* ETTINGSHAUSEN, p. 56, pl. 55, figs 7-9.

1881 *Tetrapteris vetusta* (ETTINGSHAUSEN) SIEBER, p. 19, pl. 4, figs 19-20.

1926 *Abelia quadrialata* E. M. REID et CHANDLER, p. 133, pl. 8, figs 29-31, text-fig. 11 (Bembridge).

1997 *Raskya vetusta* (ETTINGSHAUSEN) MANCHESTER et HABLY, p. 236, pls. 1-2, text-fig. 1.

**N e o t y p e :** NM G 7569 designated by Manchester and Hably (1997, pl. 2, fig. 7), Kučlín.

The fruits are preserved as elongate-fusiform impressions, transversed by numerous ribs and attached to the cen-



tre of the hypogynous quadripetalous calyx. The position of the fruit is obviously superior. Fossil calyces devoid of fruits occur more frequently. The sepals are entire on margin, free, obovate-spatulate, slightly curved on the tips, 7–11.5 mm long and max. 4 mm wide. The venation of sepals is very steep, free, dichotomizing, not well preserved in the studied specimens. The fruit body attains 9 mm in length, in the compressed state it looks 1 mm in cross section but this value does not correspond to the natural thickness due to compression. No remains of styles are observable on the fruit tip.

**D i s c u s s i o n :** The above described material complements the description of the neotype selected by Manchester and Hably (1997) from the same locality Kučlín as *Ononis vetusta* Ettingshausen, basionym. It brings definite evidence that the record from Kučlín bears all features diagnostic for *Raskya* as numerous better preserved specimens from Hungary and England described by Manchester and Hably (1997), which were employed for the re-interpretation of the genus. Due to a large diversity of the Kučlín flora and unknown affinities of *Raskya* it is at present impossible to suggest further organs of *Raskya* and attempt to reconstruct the whole plant. Aspects of the plant assemblages associated with occurrences of *Raskya* in Bohemia (Kučlín), Hungary (Eger-Kiseged, Obuda) and England (Bembridge) stress thermophilous character of this plant element.

**M a t e r i a l :** NM G7567a, b (neotype), DB KUC 16a,b, KUC 445.1.

***Callistemophyllum bilanicum* ETTINGSHAUSEN**

Pl. 12, figs 4-7

- 1869 *Callistemophyllum bilanicum* ETTINGSHAUSEN, p. 53, pl. 6, fig. 7, pl. 7, fig. 1.  
 1990 *Callistemophyllum bilanicum* ETTINGSHAUSEN; Bůžek et al., p. 172, fig. 3.27.  
 2002 *Callistemophyllum bilanicum* ETTINGSHAUSEN; Hably, p. 16, pl. 6, fig. 7.

Leaves simple, linear, entire, parallel-margined. Venation eucamptodromous, secondaries dense, looping with intersecondaries along the margin.

**D i s c u s s i o n :** This type of foliage has been known as *Callistemophyllum* SAPORTA from various Palaeogene sites of Europe but in no case its true nature has been clarified, also at Kučlín. Velenovský (coll. NM) identified such leaf forms from Kučlín as *Ficus multinervis* HEER.

**M a t e r i a l :** BP 55.2314.1, 55.2371.1, NM G 8663.

***Ternstroemites* sp.**

Pl. 10, fig. 14; Pl. 11, figs 1-5

Leaves long petiolate narrow elliptic, coarsely dentate, glandular (?)

**D i s c u s s i o n :** The margin and the form recall Theaceae.

**M a t e r i a l :** KUC 159, KUC 190, KUC 210 KUC 450, KUC 452.

**cf. *Salix* sp.**

Pl. 6, figs 8-10

- 1868 *Myrsine doryphora* UNGER; Ettingshausen, p. 35, pl. 40, figs 6, 13.

- 1868 *Myrsine heeri* ETTINGSHAUSEN, p. 36, pl. 38, fig. 11.

- 2001 *Myrsine heeri* ETTINGSHAUSEN; Hably et al., p. 29, pl. 21, fig. 3.

Leaves linear, elongate to lanceolate, subentire, venation eucamptodromous, midrib straight, secondaries dense, at wide angles to the midrib.

**D i s c u s s i o n :** Specimens assigned to this entity are very poorly preserved. Their identification as foliage of *Salix* is very equivocal.

**M a t e r i a l :** BP 55.2462.1.

***Dicotylophyllum* sp. 1**

Pl. 11, figs 10-11

- 1869 *Amygdalus bilinica* ETTINGSHAUSEN, p. 55, fig. 23;

- 2001 *Amygdalus bilinica* ETTINGSHAUSEN, Hably et al., p. 12, pl. 2, fig. 4.

The morphotype recalls *Platanus neptuni* mf. *reussii*.

**M a t e r i a l :** BP 55.2357.1.

***Dicotylophyllum* sp. 2**

Pl. 11, fig. 12

- 1868 *Andromeda protogaea* UNGER; Ettingshausen, p. 48, p. 39, fig. 9.

Possibly Ericaceae.

**M a t e r i a l :** BP 55.2470.1.

***Dicotylophyllum* sp. 3**

Pl. 11, figs 13-15

- 1868 *Apocynophyllum amsonia* UNGER; Ettingshausen, p. 28, pl. 37, fig. 3.

- 1869 *Eucalyptus oceanica* UNGER; Ettingshausen, pp. 52-53, pro parte, pl. 54, figs 20-21.

- 2001 *Apocynophyllum amsonia* UNGER; Hably et al., p. 43, pl. 42, fig. 3.

- 2001 *Eucalyptus oceanica* UNGER; Hably et al., p. 52, pl. 62, figs 2-3.

Leaves lanceolate ovate, entire-margined, venation hardly visible.

**M a t e r i a l :** BP 55.2352.1, BP 56.1134.1, BP 59.1111.1., BP 59.1134.1., KUC 411.

***Dicotylophyllum* sp. 4**

Pl. 11, fig. 16

Leaf petiolate, lamina bipartite (? anomaly), apical and lateral lobes shallowly widely crenulate, venation not visible except primaries.

**D i s c u s s i o n :** It is probably just a part of a compound/lobed leaf. Some aralias may produce similar forms.

**M a t e r i a l :** KUC 81.

***Dicotylophyllum* sp. 5**

Pl. 11, figs 17-18

- 1868 *Ardisia harpyarum* ETTINGSHAUSEN, pp. 40-41, pl. 38, fig. 1.

- 2001 *Ardisia harpyarum* ETTINGSHAUSEN, Hably et al., p. 13, pl. 3, fig. 3.

Leaf ? sub-sessile, lamina entire-margined, narrow elongate, fragmentarily preserved, base narrow cuneate, texture

? papyraceous, venation eucamptodromous, secondaries slightly wavy, tertiaries reticulate

**Material:** BP 55.245.1.

***Dicotylophyllum* sp. 6**

Pl. 11, figs 19-20

1881 *Aristolochia grandifolia* SIEBER, p. 81, pl. 3, figs 22a, b.

A large fragment of a lobed leaf (with counterpart BP as *Sterculia* sensu Ettingshausen).

**Discussion:** The reconstruction of the lamina indeed recalls a leaf of *Aristolochia*. The fossil itself is unfortunately very fragmentary and not determinable.

**Material:** NM G 354, BP 55.2326.1.

***Dicotylophyllum* sp. 7**

Pl. 11, figs 21-22

1869 *Baloghia miocenica* ETTINGSHAUSEN, p. 45, pl. 50, fig. 22.

2001 *Baloghia miocenica* ETTINGSHAUSEN; Hably et al., p. 13, pl. 4, fig. 2.

Leaves narrow elliptic, entire-margined, venation eucamptodromous, midrib thin, secondaries hardly observable.

**Material:** BP 55.2340. 1.

***Dicotylophyllum* sp. 8**

Pl. 12, figs 1-3

1868 *Bumelia oreadum* UNGER; Ettingshausen, p. 43, pl. 38, figs 13-15.

2001 *Bumelia oreadum* UNGER; Hably, p. 45, pl. 47, figs 4, 6, pl. 48, fig. 4.

Leaves obovate, entire-margined, midrib straight, secondaries very thin, hardly observable.

**Material:** BP 55.2375.1.

***Dicotylophyllum* sp. 9**

Pl. 12, fig. 12

1869 *Cassine palaeogea* ETTINGSHAUSEN, p. 38, pl. 46, fig. 14.

2001 *Cassine palaeogea* ETTINGSHAUSEN; Hably et al., p. 17, pl. 7, fig. 3.

Similar to leaves of *Sloanea nimrodi*.

**Material:** BP 55.2315.1.

***Dicotylophyllum* sp. 10**

Pl. 12, fig. 13

1869 *Celastrophyllum mimusops* ETTINGSHAUSEN, p. 36, pl. 49, figs 2, 2b.

2001 *Celastrophyllum mimusops* ETTINGSHAUSEN; Hably et al., p. 17, pl. 7, fig. 4.

Leaf (? leaflet) obovate, entire-margined, venation eucamptodromous, midrib thick, secondaries closely spaced, on one side at wider angles than on the other, tertiaries reticulate.

**Discussion:** Similar leaflets are produced by a number of legumes.

**Material:** BP 55.2486.1.

***Dicotylophyllum* sp. 11**

Pl. 12, figs 14-16

1869 *Celastrus lucinae* ETTINGSHAUSEN, p. 32, pl. 48, fig. 26.

1869 *Celastrus aeoli* (ETTINGSHAUSEN) ETTINGSHAUSEN, p. 32, pl. 48, fig. 28.

1990 *Celastrus lucinae* ETTINGSHAUSEN, Bůžek et al., p. 172, fig. 38.

2001 *Celastrus lucinae* ETTINGSHAUSEN, Hably et al., p. 17, pl. 8, fig. 2.

2001 *Celastrus aeoli* (ETTINGSHAUSEN) ETTINGSHAUSEN; Hably et al., p.47, pl. 53, fig. 1.

Leaves obovate, finely serrate with complicated steep brochidodromous-reticulate venation.

**Material:** BP55.2445.55. 5429.1.

***Dicotylophyllum* sp. 12**

Pl. 12, figs 17-18

Leaves elliptic, entire-margined, midrib straight, secondaries hardly visible, venation eucamptodromous (?).

**Discussion:** Probably a poorly preserved specimen of *Trigonobalanopsis rhamnoides*.

**Material:** KIN 242, KIN 359.

***Dicotylophyllum* sp. 13**

Pl. 13, figs 3-4

A twig of lanceolate alternate (?) leaves, margin entire, venation eucamptodromous, secondaries quite closely spaced.

**Material:** KIN 381.

***Dicotylophyllum* sp. 14**

Pl. 13, fig. 5

Leaf petiolate, petiole thick, lamina elongate, entire-margined, midrib thick, straight, venation eucamptodromous, secondaries closely spaced, at almost right angle, with intersecondaries, higher-order venation not preserved

**Material:** KIN 208.

***Dicotylophyllum* sp. 15**

Pl. 13, fig. 8

Leaf long petiolate, lamina obovate, entire-margined, venation ? eucamptodromous, midrib straight, secondaries hardly visible.

**Material:** KIN 23.

***Dicotylophyllum* sp. 16**

Pl. 13, fig. 9

Leaf ? sessile, lamina elliptic, entire-margined, venation eucamptodromous.

**Material:** KIN 431.

***Dicotylophyllum* sp. 17**

Pl. 14, fig. 1

1869 *Eugenia apollinis* UNGER; Ettingshausen, p. 52, pl. 53, fig. 16.

2001 *Eugenia apollinis* UNGER; Hably et al., p. 53, pl. 62, fig. 5.

Leaf entire-margined, lanceolate, midrib medium thick, secondaries regularly spaced, tertiaries reticulate.

**Material:** BP 55.2485.1.

***Dicotylophyllum* sp. 18**

Pl. 14, fig. 2

Leaf entire-margined, lamina elongate, base rounded, venation brochidodromous, midrib thick, straight, secondaries in regular loops subparallel, at angles of ca. 60°, with thin intersecondaries.

**Discussion:** Similar to *Ficus lobkowitzii* ETTINGSHAUSEN from the Miocene Břešťany Clay.

**Material:** KUC 441.

***Dicotylophyllum* sp. 19**

Pl. 14, fig. 3

- 1866 *Ficus kutschlinica* ETTINGSHAUSEN, p. 68, pl. 20, figs 8, 8b.  
2001 *Ficus kutschlinica* ETTINGSHAUSEN; Hably et al., p. 23, pl. 14, fig. 2.

Leaf similar by coarsely toothed margin to *Pungiphyl- lum cruciatum*.

**Material:** BP 55.1108.1.

***Dicotylophyllum* sp. 20**

Pl. 14, figs 4-5

- 1866 *Ficus urani* ETTINGSHAUSEN, p. 75, pl. 21, fig. 5.  
2001 *Ficus urani* ETTINGSHAUSEN; Hably et al, p. 24, pl. 16, fig. 2.

Leaf elliptic with eucamptodromous venation consisting of a thin midrib and regularly arranged looping secondaries. The basal pair is slightly more prominent.

**Discussion:** The leaf may represent an aberrant form of *Byttneriopsis*.

**Material:** BP 55.2401.1.

***Dicotylophyllum* sp. 21**

Pl. 14, figs 6-7

- 1869 *Laurelia glandulifera* ETTINGSHAUSEN, p.64, pl. 55, fig. 20.  
2001 *Laurelia glandulifera* ETTINGSHAUSEN; Hably et al., p. 26, pl. 18, fig. 2.

Elliptic leaf with glandular toothed margin. Venation hardly visible.

**Material:** BP 55.2410.1.

***Dicotylophyllum* sp. 22**

Pl. 14, fig. 8

- 1868 *Ligustrum priscum* ETTINGSHAUSEN, p. 24, pl. 36, fig. 8.  
2001 *Ligustrum priscum* ETTINGSHAUSEN; Hably et al., p. 29, pl. 19, figs 6-7.

A small linear lanceolate leaf with hardly visible venation.

**Material:** BP 55.2362.1.

***Dicotylophyllum* sp. 23**

Pl. 14, fig. 11

- 1868 *Notelaea philyrae* ETTINGSHAUSEN, p. 24, pl. 36, fig. 14.  
2001 *Notelaea philyrae* ETTINGSHAUSEN; Hably et al., p. 30, pl. 23, fig. 7.

Leaf lanceolate, entire-margined, venation eucamptodromous, midrib straight, secondaries dense, at 40° to the midrib, looping, with intersecondaries.

**Material:** BP 55.2370.1.

***Dicotylophyllum* sp. 24**

Pl. 14, figs 12, 13

- 1868 *Olea olympica* ETTINGSHAUSEN, p. 23, pl. 36, fig. 13.  
2001 *Olea olympica* ETTINGSHAUSEN; Hably et al., p. 30, pl. 24, fig. 1.  
1868 *Olea feroniae* ETTINGSHAUSEN, p. 22, pl. 36, fig. 15.  
2001 *Olea feroniae* ETTINGSHAUSEN; Hably et al., p. 30, pl. 23, fig. 7.

Leaves narrow elliptic, entire-margined, without visible venation, probably coriaceous.

**Material:** BP 55.2368.1, 55.2471.1.

***Dicotylophyllum* sp. 25**

Pl. 14, fig. 14

- 1869 *Pleiomerites reticulatus* ETTINGSHAUSEN, p. 38, pl. 38, fig. 6.  
2001 *Pleiomerites reticulatus* ETTINGSHAUSEN, Hably et al., p. 32, pl. 25, fig. 3.

Leaf narrow elliptic, entire-margined, without visible venation.

**Material:** BP 55.2392.1.

***Dicotylophyllum* sp. 26**

Pl. 15, fig. 6

- 1869 *Rhamnus paucinervis* ETTINGSHAUSEN, p. 43, pl. 49, fig. 19.  
2001 *Rhamnus paucinervis* ETTINGSHAUSEN; Hably et al., p. 33, pl. 27, fig. 2.

Leaf narrow elliptic, entire-margined, venation eucamptodromous, secondary steep, widely spaced and irregular.

**Discussion:** Such a type of venation can be seen in various lauroids.

**Material:** BP 55.2479.1.

***Dicotylophyllum* sp. 27**

Pl. 15, fig. 7

- 1881 *Quercus* cf. *tephrodes* UNGER; Sieber, p. 76, pl. 3, fig. 17.

Leaf ovate, on the apex wavy probably due to damage, otherwise entire-margined. Venation eucamptodromous, secondaries regularly disposed.

