The Middle Eocene flora of Csordakút (N Hungary)

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Abstract: The Middle Eocene fossil plant assemblage from Csordakút (N Hungary) comprises plant remains preserved exclusively as impressions. Algae are represented by abundant remains of Characeae, including both vegetative fragments and gyrogonites. Remains of angiosperms comprise Lauraceae (*Daphnogene* sp.), Fagaceae (cf. *Eotrigonobalanus furcinervis*), Ulmaceae (*Cedrelospermum* div. sp.), Myricaceae (*Myrica* sp., *Comptonia* div. sp.), Leguminosae (leaves and fruit), Rhamnaceae (?*Zizyphus zizyphoides*), Elaeocarpaceae (*Sloanea nimrodi, Sloanea* sp. fruit), Smilacaceae (*Smilax* div. sp.). The absence of gymnosperms is indicative of a floristic similarity to the coeval floras of Tatabánya (N Hungary) and Girbou in Romania. *Sloanea nimrodi* (Ettingshausen) Kvaček & Hably, a new element for the Hungarian fossil record indicates a floristic relation to the Late Eocene flora of Kučlin (Bohemia).

Key words: Eocene, Lutetian, paleobotany, plant macrofossils, impressions.

Introduction

The Hungarian record of Eocene floras is limited which may be due first of all to the rare occurrence of sediments preserving macroscopic remains of Eocene plants. Accordingly, reports on Eocene plants and floras from Hungary have exclusively been recorded from the Transdanubian region of Hungary.

The joint bauxite and brown coal exploration was started in the Csordakút opencast mine (Csordakút Basin, Gerecse Mountains, Fig. 1) in 1982 (Végh-Neubrandt et al. 1985). Connected to the exploration of the opencast mine collecting activities started at that time and have been carried out by the second author continuously for more than 15 years. This is the first time that the fossil plant assemblage of Csordakút has been described and published.

Though the number of fossils collected through the years is high, indeterminable specimens are numerous since plant remains are poorly preserved lacking organic matter suitable for cuticular studies.
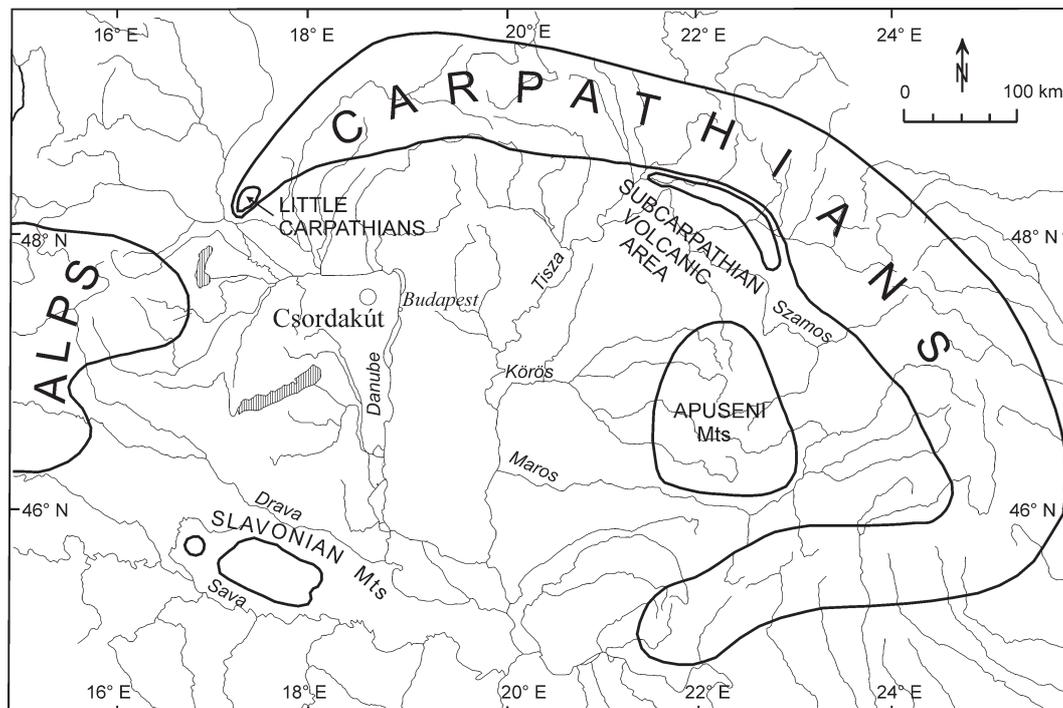

Fig. 1. Location of Csordakút.

Geology

The total thickness of Middle and Upper Eocene sediments in Hungary does not exceed 500–700 m. Eocene rocks always discordantly overlie older (Mesozoic or Paleozoic) strata (Kecskeméti 1998).

The Csordakút Basin and the westward adjacent Nagyegyház Basin have a similar sequence of strata (Csordakút 1 borehole, Gerecse Mountains, Fig. 2) since the two basins formed one tectonic unit during the coal formation and their separation started after the Oligocene due to the Savian orogenic cycle (