**Material:** NM G 352.

***Dicotylophyllum* sp. 28**

Pl. 15, figs 8-9

- 1866 *Quercus kutschlinica* ETTINGSHAUSEN, p. 61, pl. 17, figs 11, 12.  
2001 *Quercus kutschlinica* ETTINGSHAUSEN; Hably et al., p. 32, pl. 25, fig. 3.

Aberrant leaf form probably due to injury.

**Material:** BP 55.2468.1.

***Dicotylophyllum* sp. 29**

Pl. 15, fig. 12

- 1868 *Santalum salicinum* ETTINGSHAUSEN; ETTINGSHAUSEN, p. 12, pl. 37, figs 5, 6.

2001 *Santalum salicinum* ETTINGSHAUSEN; Hably et al., p. 60, pl. 34, fig. 6.

Leaf entire-margined, lamina lanceolate without well visible venation, probably coriaceous.

**M a t e r i a l:** BP 55.1190.1.

***Dicotylophyllum* sp. 30**

Pl. 16, figs 6-9

1868 *Sapotactites daphnes* (UNGER) ETTINGSHAUSEN, p. 41, pl. 38, fig. 8.

1868 *Sapotactites bilinicus* ETTINGSHAUSEN, p. 42, pl. 38, fig. 22.

2001 *Sapotactites daphnes* (UNGER) ETTINGSHAUSEN; Hably et al. p. 60, pl. 78, fig. 1.

2001 *Sapotactites bilinicus* ETTINGSHAUSEN; Hably et al., p. 36, pl. 31, fig. 5.

Leaves entire-margined, subsessile (?) oblanceolate to elongate, venation ? eucaptodromous, midrib straight, thick, secondaries hardly visible due to coriaceous texture.

**M a t e r i a l:** BP 55.2463.1, 55.2465.1.

***Dicotylophyllum* sp. 31**

Pl. 16, figs 10-14

1869 *Saxifragites crenulatus* ETTINGSHAUSEN, p. 7, pl. 41, figs 1-3.

1990 *Saxifragites crenulatus* ETTINGSHAUSEN, Bůžek et al., p. 172, fig. 3.11.

2001 *Saxifragites crenulatus* ETTINGSHAUSEN; Hably et al., p. 36, pl. 30, figs 4-5.

Leaves sub-sessile, lamina elongate, slightly falcate, at the base asymmetrical, margin glandular, finely crenulate.

**M a t e r i a l:** BP 55.2405.1, 55.2495.1, KUC 429, 430.

***Dicotylophyllum* sp. 32**

Pl. 17, fig. 1

1869 *Sciadophyllum haidingeri* ETTINGSHAUSEN, p. 2, pl. 40, fig. 1.

2001 *Sciadophyllum haidingeri* ETTINGSHAUSEN; Hably et al., p. 37, pl. 33, fig. 6.

Leaf long petiolate, lamina narrow elliptical, venation not discernible.

**D i s c u s s i o n:** The morphotype is characterized by a probably coriaceous texture and an unusually long petiole.

**M a t e r i a l:** BP 55.2331.1.

***Dicotylophyllum* sp. 33**

Pl. 17, fig. 2

1869 *Sorbus palaeoaria* ETTINGSHAUSEN, p. 48, pl. 53, fig. 24.

2001 *Sorbus palaeoaria* ETTINGSHAUSEN, Hably et al., p. 37, pl. 34, fig. 4.

Leaf fragment showing regular craspedodromous secondaries and finely serrate margin.

**D i s c u s s i o n:** It recalls Betulaceae rather than Rosaceae and belongs certainly to foliage of a summergreen plant.

**M a t e r i a l:** BP 59.843.1.

***Dicotylophyllum* sp. 34**

Pl. 17, fig. 3

1868 *Styrax stylosa* HEER; Ettingshausen, p. 47, pl. 80, fig. 4.

2001 *Styrax stylosa* HEER; Hably et al., p. 61, pl. 80, fig. 4.

Leaf petiolate, lamina lanceolate, entire-margined, venation eucamptodromous, midrib slightly bent, secondaries moderately steep, widely spaced.

**M a t e r i a l:** BP 55.2418.1.

***Dicotylophyllum* sp. 35**

Pl. 16, figs 1-2

Leaf elongate, parallel-margined, margin entire, venation eucamptodromous, midrib straight, thick, secondaries very dense, at more than 80°, looping very near the margin, intersecondaries single present.

**M a t e r i a l:** KUC 228.1A.

***Carpolithes* sp. 1**

Pl. 17, figs 4-6

Dichasial infructescence with small rounded remains of fruits 3 mm in diameter.

**M a t e r i a l:** KUC 43A, B.

***Carpolithes* sp. 2**

Pl. 17, fig. 7

A group of long stalked elongate flower impressions.

**M a t e r i a l:** KIN 377.

***Carpolithes* sp. 3**

Pl. 17, fig. 8

A group of sessile striated broadly oval capsule fruits 4 mm long.

**M a t e r i a l:** KIN 249.1.

***Carpolithes* sp. 4**

Pl. 17, fig. 9

Roundish seeds well flattened, 4 and 6 mm in diameter.

**M a t e r i a l:** KIN 27.1.

***Carpolithes* sp. 5**

Pl. 17, fig. 10

Stalked capsule (?) obovate, strongly compressed 10 mm long.

**M a t e r i a l:** KIN 48.

***Carpolithes* sp. 6**

Pl. 17, fig. 11

A group of longly stalked strongly compressed roundish fruits 3 mm in diameter.

**M a t e r i a l:** KIN 50.

***Carpolithes* sp. 7**

Pl. 17, fig. 12

A group of stalked strongly compressed flower remains ca. 12 mm long.

**M a t e r i a l:** KIN 256.

***Carpolithes* sp. 8**

Pl. 17, fig. 13

Mold of a stone broadly elliptic, on apex showing dehiscence line, 13 mm wide and ca. 20 mm long.

**M a t e r i a l:** KIN 460.

### *Carpolithes* sp. 9

Pl. 17, fig. 14

A cylindrical catkin 5 mm wide and 35 mm long consisting of narrow densely arranged pointed bracts.

Material: KIN 38.1.

### *Carpolithes* sp. 10

Pl. 17, fig. 15

Calyces (?) stalked elongate, 8 mm long attached in group to a twig.

Material: KIN 269.

### *Carpolithes* sp. 11

Pl. 17, fig. 6

1869 *Paliurus favonii* UNGER; Ettingshausen, p. 39, pro parte, pl. 50, fig. 7.

2001 *Paliurus favonii* UNGER; Hably et al., p. 56, pl. 59, fig. 5.

An impression of berry (?); the locality was wrongly indicated by Ettingshausen (1869) as Sobrussan (Zabrušany) and the fossil has nothing to do with the fruits of *Paliurus favonii*. According to the matrix the sample comes clearly from Kučlín.

Material: BP 55.1163.1.

## General characteristics of the flora of Kučlín

Among the studied sites in north Bohemia dated as Late Eocene, Kučlín belongs to the most noteworthy. Differences between these floras (Kvaček 2002a) are due to two factors. First the possibilities of collecting vary from site to site (Kučlín vs. Mrtvý vrch vs. cores at Lbín vs. Roudníky). Second, different environmental conditions may bias the composition of coeval floras (mesophytic vegetation on fertile volcanogenic soils vs. azonal vegetation in alluvial settings in the Staré Sedlo Formation). Similar phenomenon can be noticed in the Middle Eocene of Germany, when comparing plant assemblages of the lignite basin of the Geiselal and the maar fills of Eckfeld and Messel (Wilde 1995). The same applies to the Early Oligocene vegetation of Haselbach representing coal-forming and alluvial vegetation in comparison with Oligocene “volcanic” plant assemblages in the České středohoří Mountains, Markvartice and Seifhennersdorf (Kvaček and Walther 2001).

The flora of Kučlín was explored for a longest period and its plant assemblages are most diversified. Aquatic and helophytic plants (Nymphaeaceae, Araceae and other monocots) were confined to shallow water of the lake. Deep swamps were not developed along the lake, at least in such an extent to produce mighty lignite layers. The only hygrophilic conifer, *Doliosrobis*, was present, but in medium frequency. The other trees common in the basins and the alluvial sandy facies (oligotrophic substrates), notably *Eotrigonobalanus*, *Steinhauera*, *Sabal*, were either rare or lacking. The most common plant fossils in the Kučlín diatomite are seeds of Nymphaeaceae, which may belong to the same plants as co-occurring rhizomes of *Nymphaea polyrrhiza*. Other herbaceous elements (ferns, monocots) are rare. We may reasonably assume that also the araceous *Nitophyllites bohemicus*, represented by a few fragments,

belonged to helophytic vegetation, which bordered the volcanic lake. Rare remains of *Sabal*, Musaceae (*Musa bilinica*) and strap-like monocot foliage are further elements of this community. Heavy infructescences and whole branches of *Platanus neptuni* may indicate that even this tree grew partly on the banks near the lake. The Kučlín flora is typically heterogenous, and includes also mesophytic elements, which were blown into the lake by wind (winged fruits or seeds of *Raskya vetusta*, “*Acer*” *sotzkianum*, *Engelhardia macroptera*, *Hooleya hermis*, *Apocynospermum*).

The overall character of the vegetation of Kučlín fits best to a flatland with surrounding moderate uplands. Most of the recovered woody plants including lianas are mesophytic, like Lauraceae (narrow-leafed *Daphnogene*, *Laurophyllum*), Juglandaceae (*Engelhardia*, *Hooleya*), Icacinaceae (*Palaeohosiea*), Elaeocarpaceae (*Sloanea*), and even subxerophytic (*Cedrelospermum*, *Ziziphus*, *Podocarpium*). Affinities of many plants from Kučlín have not been clarified so far but none of them can be interpreted as a modern Arcto-Tertiary element in the sense of Kvaček (1994), i.e., an Oligocene immigrant from Asia. *Tetraclinis salicornioides*, *Platanus neptuni*, *Sterculia labrusca*, *Raskya vetusta* and others accompany evergreen forests elsewhere in Europe, mainly in the Late Eocene and earliest Oligocene. Physiognomy of the vegetation of Kučlín was similar to the Middle Eocene sites of Messel and Eckfeld (Wilde 1989, Wilde and Frankenhäuser 1998) and the Oligocene sites Suletice-Berand and Holý Kluk (Kvaček and Walther 1995, Radoň et al. 2006). These floras, however, are of different age and include partly different species spectra.

The Kučlín Lake was obviously a freshwater reservoir as documented by diatoms (Řeháková in Malkovský et al. 1985). Facultative halophytes, like *Acrostichum*, cannot unequivocally provide evidence of salt marshes; because today this fern is spread also outside mangroves (see Frankenhäuser and Wilde 1993). The fish fauna includes the only marine representative, *Morone* that penetrates inland into the freshwater environment via rivers (Micklich and Böhme 1997, Přikryl 2008). But successors of another member of the fish fauna – a percoid *Bilinia* (Obrhelová 1969, 1976) today also live in marine environments. Therefore, Obrhelová and Obrhel (1987) supposed a higher mineral content in the lake due to mineral springs. The remaining *Thaumaturus* and *Amia* (treated recently as *Cyclurus* by Gaudant 1977, 1996, Bellon et al. 1998) are obligate freshwater dwellers, like other aquatic animals – *Diplocynodon* (Kafka 1911), *Trionyx* (Laube 1882), little crayfish (Meyer 1852, Frič 1872) and a newly recovered frog (coll. DB). The freshwater diatoms *Melosira distans*, *Fragilaria* and *Synedra* dominate algal taphocoenoses. Řeháková (in Malkovský et al. 1985) lists 19 species of pennate diatoms and a stenothermic *Eunotia clevei* typical of cold waters. She recognized the Kučlín assemblage as the most ancient among diatomite occurrences.

The land around the Kučlín Lake was well above the ground water, where evergreen forests with rare ferns on the floor were developed. Even low slopes can be expected due to the presence of subxerophytic plants, like *Cedrelospermum* with extremely narrow leaves, and *Ziziphus*. Palynological data (Mazancová in Horáčková et al. 1967, Konzalová 1981) provide additional information on the sur-

rounding vegetation. The pollen spectra from the marl underlying the diatomite yielded the bituminous alga *Botryococcus*, which is typical of stagnant eutrophic waters, and microsporangia of aquatic ferns. Among leptosporangiate ferns, a thermophilic climber (*Lygodium*), Gleicheniaceae and some more exotic spores of unknown affinities have been noted. Conifers are represented by the cupressaceous *hiatus-dubius* group, but also by the araucarioid pollen probably corresponding to *Doliostrobus*. Various bisaccate forms document the Pinaceae, including the *haploxylon*-type today partly referred to *Cathaya*. Among the Juglandaceae-Myricaceae group, pollen of *Carya*, *Engelhardia* and *Myrica* occurred. Tilioid pollen documents some extinct members of the Malvales. Various forms of tricolpoporoid pollen have usually been interpreted as Fagaceae, Leguminosae, Nyssaceae, Aquifoliaceae and Araliaceae, tetracolpoporoid forms as Sapotaceae and Meliaceae. Noteworthy are stratigraphically significant spore-morphs – the *rhizophorus*-type (comparable with the lianas *Iodes* ~ *Palaeohosiea*, Icacinaceae) and *Cupaneidites* (Myrtaceae vel Sapindaceae). Among monocots, rare pollen of *Sparganium* and palms has been identified. Beetles inhabiting dry land dominate by 90 % among the insects (Prokop in press). The Curculionidae makes half of the respective taphocenosis, two other groups – Elateridae and Buprestidae are also well represented, while only a single aquatic element, *Anisops heidenii* DEICHM., is present. In composition and aspect, the Kučlín insect fauna matches those of the Middle Eocene sites Eckfeld and Messel. Large forms, whose extant analogues are most diversified in modern tropic and subtropic areas (Dascillidae, Buprestidae, and Trogositidae), suggest its very thermophilic character.

## Vegetation of Kučlín

The above described fossil plant assemblage of Kučlín was evaluated using IPR-vegetation analysis in the following characteristic: BLD 46 %, BLE 41%, SCL+LEG 12%, ZONAL HERB (D-HERB + M-HERB) 3.5 %, sum of taxa 106, sum of zonal taxa 82, sum of zonal woody angiosperms 88, problematic taxa 6 (for detailed taxa scoring see Teodoridis 2011a). According to the thresholds of key components for a defined vegetation types (the first four above mentioned components) modified by Teodoridis et al. (2011a, table 8), the flora of Kučlín belongs to the “Broad-leaved Evergreen forest (BLEF)” vegetation type. Comparing the result of Kučlín to those from the Late Eocene sites from Weissester Basin (Haselbach, Kayna-Süd, Klaus, Knau, Mosel, Phönix-Nord and Profen, i.e., BLE 68–92 % and BLD 8–25 %) and the Staré Sedlo Formation (Český Chloumek, Nový Kostel, Staré Sedlo and Žitenice, i.e., BLE 55–66 % and BLD 17–34 %) referred by Teodoridis et al. (submitted), the Kučlín assemblage shows significantly low value of the BLE component and/or predominance of BLD component. On the other hand the value of SCL+LEG component distinctly overlapped those from the Late Eocene sites from Saxony and North Bohemia that proved the above stressed taxonomic uniqueness of Kučlín. IPR results of taxonomically close sites of the Early Oligocene from the Czech Republic and Germany (i.e., Kundratice, Seiffenhensdorf, Knížecí-Hrazený, Sulestice-Berand, Holý

Kluk and Markvartice-Veseličko) show variability of the BLE and BLD components from 50 to 65 % vs. 29 to 35 % (Teodoridis 2011b, Teodoridis et al. in prep.). Similarly the site of Sulestice-Berand indicates a predominance of SCL+LEG component equalling to 16 % and can be interpreted as the closest physiognomically related assemblage to Kučlín based on results of the cluster analysis (Teodoridis et al. in prep.). The relatively low value of the BLE component at Kučlín is due to a close affinity to modern vegetation units of *Eurya-Cryptomeria japonica* association, *Tsuga sieboldii* subassociation and of summarized results for *Eurya-Cryptomeria japonica* association from Yakushima Island in Japan. These vegetation types are empirically defined as Mixed Mesophytic Forest vegetation (Teodoridis et al. 2011a). The affinity is also corroborated by the cluster analysis sensu Teodoridis et al. (2011a, submitted). The Leaf Size Analysis (LSA) applied on Kučlín shows an almost balance percentage of the microphyllous and notophyllous leaf size categories (45.6 vs 46.8 %) and 7.6 % of macrophyllous leaves. This result corresponds best with those of the Late Eocene sites of Profen (41 %, 39 %, 11 %) and Staré Sedlo (34 %, 53 %, 12 %) – see Mai and Walther (1985), Teodoridis et al. (submitted) as well with modern vegetation units from extrazonal and zonal zones of subtropical and warm-temperate areas in China and Japan (Oshawa and Ozaki 1992, Tang and Oshawa 1999). Kvaček (2010) defined a Mid-latitude Notophyllous Broad-leaved Evergreen Forest vegetation type documented at the Middle Eocene floras of Eckfeld (Germany) and Lábatlan (Hungary) and at the Late Eocene floras of Hordle (England) and Kučlín (Czech Republic). Our results of IPR-vegetation analysis and LSA corroborate the former Z. Kvaček’s opinion, however, the predominance of the notophyllous taxa are not so significant.

## Paleoclimatic signals

The plant assemblage of Kučlín was evaluated by CLAMP and LMA techniques. CLAMP employed a physiognomic characteristic of Kučlín presented in table 1 and used the 189 physiognomic and meteorological reference datasets sensu Jacques et al. (2011). The CLAMP results of Kučlín are as follows: MAT 16.8 °C, WMMT 26.1 °C, CMMT 8.1 °C, 3-WET 638 mm, 3-DRY 14.2 mm, GROWSEAS 9.6 month, GSP 126.7 cm, MMGSP 89 mm, RH 69.1 %, SH 8.7 g/kg, and ENTHAL 32.4 kJ/kg. Leaf Margin Analysis (LMA) estimates of MAT<sub>1</sub> is 23.0 °C (sensu Wolfe (1979) and MAT<sub>2</sub> is 20.5 °C (sensu Su et al. 2010), and value of the sampling error sensu Miller et al. (2006) is 1.9 °C. The obtained climate proxies correspond more or less to those of stratigraphic analogous sites from the Staré Sedlo Formation and the Weissester Basin, such as Staré Sedlo locality (i.e., MAT = 16.2°C, WMMT = 25.9°C and CMMT = 6.3°C, MAT<sub>1</sub> = 19.9°C, MAT<sub>2</sub> = 17.7°C SE = 2.9°C) and proxies based on the compiled late Eocene floras from the Weissester Basin (i.e., MAT = 17.2°C, WMMT = 24.2°C and CMMT = 8.4°C, for locality Knau MAT<sub>1</sub> = 24.4°C, MAT<sub>2</sub> = 21.7°C SE = 3.9°C) – see for detailed Teodoridis (2011b), Teodoridis et al. (submitted). Anyway, the analogous Late Eocene floras from Saxony (Haselbach, Knau and Profen) and the Czech Republic (Staré Sedlo) exhibit the following average paleo-

**Table 1. Percentages of foliar physiognomic characters of the studied fossil flora of Kučlín.**

Foliar Physiognomic Characters [%]		Kučlín
Margin Character States	Lobed	11,54
	No Teeth	70,51
	Tth Regular	23,40
	Teeth Close	15,06
	Teeth Round	13,53
	Teeth Acute	16,60
	Tth Compound	0,00
Size Character States	Nanophyll	0,00
	Leptophyll I	0,00
	Leptophyll II	0,00
	Microphyll I	12,60
	Microphyll II	36,47
	Microphyll III	33,40
	Mesophyll I	14,38
	Mesophyll II	1,54
	Mesophyll III	1,54
Apex Character States	Apex Emarginate	2,56
	Apex Round	24,77
	Apex Acute	45,28
	Apex Attenuate	27,33
Base Character States	Base Cordate	4,27
	Base Round	33,76
	Base Acute	61,96
Length to Width Character States	L:W < 1:1	1,28
	L:W 1-2:1	10,68
	L:W 2-3:1	22,85
	L:W 3-4:1	45,15
	L:W > 4:1	19,99
Shape Character States	Obovate	11,54
	Elliptic	47,05
	Ovate	41,41
Total number of taxa		78

climatical character derived from the Coexistence Approach application sensu Mosbrugger and Utescher (1997): MAT 18 °C, WMMT 26 °C, CMMT 9 °C, and MAP 1272 mm (for detail see Roth-Nebelsick et al. 2004, Mosbrugger et al. 2005, Uhl et al. 2007). These paleoclimatic proxies as well our CLAMP results are comparable with the former estimates, i.e., MAT = 15–20°C, WMMT 15–23 °C, and CMMT = 6–13°C, for the Weisselster Basin (Mai and Walther 1983) and Staré Sedlo Formation (Knobloch et al. 1996).

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## Přehled svrchnoeocénní květeny Kučlína u Bíliny v severních Čechách

Zlatko Kvaček – Vasilis Teodoridis

Na základě morfologické studie většiny dosud publikovaných fosilních dokladů o svrchnoeocénní květeně diatomitu Kučlína z Českého středohoří severních Čech je podán přehled o jejím složení. Obsahuje zástupce jak vymřelých tak současných rodů vyšších rostlin doložených především listovými morfologickými typy, méně často plody a semena.

Doklady lze zařadit mezi kapradiny (Osmundaceae, Thelypteridaceae, Blechnaceae etc.), jehličnany (Cupressaceae, Doliostrobaceae) a hlavně mezi krytosemenné rostliny. Byli zjištěni zástupci čeledi Nymphaeaceae, Magnoliaceae, Lauraceae, Platanaceae, Ulmaceae, Fagaceae, Juglandaceae, Fabaceae a řady dalších zčásti exotických skupin. Mezi nimi jsou nejčastější Icacinaceae, Simaroubaceae a Rutaceae. Často se vyskytují zástupci zcela vymřelých skupin, které se dosud nepodařilo zařadit mezi žijící čeledi (např. *Raskya*). U řady z nich se nepodařilo zjistit žádné příbuzenské vztahy. V celku obsahuje kučlínská flóra podle této revize 95 taxonů založených na listových fosilích a 34 taxonů založených na plodech a semenech. Rostlinné společenstvo Kučlína obsahuje jednak eocénní indexové elementy (*Hooleya*, *Byttneriopsis*) a také mnohé další přežívající do oligocénu (*Eotrigonobalanus*) a miocénu (*Platanus neptuni*). Paleoenvironmentální a klimatické odhady odvozené podle charakteru olisnění krytosemenných rostlin dokládají poměry srovnatelné s jinými květenami eocénního a oligocénního stáří a rozšiřují informaci o vývoji klimatu střední Evropy v tomto časovém úseku.

## Explanation of the plates

### PLATE 1

*Equisetum ettingshausenii* KVAČEK et TEODORIDIS sp. n.

1. Fully flattened stem, holotype, orig. Ettingshausen 1866, pl. 2, fig. 15, as *Equisetites bilinicus*, BP 55.2366 (scale bar 10 mm).
2. Nodal diaphragm, paratype, NM G 8652a (scale bar 5 mm).

3. Fragment of a leafy sheath, NM G 8653 (scale bar 5 mm). *Osmunda lignitum* (GIEBEL) STUR
4. Fragmentary pinna showing venation, NM G 7896a (scale bar 5 mm).
5. Detail of Fig. 4 (scale bar 5 mm). *Pronephrium stiriacum* (UNGER) E. KNOBLOCH et KVAČEK
6. Fragmentary pinna, KUC 234 (scale bar 5 mm). *Lomariopsis (?) bilinica* ETTINGSHAUSEN
7. Partial pinna, orig. Ettingshausen 1866, pl. 3, fig. 13, BP 55.2489.1 (scale bar 10 mm).
8. Detail of Fig. 7 (scale bar 5 mm). *Acrostichum* sp.
9. Detail of frond, CGU s.n. (scale bar 10 mm). *Pronephrium stiriacum* (UNGER) E. KNOBLOCH et KVAČEK
10. Fragmentary sterile leaf, assigned by Ettingshausen to *Aspidium fischeri*, BP 55.2353.1 (scale bar 5 mm). *Rumohra recentior* (UNGER) BARTHEL
11. Fragmentary sterile frond, NM G 416 (scale bar 5 mm).
12. Detail of anadromous venation from Fig. 13 (scale bar 1 mm).
13. Large part of a leafy frond, KUC 37 (scale bar 10 mm). *Doliosrobos taxiformis* (STERNBERG) KVAČEK var. *sternbergii* MAI et WALTHER
14. Leafy twig, orig. Ettingshausen 1866, pl. 13, fig. 6, as *Sequoia sternbergii*, BP 55.2443.1 (scale bar 5 mm).
15. Cone scale, orig. Sieber 1881, as *Carpolithes carpini cuiusdam ?*, NM G 363 (scale bar 5 mm).
16. Leafy twig, orig. Menzel 1901, as *Sequoia sternbergii*, KIN 2.1 (scale bar 5 mm). *Tetraclinis salicornioides* (UNGER) KVAČEK
17. Seed, KUC 457A (scale bar 1 mm).
18. Twig fragment, NM G 8598 (scale bar 5 mm). *Doliosrobos taxiformis* (STERNBERG) KVAČEK
19. Seed with one lateral wing, KUC 445.2 (scale bar 5 mm). *Anoetomeria brongniartii* SAPORTA
20. Leaf scar (?or a group of seeds), KUC 457A (scale bar 10 mm).

## PLATE 2

- Anoetomeria brongniartii* SAPORTA
1. Leaf scar, (?or a group of seeds), KUC 457A (scale bar 3 mm).
  2. Leaf scar on a rhizome, orig. Ettingshausen 1869, pl. 41, fig. 14, BP 55.2336.1 (scale bar 5 mm).
  3. Leaf scar on a rhizome, orig. Ettingshausen 1869, pl. 41, fig. 11, BP 55.2428.1 (scale bar 5 mm).
- Nymphaeaceae gen.
4. Leaf, NM G 8638 (scale bar 10 mm).
  5. Detail of G 8639 (scale bar 10 mm).
- Nymphaea polyrhiza* SAPORTA
6. Leaf scar on a rhizome, NM G 8635 (scale bar 5 mm).
  7. Leaf scar on a rhizome, KUC 419A (scale bar 5 mm).
  8. Leaf scar on a rhizome, NM G 8657a (scale bar 10 mm).
- Sabrenia vel Dusembaya* sp.
9. Seed (scale bar 3 mm).
- “*Butomus*” *heerii* ETTINGSHAUSEN
10. Inflorescence, NM G 8647b (scale bar 10 mm).
  11. Inflorescence, detail of orig. Ettingshausen 1866, pl. 6, fig. 12, BP 59.1103.1 (scale bar 3 mm).
- Musa bilinica* ETTINGSHAUSEN
12. Leaf fragment, orig. Ettingshausen, 1866, pl. 7, fig. 5, BP 55.1145.1 (scale bar 10 mm).

13. Detail of fig. 12 (scale bar 5 mm). *Sabal raphifolia* (STERNBERG) E. KNOBLOCH et KVAČEK
14. Leaf fragment, orig. Ettingshausen 1866, pl. 6, fig. 3, as *Cyperus chavannesi* (scale bar 10 mm). *Poacites acuminatus* ETTINGSHAUSEN
15. Leaf fragment Ettingshausen 1866, pl. 6, fig. 6, BP 59.1142.1 (scale bar 5 mm). “*Arundo*” *heerii* ETTINGSHAUSEN
16. Fragment of rhizome, orig. Ettingshausen 1866, pl. 4, fig. 5, BP 59.1346.1 (scale bar 5 mm).

## PLATE 3

- ? *Dioscorea* sp.
1. Partial fruitlet, KIN 448-2 (scale bar 3 mm).
  2. Foliage fragment, KUC 216 (scale bar 10 mm). *Smilax* sp.
  3. Foliage fragment, NM G 8634a (scale bar 10 mm) *Nitophyllites bohemicus* WILDE, KVAČEK et BOGNER
  4. Leaf apex, NM G 77728 (scale bar 10 mm). cf. *Orontium* sp.
  5. Leaf base, KUC 431 (scale bar 10 mm).
  6. Detail of fig. 5 (scale bar 5 mm). “*Chamaerops*” *kutschlinica* ETTINGSHAUSEN
  7. ?Rhizome, orig. Ettingshausen 1866, pl. 7, fig. 16, BP 59.1179.1 (scale bar 10 mm).
  8. Detail of fig. 7 (scale bar 5mm). *Sabal raphifolia* (STERNBERG) E. KNOBLOCH et KVAČEK
  9. Leaf fragment, BP 55.2360.1 (scale bar 10 mm). cf. *Arecaceae* gen.
  10. ? Fragment of inflorescence, orig. Ettingshausen 1868, pl. 34, fig. 7, as *Leptomeria bilinica*, BP 59.1144.1 (scale bar 10 mm). *Nitophyllites bohemicus* WILDE, KVAČEK et BOGNER
  11. Leaf base, holotype, NM G 7778 (scale bar 10 mm). *Magnolia longipetiolata* ETTINGSHAUSEN
  12. Leaf base, syntype, Ettingshausen 1869, pl. 41, fig. 9, BP 59.1113.1 (scale bar 10 mm).

## PLATE 4

- Magnolia longipetiolata* ETTINGSHAUSEN
1. Leaf, KUC 442 (scale bar 10 mm). Magnoliaceae gen.
  2. Leaf, BP 59.1156.1 (scale bar 5 mm).
  3. Leaf, ident. by Ettingshausen as *Magnolia crassifolia* GÖPP., BP 55.2343.1 (scale bar 10mm).
  4. Detail of fig. 3 (scale bar 10 mm).
  5. Leaf, orig. Ettingshausen 1869, pl. 41, fig. 7, as *Magnolia primaeva* (scale bar 10 mm).
- Liriodendron* sp.
6. Leaf, NM G 8655 (scale bar 10 mm).
  7. Detail of fig. 6 (scale bar 3 mm).
- Daphnogene cinnamomifolia* (BRONGNIART) UNGER
8. Leaf, orig. Ettingshausen 1868, pl. 33, fig. 17, as *Cinnamomum polymorphum*, BP 55.2426.1 (scale bar 10 mm).
  9. Leaf, orig. Ettingshausen 1868, pl. 33, fig. 17, as *Cinnamomum buchii*, BP 59.1100.1 (scale bar 10 mm).
- Daphnogene* sp.
10. Leaf, KUC 146a (scale bar 10 mm).
  11. Leaf, NM G 8646 (scale bar 5 mm).
  12. Leaf, orig. Ettingshausen 1868, pl. 31, fig. 12, as *Sassafras aesculapi*, BP 55.1171.1 (scale bar 10 mm).

*Laurophyllum* sp. 1

13. Leaf, orig. Ettingshausen 1868, pl. 31, fig. 1, as *Nectandra arcinervia*, BP 55.2413.1 (scale bar 10 mm).

14. Leaf, KUC 415B (scale bar 10 mm).

*Laurophyllum* sp. 2

15. Leaf, orig. Ettingshausen 1868, pl. 31, fig. 10, as *Laurus nectandroides*, BP 55.2312.1 (scale bar 10 mm).

## PLATE 5

*Laurophyllum* sp. 2

1. Leaf, orig. Ettingshausen 1869, pl. 48, fig. 19, as *Celastrus microtropoides*, BP 55.2419.1 (scale bar 10 mm).

2. Leaf, orig. Ettingshausen 1869, pl. 35, fig. 29, as *Cinchonidium bilinicum*, BP 59.2344.1 (scale bar 10 mm).

3. Leaf, orig. Ettingshausen 1869, pl. 36, fig. 1, as *Cinchonidium randiaefolium*, BP 55.1233.1 (scale bar 10 mm).

4. Detail of fig. 3 (scale bar 5 mm).

*Berberis* sp.

5. Leaf, KUC 76 (scale bar 5 mm).

cf. *Mahonia* sp.

6. Leaflet ?, KUC 446 (scale bar 10 mm).

*Platanus neptuni* (ETTINGSHAUSEN) BŮŽEK, HOLÝ et KVAČEK

7. Inflorescence, type, Ettingshausen 1866, pl. 7, fig. 10, as *Sparganium neptuni*, BP 59.2498.1 (scale bar 5 mm).

8. Inflorescence, type, Ettingshausen 1866, pl. 7, fig. 11, as *Sparganium neptuni*, BP 55.2491.1, (scale bar 5 mm).

9. Leaf, orig. Ettingshausen 1869, pl. 41, fig. 5, as *Ceratopetalum haeringianum*, BP 2437.1 (scale bar 10 mm).

10. Leaf, forma *fraxinifolia*, KIN 84 (scale bar 10 mm).

11. Entire-margined leaf form, KUC 440 (scale bar 10 mm).

cf. *Ampelopsis* sp.

12. Leaf, KIN 363.1 (scale bar 5 mm).

*Palaeohosiea bilinica* (ETTINGSHAUSEN) KVAČEK et BŮŽEK

13. Mold of endocarp, orig. Sieber 1891, as *Prunus bilinica*, NM G 363 (scale bar 3 mm).

14. Mold of endocarp, KUC 5B (scale bar 3 mm).

*Leguminocarpon* sp.

15. Fragmentary pod, NM G 8648a (scale bar 10 mm).

*Podocarpium hirsutum* (ETTINGSHAUSEN) comb. n.

16. Leaflet, KUC 414 (scale bar 10 mm).

17. Detail of fig. 16 (scale bar 3 mm).

18. Pod, type, orig. Ettingshausen 1869, pl. 55, fig. 11, as *Podogonium hirsutum*, BP 59.1106.1 (scale bar 3 mm).

*Leguminosites* sp. 1

19. Leaflet, KIN 358 (scale bar 10 mm).

20. Leaflet, KUC 423 (scale bar 10 mm).

## PLATE 6

*Leguminosites* sp. 2

1. Leaflet, KIN 209 (scale bar 10 mm).

2. Leaflet, KIN 388 (scale bar 10 mm).

*Sloanea nimrodi* (ETTINGSHAUSEN) KVAČEK et HABLY

3. Leaf, NM G 7900b (scale bar 10 mm).

*Sloanea olmediifolia* (UNGER) KVAČEK et HABLY

4. Leaf, ČB 4b (scale bar 10 mm).

*Sloanea engelhardtii* KVAČEK et TEODORIDIS, sp. n.

5. Fruit, type, KIN 398 (scale bar 5 mm).

*Sloanea nimrodi* (ETTINGSHAUSEN) KVAČEK et HABLY

6. Leaf, type, orig. Ettingshausen 1868, pl. 40, Fig. 6, as *Cissus nimrodi*, BP 55.2324.1 (scale bar 10 mm).

*Sloanea manchesteri* KVAČEK et TEODORIDIS, sp. n.

7. Fruit, type, NM G 7895 (scale bar 5 mm).

cf. *Salix* sp.

8. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 11 as *Myrsine heeri*, BP 55.2462.1 (scale bar 10 mm).

9. Leaf, orig. Ettingshausen 1868, pl. 37, fig. 6 as *Myrsine doryphora*, BP 55.2354.1 (scale bar 10 mm).

10. Leaf, orig. Ettingshausen 1868, pl. 37, fig. 13 as *Myrsine doryphora*, BP 55.1116.1 (scale bar 10 mm).

*Tremophyllum microphyllum* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS, comb. n.

11. Leaf, orig. Ettingshausen 1869, pl. 40, fig. 15, as *Callicoma microphylla*, BP 55.2492.1, (scale bar 5 mm).

12. Leaf, orig. Ettingshausen 1869, pl. 40, fig. 21, as *Callicoma microphylla*, BP 55.2421.1, (scale bar 5 mm).

13. Leaf, orig. Ettingshausen 1869, s. ic., as *Callicoma microphylla*, BP 55.2438.1 (scale bar 5 mm).

*Cedrelospermum leptospermum* (ETTINGSHAUSEN) MANCHESTER

14. Fruit, NM G 7894 (scale bar 3 mm).

15. Fruit, KIN 192 (scale bar 3 mm).

*Ulmites* sp.

17. Leaf, orig. Ettingshausen 1869, pl. 50, fig. 19, as *Rhamnus bilinica*, BP 59.1072.1 (scale bar 5 mm).

*Tremophyllum microphyllum* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS, comb. n.

16. Leaf, NM G 7897a (scale bar 5 mm).

18. Leaf, KIN 35 (scale bar 10 mm).

19. Leaf, KUC 418 (scale bar 5 mm).

20. Leaf, KIN 40 (scale bar 10 mm).

21. Leaf, KIN 78 (scale bar 10 mm).

## PLATE 7

*Apocynophyllum bilinicum* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS, comb. n.

1. Leaf, orig. Ettingshausen 1868, pl. 36, fig. 20, as *Nerium bilinicum*, BP 55.2447.1 (scale bar 10 mm).

2. Detail of fig. 1 (scale bar 10 mm).

3. Leaf, orig. Ettingshausen 1868, pl. 39, fig. 19, as *Rhododendron haueri*, BP 55.2457.1 (scale bar 10 mm).

*Hemitrapa* cf. *pomelii* (BOULEY) MAI

4. Fruit, NM G 8650 (scale bar 10 mm).

5. Fruit, NM G 8649 (scale bar 5 mm).

6. Fruit, KIN 449 (scale bar 10 mm).

*Trigonobalanopsis rhamnoides* (ROSSMÄSSLER) KVAČEK et WALTHER

7. Leaf, KIN 372 (scale bar 10 mm).

*Eotrigonobalanus furcinervis* (ROSSMÄSSLER) KVAČEK et WALTHER

8. Leaf, NM G 8629 (scale bar 10 mm).

9. Detail of fig. 8 (scale bar 5 mm).

10. Leaf, KUC 1 (scale bar 10 mm).

? *Quercus* sp.

11. Cupule, KUC 401B (scale bar 3 mm).

*Juglandiphyllites* sp.

12. Leaflet, orig. Ettingshausen 1868, pl. 35, fig. 10, as *Dryandroides acuminata*, BP 55.2380.1 (scale bar 10 mm).

? *Carya fragiliformis* (STERNBERG) KVAČEK et WALTHER

13. Leaflet, orig. Ettingshausen 1869, pl. 52, fig. 7, as *Carya bilinica*, BP 55.2495.1 (scale bar 10 mm).



14. Detail of fig. 13 (scale bar 10 mm).  
*Engelhardia orsbergensis* (WESSEL et WEBER) JÄHNICHEN, MAI et WALTHER
15. Leaflet, NM G 360 (scale bar 10 mm).
16. Leaflet, NM G 8631 (scale bar 10 mm).
17. Leaflet, KIN 375 (scale bar 10 mm).
18. Leaflet, orig. Ettingshausen 1869, pl. 47, fig. 5 as *Sapindus bilinicus*, BP 55.2495.1 (scale bar 10 mm).  
*Engelhardia macroptera* (BRONGNIART) UNGER
19. Fruit, KIN 516 (scale bar 5 mm).  
*Hooleya hermis* (UNGER) E.M. REID et CHANDLER
20. Fruit, KIN 128 (scale bar 5 mm).
21. Fruit, KIN 126 (scale bar 5 mm).

### PLATE 8

*Juglandiphyllites* sp.2

1. Leaflet, orig. Ettingshausen 1869, pl. 47, fig. 13, as *Sapindus basilicus*, BP 55.2341.1 (scale bar 10 mm).
2. Leaflet, KIN 20.1 (scale bar 10 mm).  
cf. *Acherniophyllum hydrarchos* (UNGER) HABLY
3. Leaf, orig. Ettingshausen 1866, pl. 22, fig. 11, as *Populus mutabilis*, BP 56.1140.1 (scale bar 10 mm).  
*Byttneriopsis daphnogenes* (ETTINGSHAUSEN) KVAČEK et WILDE
4. Leaf, KUC 53 (scale bar 10 mm).
5. Leaf, orig. Ettingshausen 1866, pl. 22, fig. 1, as *Ficus daphnogenes*, BP 55.2481.1 (scale bar 5 mm).
6. Leaf, orig. Ettingshausen 1869, pl. 43, fig. 1, as *Sterculia deperdita*, BP 55.2361 (scale bar 10 mm).  
*Saportaspermum kovacsiae* KVAČEK et WILDE
7. Seed, KIN 54 (scale bar 5 mm).
8. Seed, KUC 12A (scale bar 5 mm).  
*Saportaspermum* sp.
9. Seed, KUC 456 (scale bar 5 mm).  
*Byttneriopsis steuerii* (ENGELHARDT) KVAČEK et WILDE
10. Leaf, KIN 409 (scale bar 20 mm).
11. Leaf, KUC 218 (scale bar 10 mm).
12. Detail of KUC 51 (scale bar 10 mm).
13. Leaf, KUC 51 (scale bar 10 mm).

### PLATE 9

cf. *Magnolia longipetiolata* ETTINGSHAUSEN

1. Enormously large leaf, holotype of *Ficus hercules* Ettingshausen, 1866, pl. 21, fig. 1, BP 55.2327.1 (scale bar 10 mm).
2. Detail of fig. 1 (scale bar 10 mm).  
? *Luheopsis* sp.
3. Leaf, KUC 226 (scale bar 10 mm).
4. Detail of fig. 3 (scale bar 5 mm).  
*Sterculia labrusca* (UNGER) UNGER
5. Leaf, orig. Ettingshausen 1868, pl. 43, fig. 4, BP 55.2401.1 (scale bar 10 mm).
6. Detail of fig. 5 (scale bar 10 mm).  
*Sterculia crassinervia* (ETTINGSHAUSEN) PROCHÁZKA
7. Detail of leaf, orig. Ettingshausen 1869, pl. 45, fig. 12, as *Acer crassinervium*, BP 55.2476.1 (scale bar 10 mm).
9. Leaf, orig. Ettingshausen 1869, pl. 45, fig. 9, as *Acer crassinervium*, BP 55.2393.1 (scale bar 10 mm).
11. Leaf, lectotype, orig. Ettingshausen 1869, pl. 45, fig. 13, as *Acer crassinervium*, BP 55.2416.1 (scale bar 10 mm).

“*Acer*” *sotzkianum* UNGER

8. Fruit, NM G 7893a (scale bar 10 mm).
10. Detail of orig. Ettingshausen 1869, pl. 45, fig. 8, as *Acer crassinervium*, BP 55.1132.1 (scale bar 3 mm).  
*Ailanthus palaeorhus* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS, comb. n.
12. Leaflet, KUC 453 (scale bar 10 mm).
13. Leaflet, lectotypus, orig. Ettingshausen 1869, pl. 46, fig. 12, BP 55.2486.1 (scale bar 10 mm).

### PLATE 10

cf. *Ailanthus* sp.

1. Leaflet, BP s.n. ident. Ettingshausen as *Salix varians* (scale bar 10 mm).
2. Detail of fig. 1 (scale bar 5 mm).
3. Leaflet, BP s.n. ident. Ettingshausen as *Salix varians* (scale bar 10 mm).  
*Chaneya palaeogaea* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS comb. n.
4. Flower, type, orig. Ettingshausen 1868, pl. 38, fig. 25, as *Diospyros palaeogaea*. BP 56.1133.1 (scale bar 5 mm).  
cf. *Ailanthus* sp.
5. ? Leaflet, NM G 8633a (scale bar 10 mm).
6. Detail of fig. 5 (scale bar 5 mm).  
*Ailanthus palaeorhus* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS comb. n.
7. Leaflet, KUC 428A (scale bar 5 mm).
8. Detail of fig. 7 (scale bar 5 mm).
11. Leaflet, orig. Ettingshausen 1868, pl. 35, fig. 8, as *Grevillea grandis* (scale bar 10 mm).  
*Ailanthus tardensis* HABLY
9. Fruit, KUC 77 (scale bar 5 mm).
10. Fruit, NM G 7898b (scale bar 5 mm).  
*Hydrangea microcalyx* SIEBER
12. Flower, holotype, Sieber 1881, NM G 337 (scale bar 10 mm).
13. Flower, NM G 7892 (scale bar 5 mm).  
*Ternstroemites* sp.
14. Leaf, KUC 450 (scale bar 5 mm).

### PLATE 11

*Ternstroemites* sp.

1. Leaf, KUC 159 (scale bar 10 mm).
2. Leaf, detail of fig. 1 (scale bar 10 mm).
3. Leaf, KUC 452 (scale bar 10 mm).
4. Leaf, detail of KUC 210 (scale bar 10 mm).
5. Leaf, KUC 190 (scale bar 10 mm).  
*Apocynospermum striatum* E. M. REID et CHANDLER
6. Two seeds together, KUC 118 (scale bar 5 mm).
7. Seed, KUC 73 (scale bar 10 mm).
8. Seed, KUC 454 (scale bar 10 mm).
9. Seed, KUC 453 (scale bar 5 mm).  
*Dicotylophyllum* sp. 1
10. Leaf, orig. Ettingshausen 1869, pl. 53, fig. 23, PB 55.2357.1 (scale bar 10 mm).
11. Detail of fig. 10 (scale bar 5 mm).  
*Dicotylophyllum* sp. 2
12. Leaf, orig. Ettingshausen 1868, pl. 39, fig. 9, as *Andromeda protogaea*, BP 55.2470.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 3

13. Leaf, orig. Ettingshausen 1869, pl. 54, fig. 20, as *Eucalyptus oceanica*, BP 59.1134.1 (scale bar 10 mm).

14. Leaf, KUC 411 (scale bar 10 mm).

15. Detail of fig. 14 (scale bar 5 mm).

*Dicotylophyllum* sp. 4

16. Leaf, KUC 81 (scale bar 10 mm).

*Dicotylophyllum* sp. 5

17. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 1, as *Ardisia laharpii*, BP 55.2415.1 (scale bar 10 mm).

18. Detail of fig. 17 (scale bar 5 mm).

*Dicotylophyllum* sp. 6

19. Leaf, counterpart of orig. Sieber 1881, as *Aristolochia grandifolia*, det. Ettingshausen as *Sterculia*, BP s.n. (scale bar 10 mm).

20. Detail of fig. 19 (scale bar 5 mm).

*Dicotylophyllum* sp. 7

21. Detail of fig. 22 (scale bar 10 mm).

22. Leaf, orig. Ettingshausen 1869, pl. 50, fig. 22, as *Baloghia miocenica*, BP 55.2340.1 (scale bar 10 mm).

**PLATE 12**

*Dicotylophyllum* sp. 8

1. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 13, as *Bumelia oreadam*, BP 55.2386.1 (scale bar 5 mm).

2. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 15, as *Bumelia oreadam*, BP 55.2322.1 (scale bar 5 mm).

3. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 12, as *Bumelia oreadam*, BP 55.2375.1 (scale bar 5 mm).

*Callistemophyllum bilanicum* ETTINGSHAUSEN

4. Leaf, orig. Ettingshausen 1869, pl. 54, fig. 1, as *Callistemophyllum melaleucaeforme*, BP 55.2320.1 (scale bar 10 mm).

5. Leaf, NM G 8663, det. Velenovský as *Salix* (scale bar 10 mm).

6. Leaf, orig. Ettingshausen 1869, pl. 55, fig. 2, as *Callistemophyllum bilanicum*, BP 55.2314.1 (scale bar 10 mm).

7. Detail of fig. 6 (scale bar 5 mm).

*Camptodromites* sp.

8. Leaf, orig. Ettingshausen 1869, pl. 49, fig. 15, as *Berchemia multinervis*, BP 55.2451.1 (scale bar 10 mm).

9. Leaf, KUC 399 (scale bar 10 mm).

10. Leaf, NM G 8632a (scale bar 10 mm).

11. Detail of fig. 10 (scale bar 5 mm).

*Dicotylophyllum* sp. 9

12. Leaf, orig. Ettingshausen 1869, pl. 46, fig. 13, as *Cassine palaeogea*, BP 55.2320.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 10

13. Leaf, orig. Ettingshausen 1869, pl. 49, fig. 2, as *Celastrophyllum mimusops*, BP 55.2486.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 11

14. Leaf, orig. Ettingshausen 1869, pl. 48, fig. 28, as *Celastrus aeoli*, BP 55.2445.1 (scale bar 10 mm).

15. Leaf, orig. Ettingshausen 1869, pl. 48, fig. 26, as *Celastrus luciae*, BP 55.2429.1 (scale bar 10 mm).

16. Detail of fig. 15 (scale bar 5 mm).

*Dicotylophyllum* sp. 12

17. Leaf, KIN 242 (scale bar 10 mm).

18. Leaf, KIN 359 (scale bar 10 mm).

**PLATE 13**

*Craspedodromophyllum betuloides* KVAČEK et TEODORIDIS sp. n.

1. Leaf, holotype, KUC 4 (scale bar 10 mm).

2. Detail of fig. 1 (scale bar 10 mm).

*Dicotylophyllum* sp. 13

3. Leaves on a twig, KIN 381 (scale bar 10 mm).

4. Another part of the twig, KIN 381 (scale bar 10 mm).

*Dicotylophyllum* sp. 14

5. Leaf, KIN 208 (scale bar 10 mm).

*Sterculia labrusca* (UNGER) UNGER

6. Leaf, NM G 8654 (scale bar 10 mm).

7. Detail of fig. 6 (scale bar 10 mm).

*Dicotylophyllum* sp. 15

8. Leaf, KIN 23 (scale bar 10 mm).

*Dicotylophyllum* sp. 16

9. Leaf, KIN 431 (scale bar 10 mm).

*Diospyros ? microcalyx* (ETTINGSHAUSEN) KVAČEK et TEODORIDIS comb. n.

10. Leaf, KUC 437 (scale bar 10 mm).

11. Detail of fig. 10 (scale bar 10 mm).

12. Leaf, BP s.n., as *Diospyros*, det. Ettingshausen (scale bar 10 mm).

13. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 34, as *Diospyros paradisiaca*, BP 55.2439.1 (scale bar 10 mm).

14. Calyx, KIN 26 (scale bar 5 mm).

15. Calyx, KIN 313.1 (scale bar 5 mm).

16. Calyx, orig. Ettingshausen 1868, pl. 39, fig. 4, as *Macreightia microcalyx*, BP 55.2342 (scale bar 5 mm).

17. Calyx, KIN 285 (scale bar 5 mm).

18. Calyx, orig. Ettingshausen 1868, pl. 39, fig. 5, as *Macreightia microcalyx*, BP 55.2500 (scale bar 5 mm).

**PLATE 14**

*Dicotylophyllum* sp. 17

1. Leaf, orig. Ettingshausen 1869, pl. 53, fig. 16, as *Eugenia apollinis*, BP 55.2485.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 18

2. Leaf, KUC 441 (scale bar 10 mm).

*Dicotylophyllum* sp. 19

3. Leaf, orig. Ettingshausen 1866, pl. 20, fig. 8 a, b, as *Ficus kutschlinica*, BP 55.2485.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 20

4. orig. Ettingshausen 1866, pl. 21, fig. 5, as *Ficus urani*, BP 55.2408.1 (scale bar 10 mm).

5. Detail of fig. 4 (scale bar 10 mm).

*Dicotylophyllum* sp. 21

6. Leaf, orig. Ettingshausen 1869, pl. 55, fig. 20, as *Laurelia glandulifera*, BP 55.2410.1 (scale bar 10 mm).

7. Detail of fig. 6 (scale bar 5 mm).

*Dicotylophyllum* sp. 22

8. Leaf, orig. Ettingshausen 1868, pl. 20, fig. 8 a, b, as *Ligustrum priscum*, BP 55.2362.1 (scale bar 10 mm).

*Majanthemophyllum* sp.

9. Leaf, KUC 191 (scale bar 10 mm).

10. Detail of fig. 9 (scale bar 5 mm).

*Dicotylophyllum* sp. 23

11. Leaf, orig. Ettingshausen 1868, pl. 36, fig. 14, as *Note-laea phillyrae*, BP 55.2370.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 24

12. Leaf, orig. Ettingshausen 1868, pl. 36, fig. 15, as *Olea feroniae*, BP 55.2368.1 (scale bar 10 mm).

13. Leaf, orig. Ettingshausen 1868, pl. 36, fig. 13, as *Olea olympica*, BP 55.2471.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 25

14. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 6, as *Pleio-merites reticulatus*, BP 59.1107.1 (scale bar 10 mm).

#### PLATE 15

*Pungiphyllum heerii* (SIEBER) KVAČEK et TEODORIDIS comb. n.

1. Leaf, KUC 48 (scale bar 10 mm).

2. Leaf, KUC 214A (scale bar 10 mm).

3. Leaf, KUC 55b (scale bar 10 mm).

4. Leaf, neotype, KUC 74A (scale bar 5 mm).

5. Detail of fig. 4 (scale bar 3 mm).

*Dicotylophyllum* sp. 26

6. Leaf, orig. Ettingshausen 1869, pl. 49, fig. 19, as *Rhamnus paucinervis*, BP 55.2479.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 27

7. Leaf, orig. Sieber 1881, as *Quercus*, NM G 352 (scale bar 10 mm).

*Dicotylophyllum* sp. 28

8. Leaf, orig. Ettingshausen 1866, pl. 17, fig. 11, as *Quercus kutschlinica*, BP 55.2468.1 (scale bar 10 mm).

9. Detail of fig. 8 (scale bar 10 mm).

*Raskya vetusta* (ETTINGSHAUSEN) MANCHESTER et HABLY

10. Winged fruit, NM G 7567a (scale bar 5 mm).

11. Winged fruit, KUC 168 (scale bar 5 mm).

*Dicotylophyllum* sp. 29

12. Leaf, orig. Ettingshausen 1868, pl. 34, fig. 6, as *Santalum salicinum*, BP 59.1190.1 (scale bar 10 mm).

#### PLATE 16

*Dicotylophyllum* sp. 35

1. Leaf, KUC 228.1A (scale bar 10 mm).

2. Detail of fig. 1 (scale bar 10 mm).

*Ziziphus bilinica* ETTINGSHAUSEN

3. Leafy twig, orig. Ettingshausen 1869, pl. 51, fig. 1, BP 59.1139.1 (scale bar 10 mm).

4. Detail of fig. 3 (scale bar 10 mm).

5. Leaf, KUC 141A (scale bar 10 mm).

*Dicotylophyllum* sp. 30

6. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 22, as *Sapotacites bilinicus*, BP 55.2463.1 (scale bar 10 mm).

7. Leaf, orig. Ettingshausen 1868, pl. 38, fig. 23, as *Sapotacites daphnes*, BP 55.2465.1 (scale bar 10 mm).

8. Leaf, NM G 355 (scale bar 10 mm).

9. Detail of fig. 8 (scale bar 10 mm).

*Dicotylophyllum* sp. 31

10. Leaf, orig. Ettingshausen 1869, pl. 41, fig. 1, as *Saxifragites crenulatus*, BP 55.2409.1 (scale bar 5 mm).

11. Detail of fig. 10 (scale bar 10 mm).

12. Leaf, KUC 430 (scale bar 10 mm).

13. Detail of Fig. 12 (scale bar 10 mm).

14. Leaf, KUC 429 (scale bar 10 mm).

#### PLATE 17

*Dicotylophyllum* sp. 32

1. Leaf, orig. Ettingshausen 1869, pl. 40, fig. 1, as *Sciadophyllum haidingeri*, BP 55.2331.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 33

2. Leaf, orig. Ettingshausen 1869, pl. 53, fig. 24, as *Sorbus palaeoaria*, BP 59.843.1 (scale bar 10 mm).

*Dicotylophyllum* sp. 34

3. Leaf, orig. Ettingshausen 1869, pl. 38, fig. 33, as *Styrax stylosa*, BP 55.2418.1 (scale bar 10 mm)

*Carpolithes* sp. 1.

4. Infructescence, KUC 43A (scale bar 1 mm).

5. Infructescence, KUC 43B (scale bar 10 mm).

*Carpolithes* sp. 11

6. Fruit impression, as *Paliurus favonii*, orig Ettingshausen 1869, pl. 50, fig. 7, BP 55.1163.2 (scale bar 5 mm).

*Carpolithes* sp. 2

7. Fruit impression, KIN 377 (scale bar 5 mm).

*Carpolithes* sp. 3

8. Fruit impression, KIN 249.1 (scale bar 10 mm).

*Carpolithes* sp. 4

9. Fruit impression, KIN 460 (scale bar 5 mm).

*Carpolithes* sp. 5

10. Fruit impression, KIN 48 (scale bar 5 mm).

*Carpolithes* sp. 6

11. Fruit impression, KIN 50 (scale bar 5 mm).

*Carpolithes* sp. 7

12. ? Inflorescence, KIN 256 (scale bar 10 mm).

*Carpolithes* sp. 8

13. Fruit impression, KIN 460 (scale bar 10 mm).

*Carpolithes* sp. 9

14. Catkin, KIN 38.1 (scale bar 10 mm).

*Carpolithes* sp. 10

15. ? Inflorescence, KIN 269 (scale bar 10 mm).

#### PLATE 18

*Sabal raphifolia* (STERNBERG) E. KNOBLOCH et KVAČEK

1. A large segment of the leaf, KUC 458 (scale bar 10 mm).

*Eotrigonobalanus furcinervis* (ROSSMÄSSLER) WALTHER et KVAČEK

2. Large part of the leaf base, ČB 1 (scale bar 10 mm).

3. Upper part of coarsely dentate leaf apex, ČB 2 (scale bar 10 mm).

#### PLATE 19

Kučlín locality, Trupelník Hill

1. View to south, place of excavation of the fossil trunk in 1976, photo M. Mag (courtesy Regional Museum Teplice).

2. Excavation in 2011, photo P. Dvořák.

PLATE 1

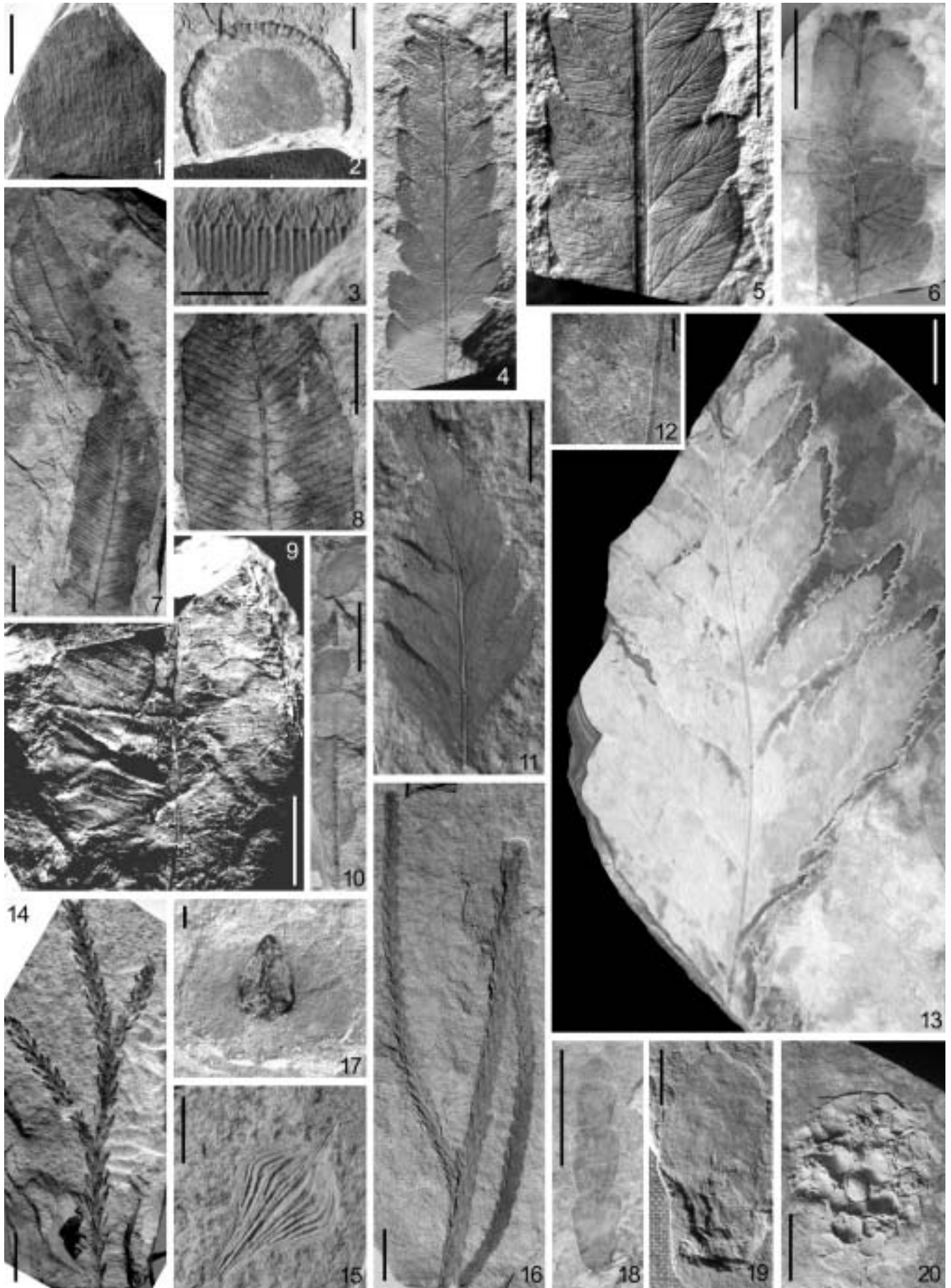
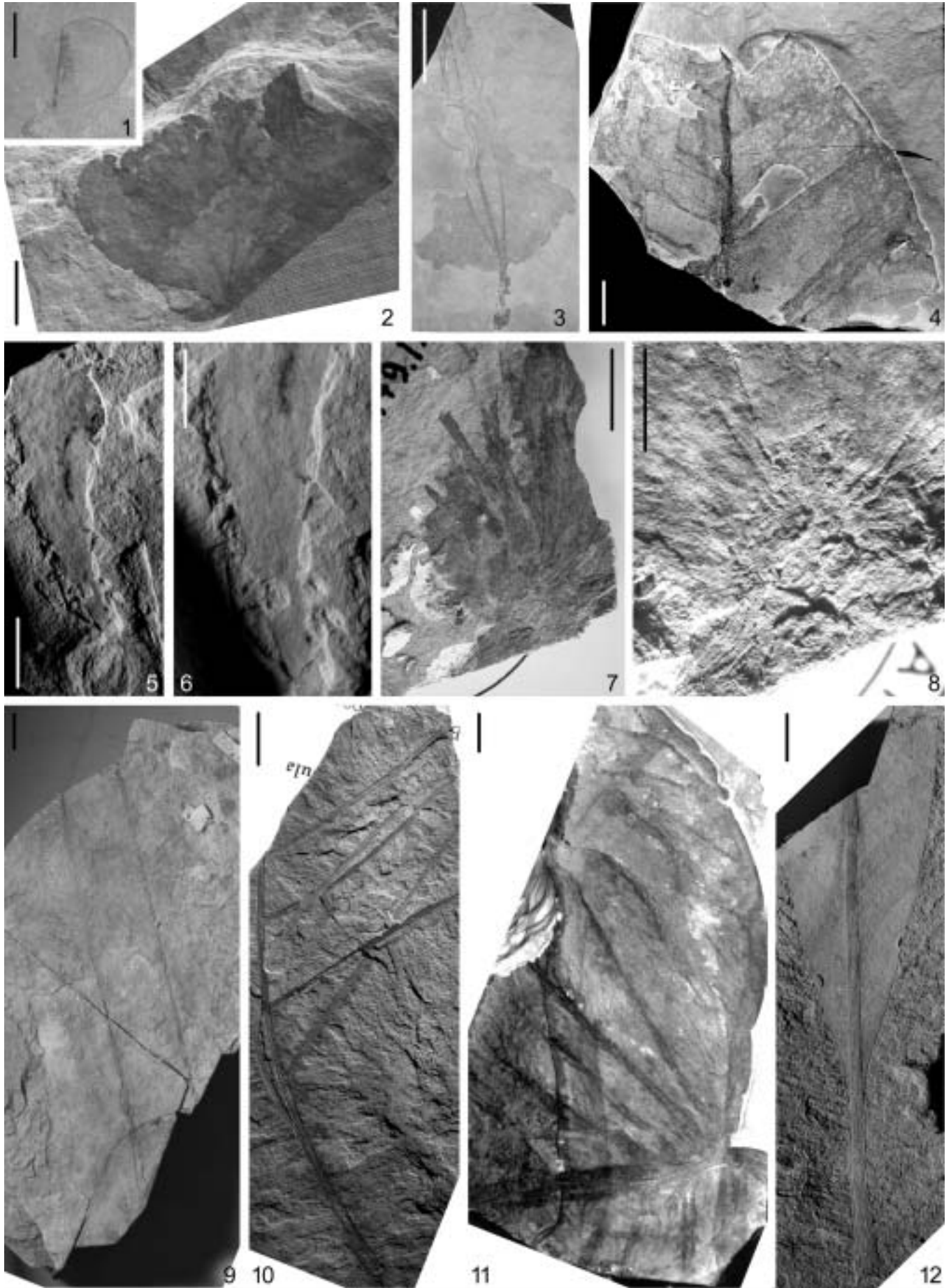




PLATE 3



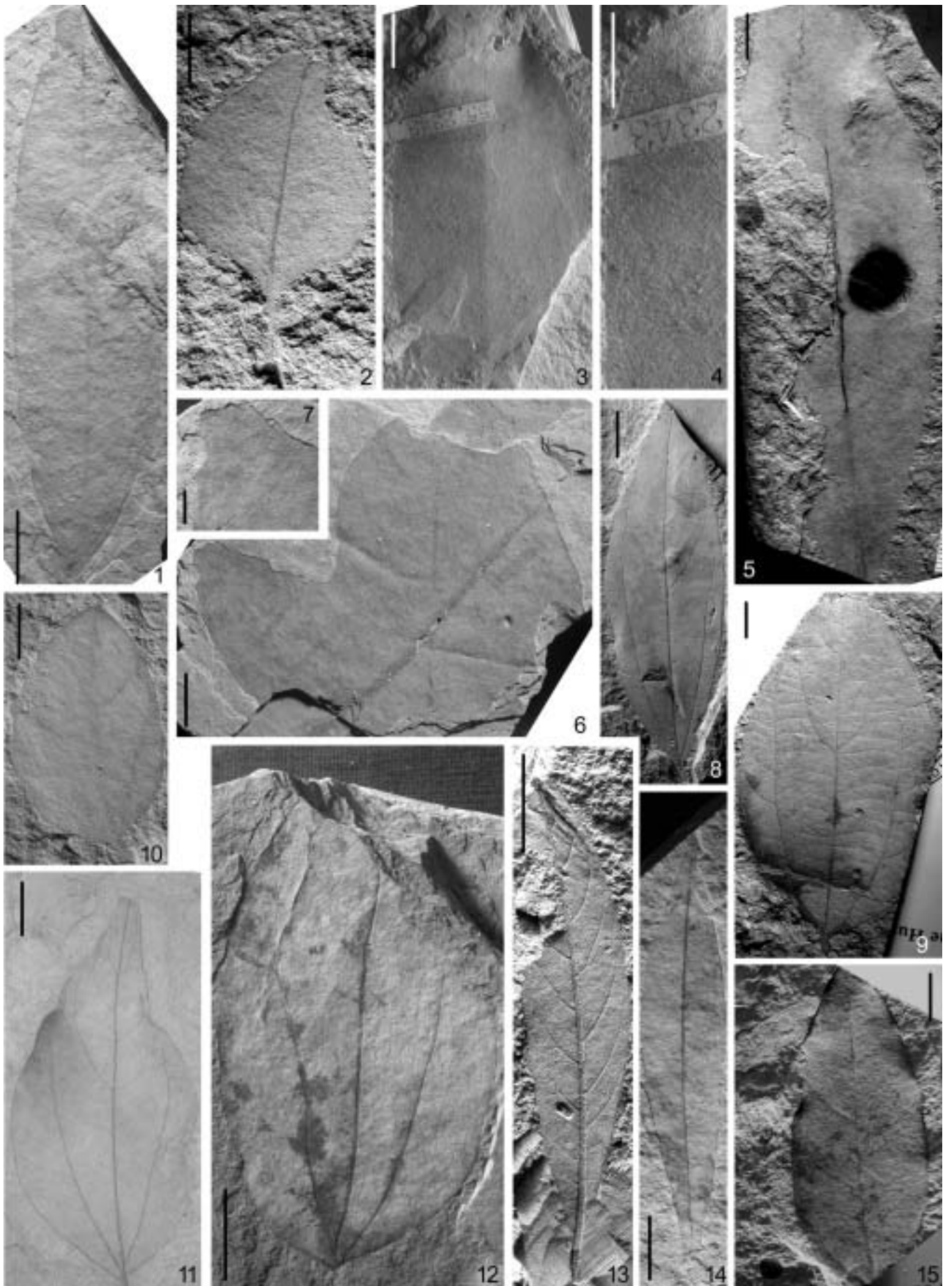
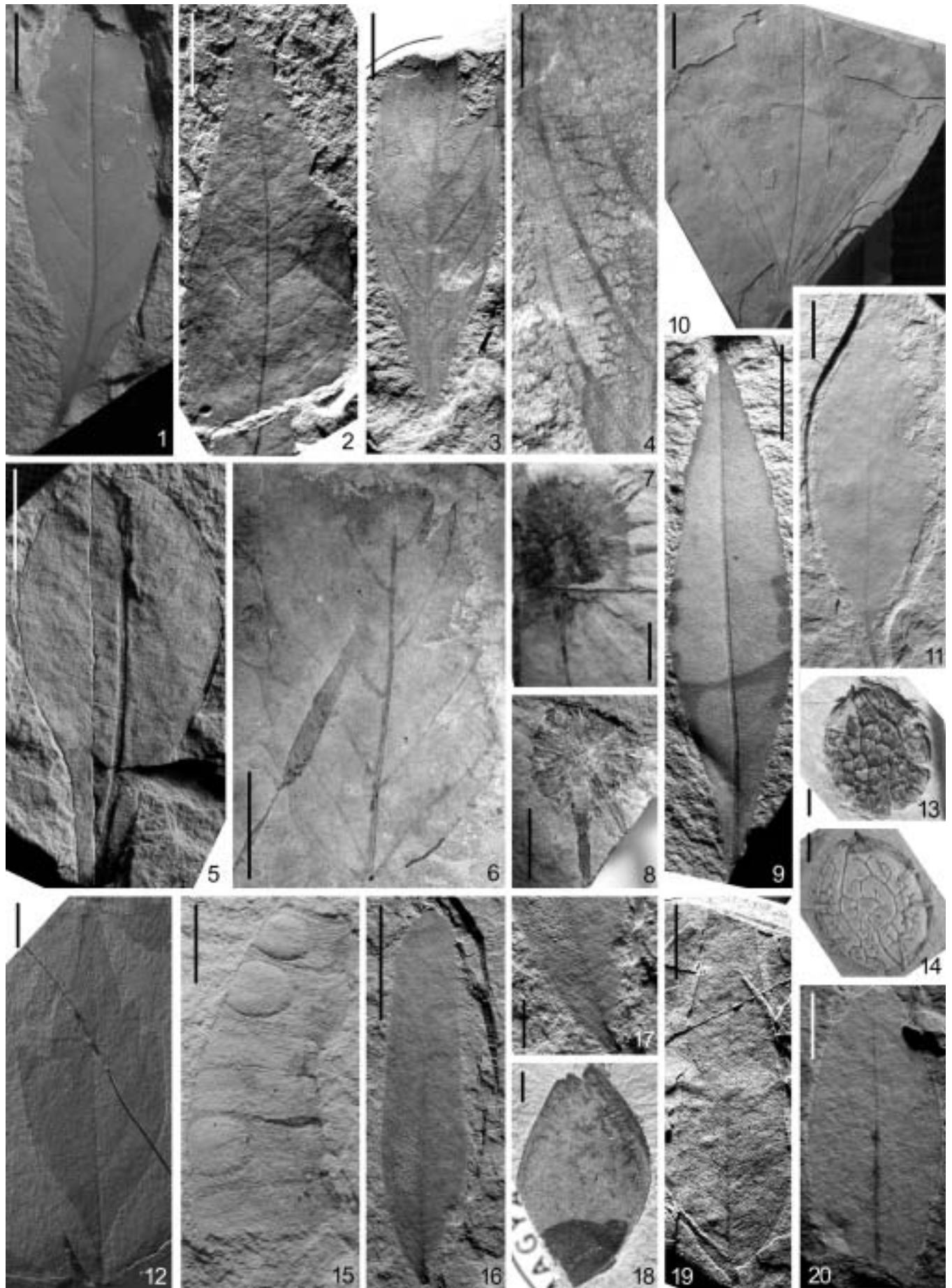


PLATE 5





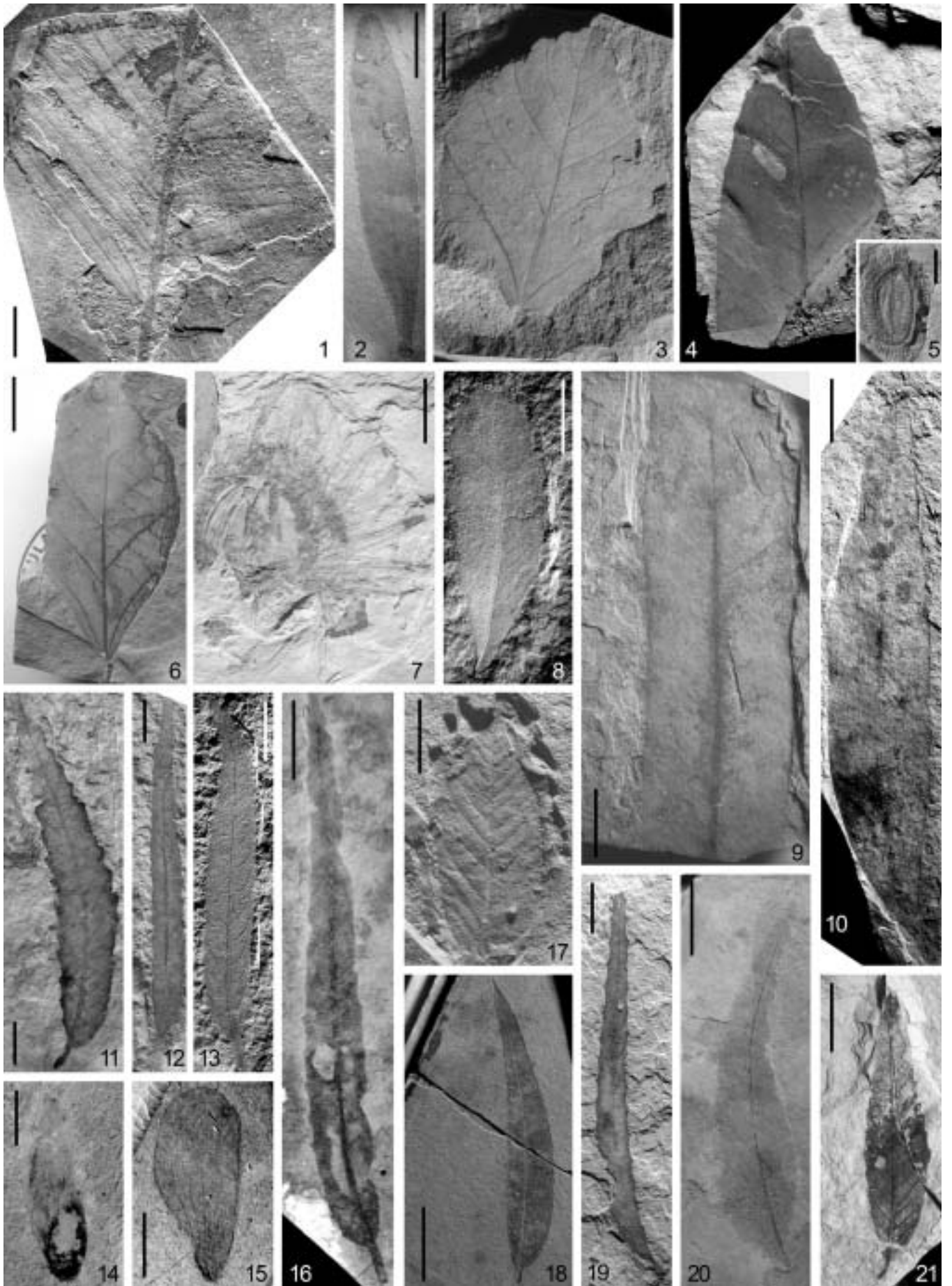
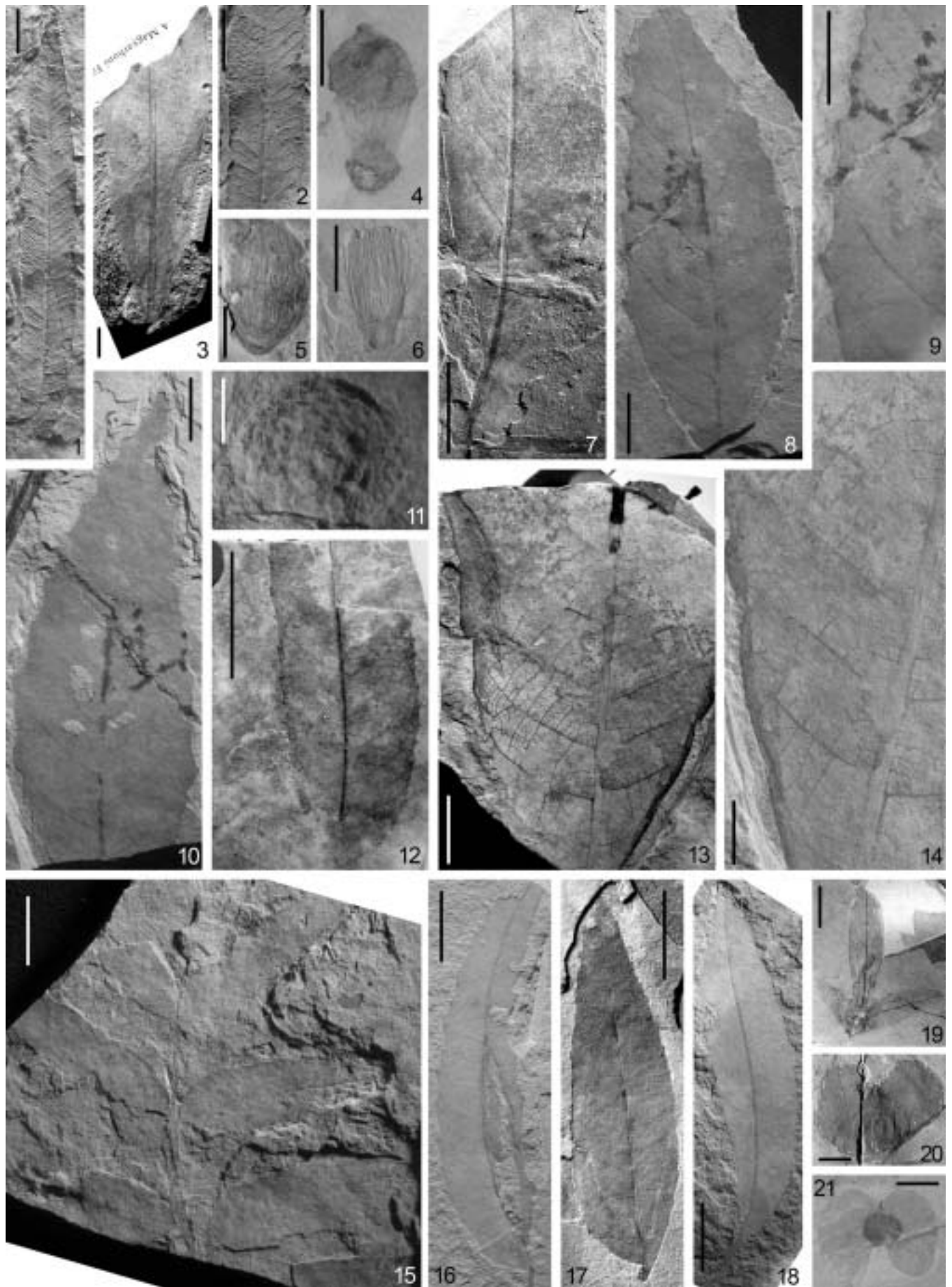


PLATE 7



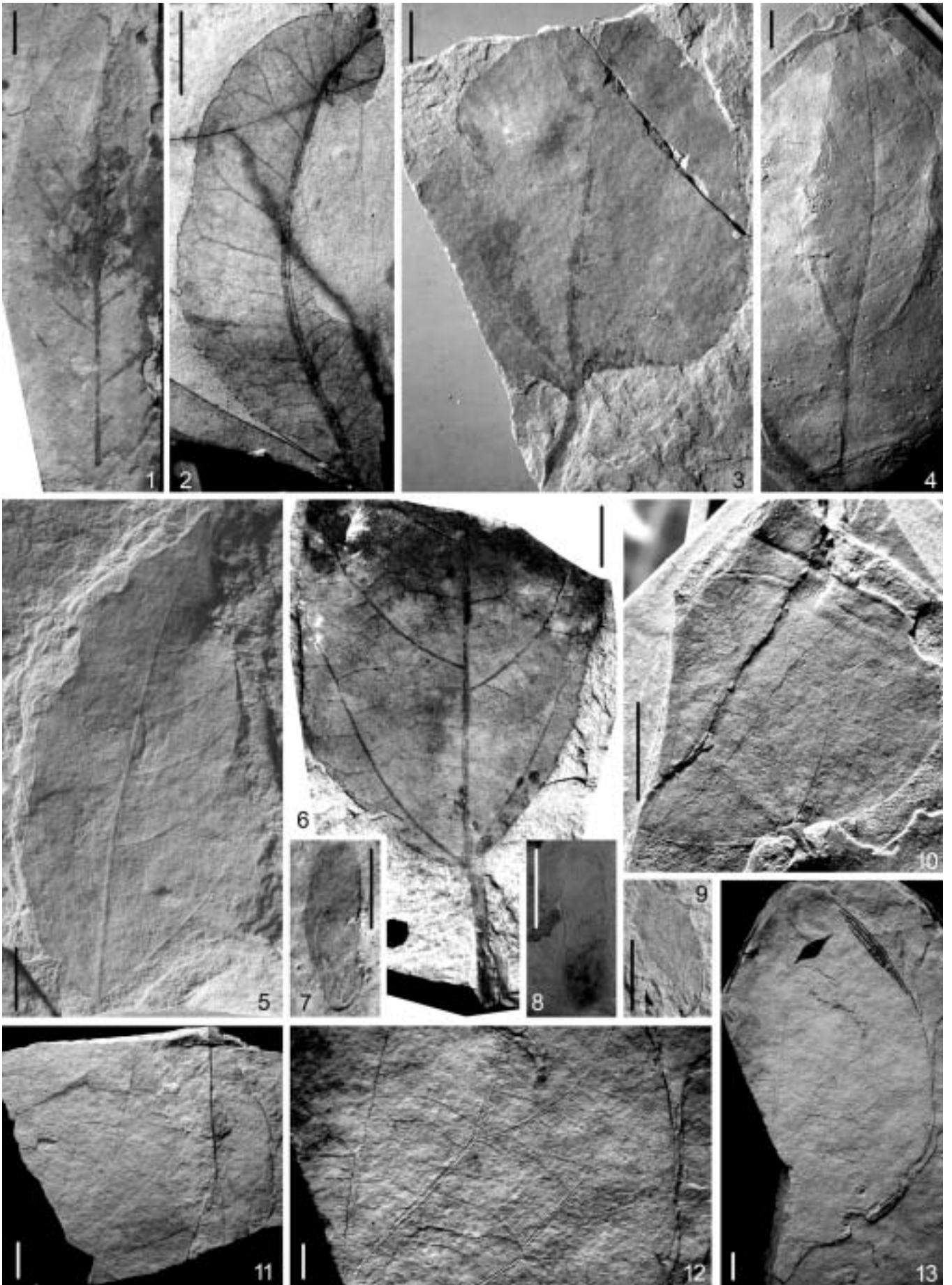
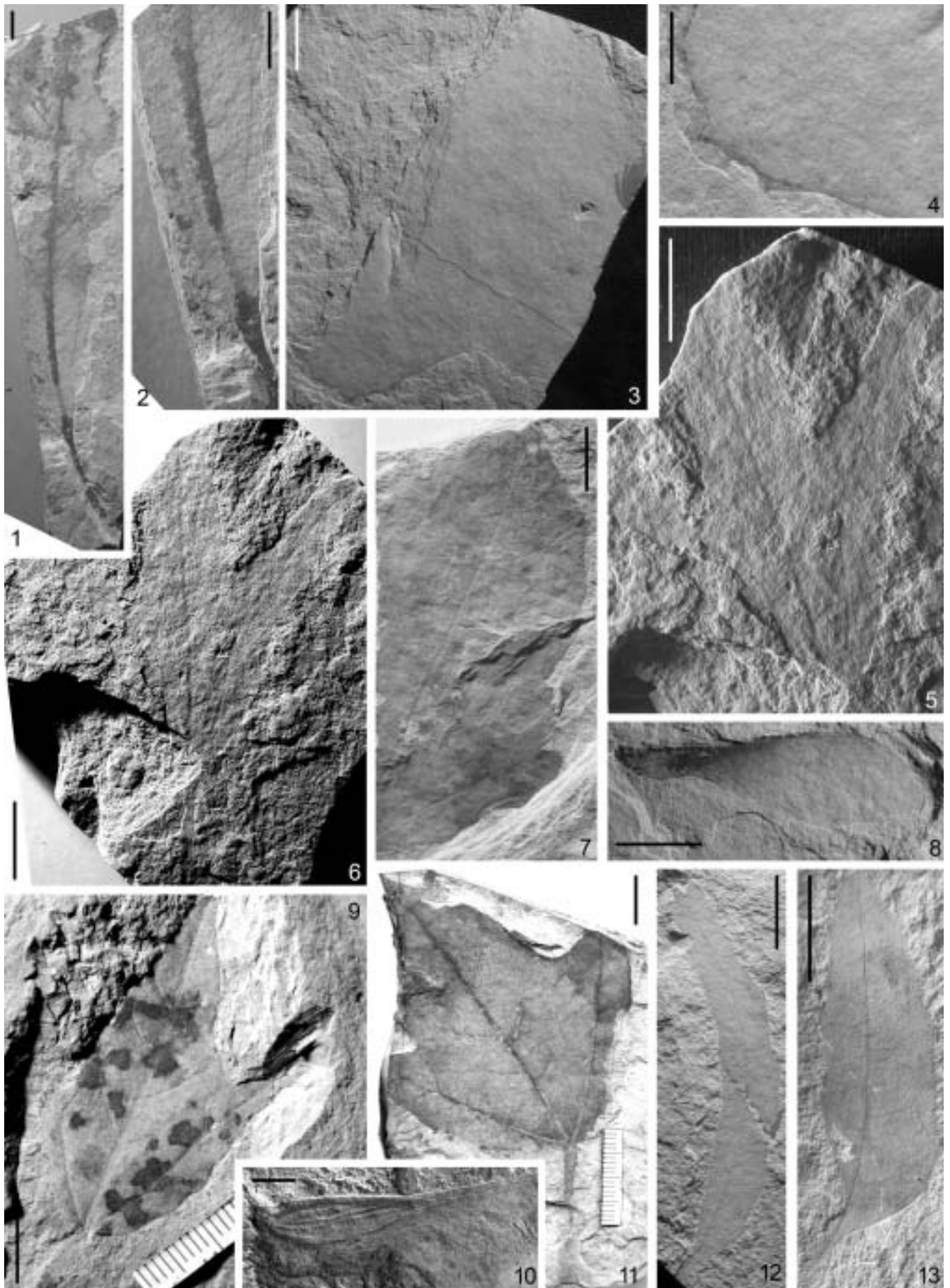


PLATE 9



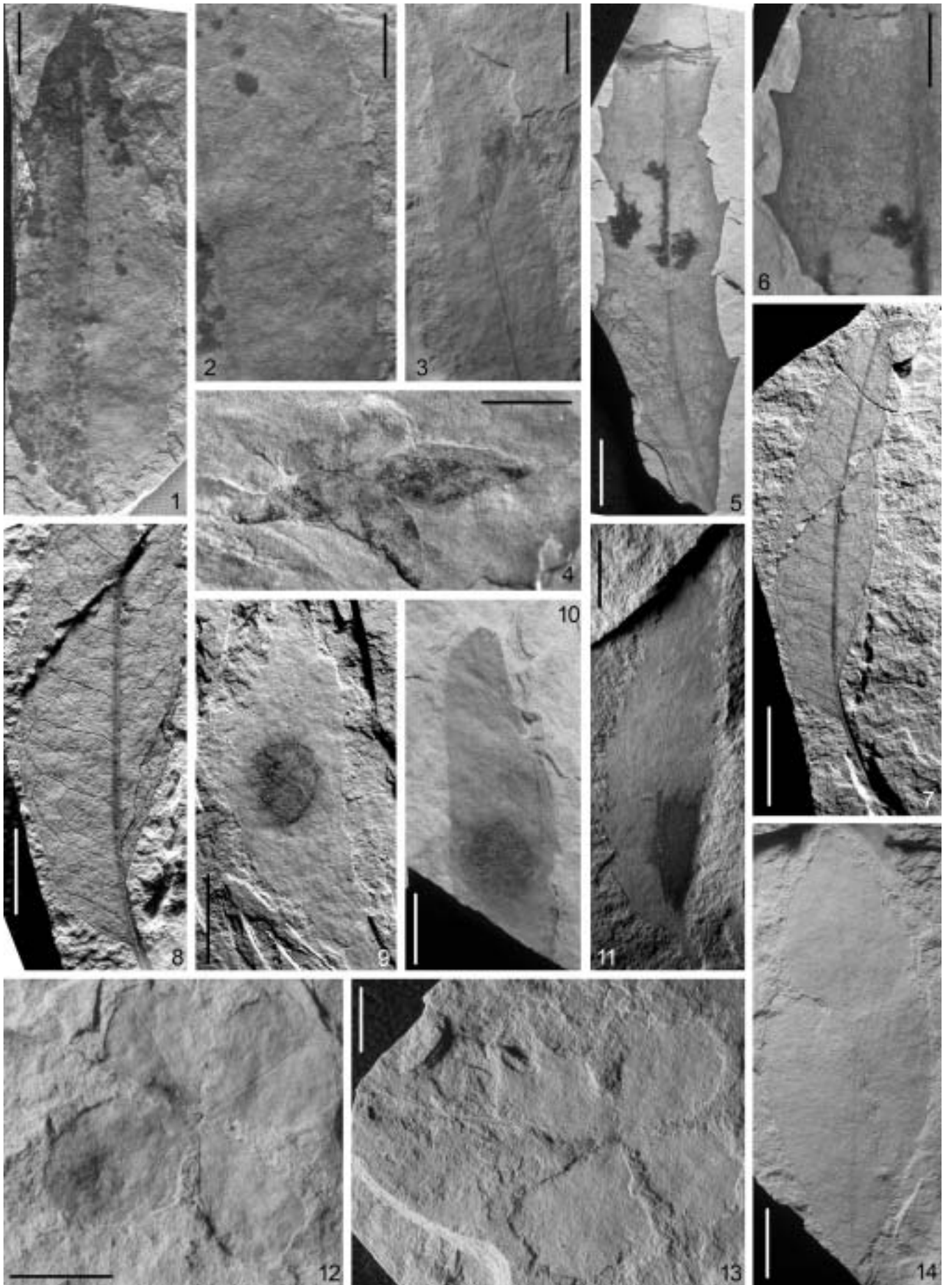
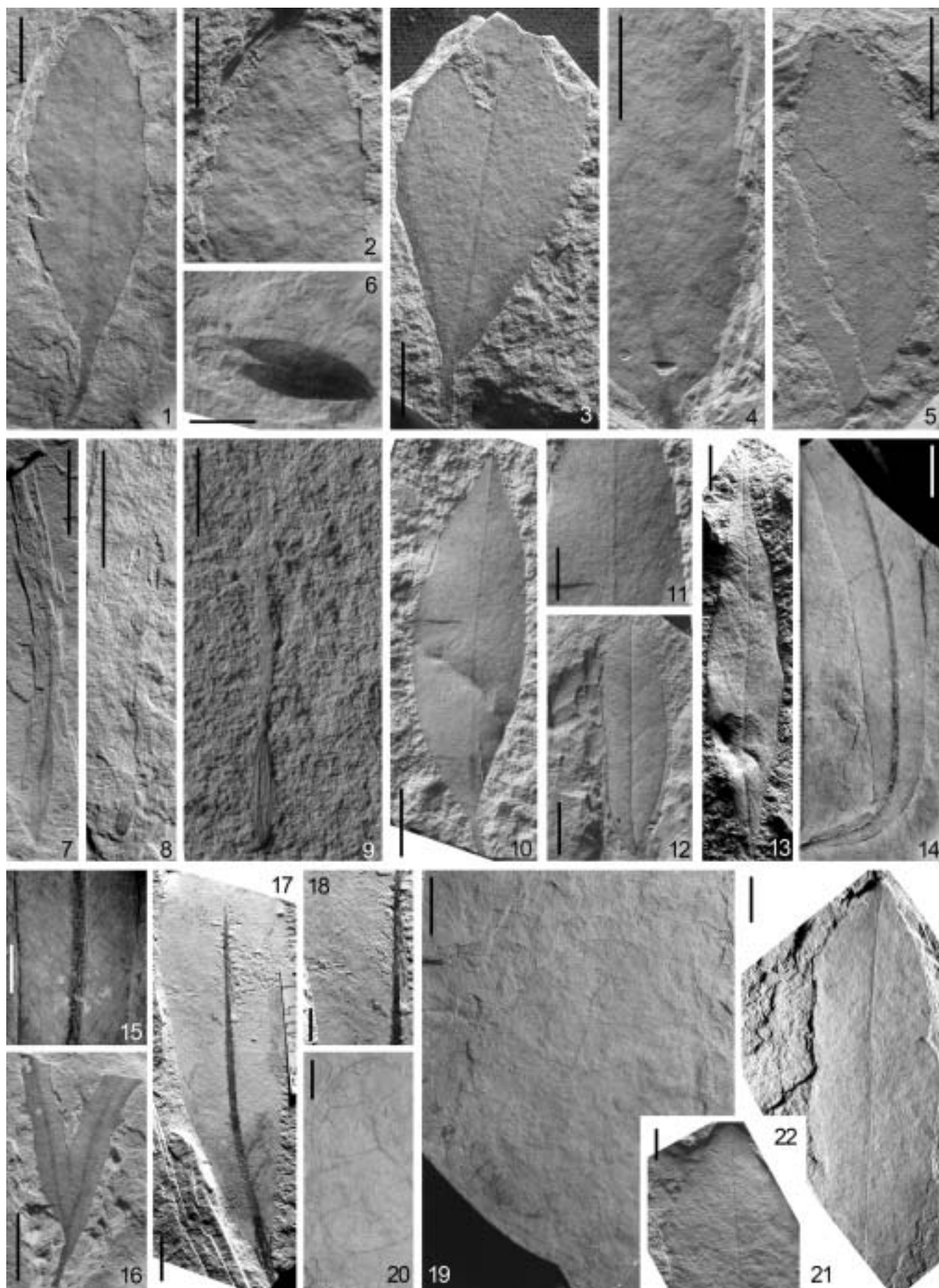


PLATE 11



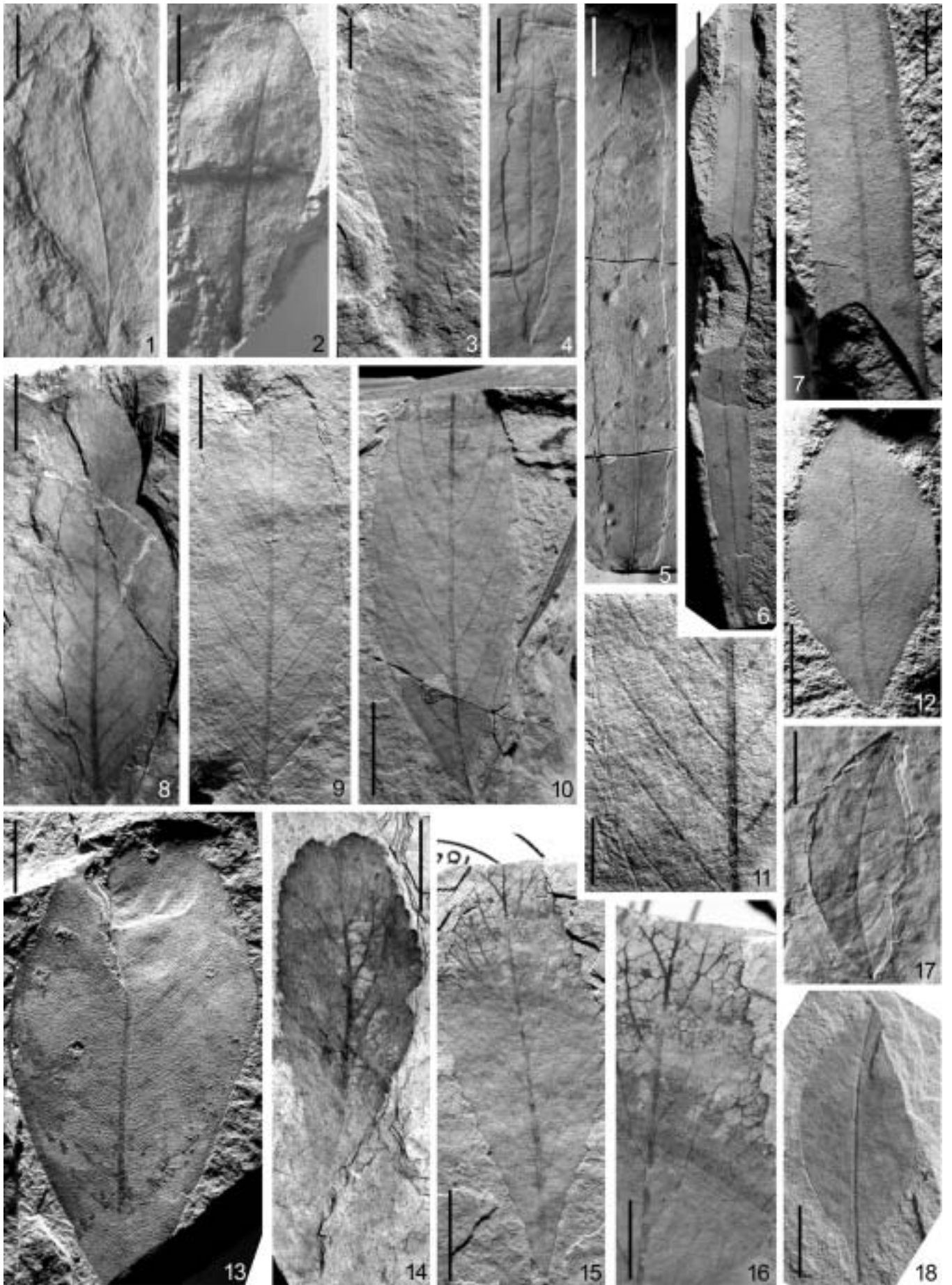
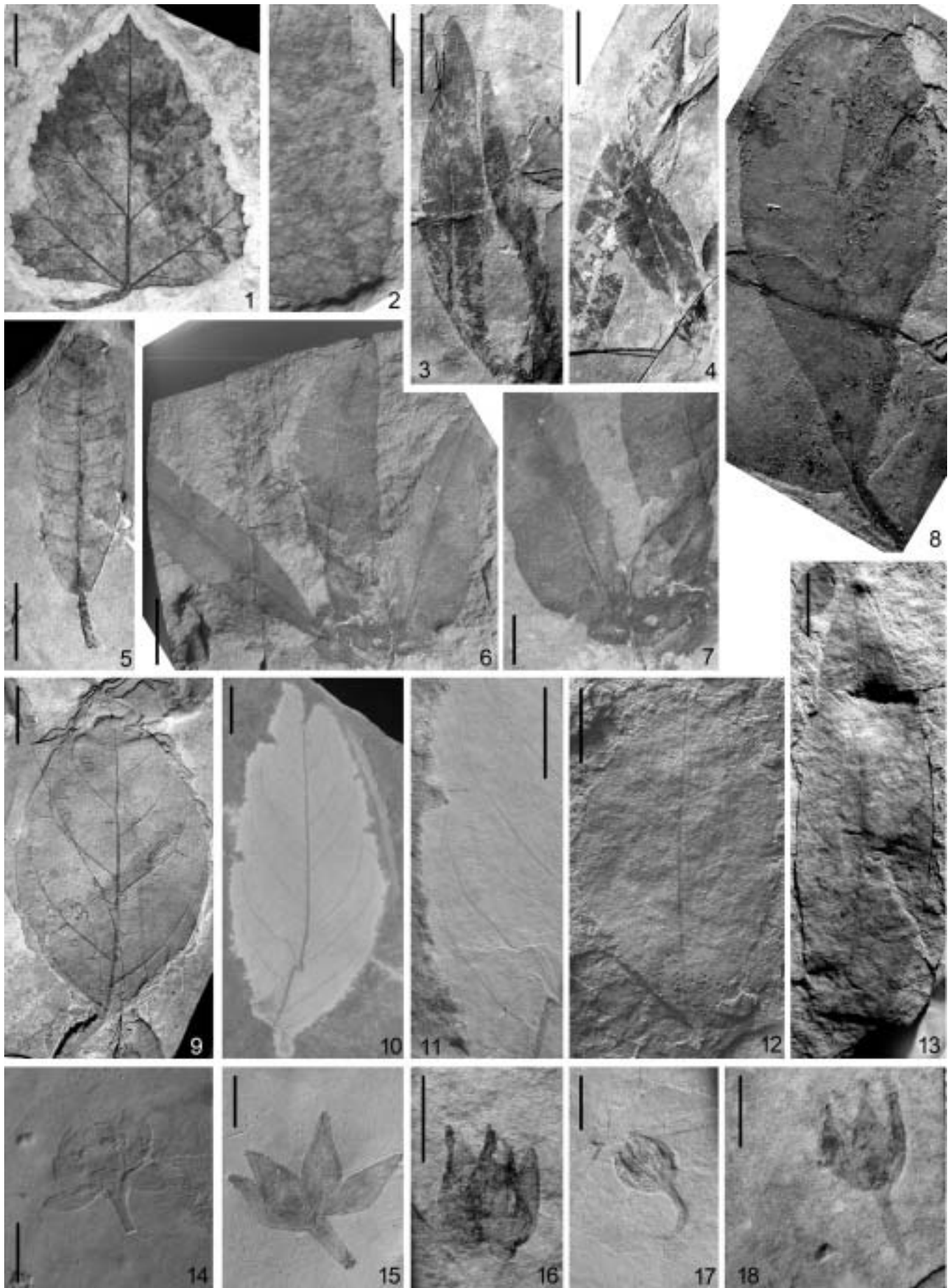


PLATE 13





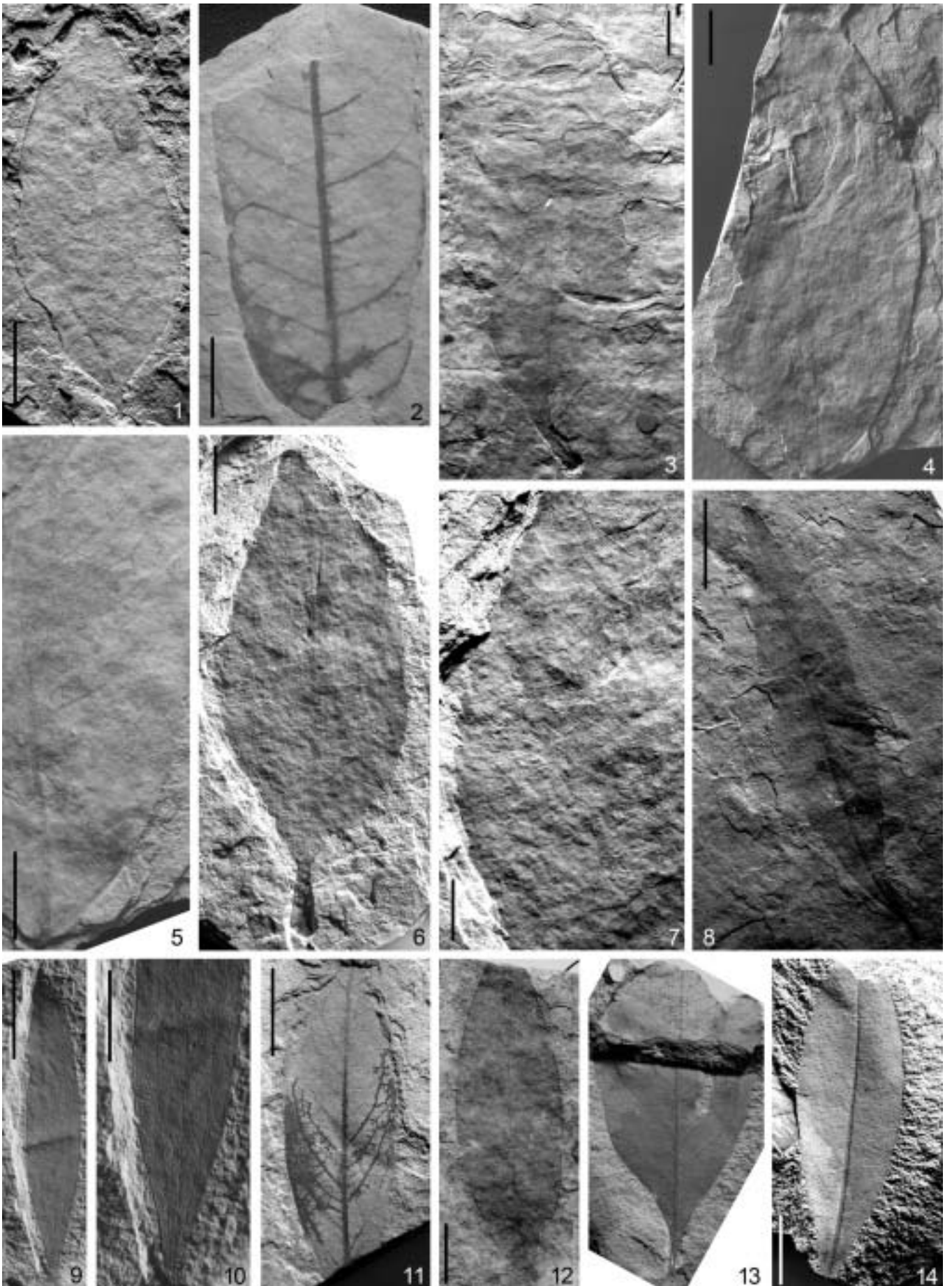
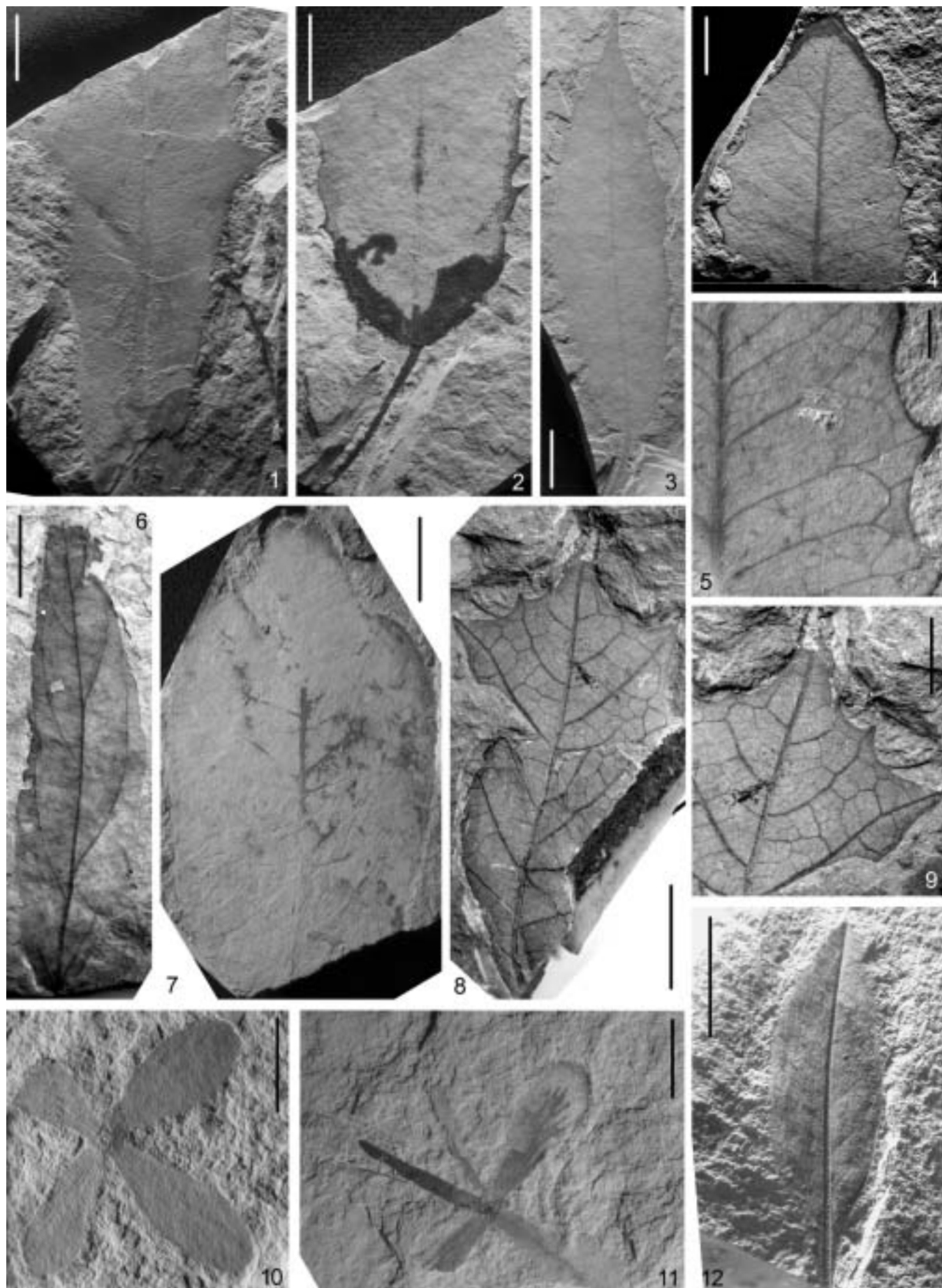


PLATE 15



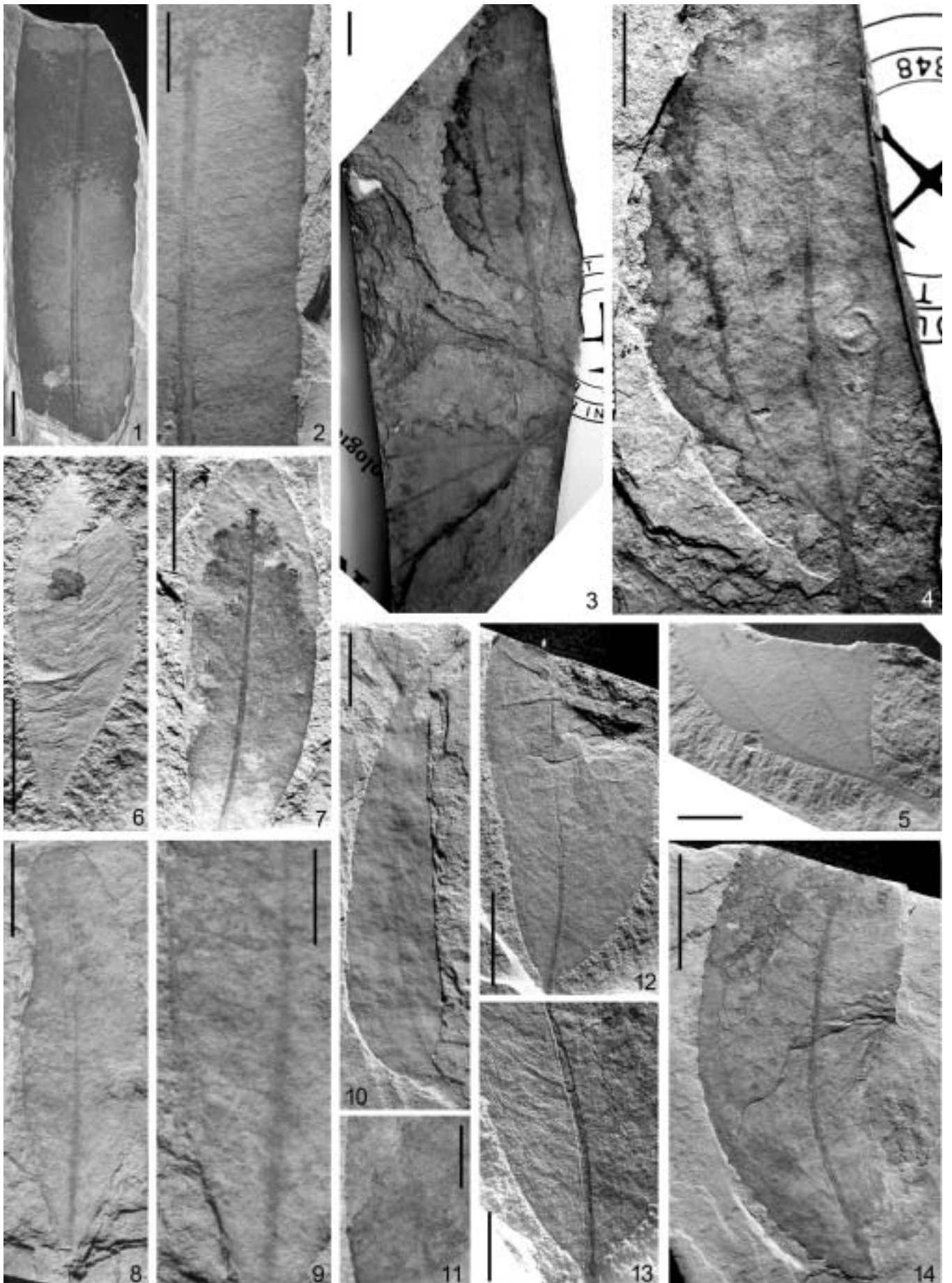


PLATE 17

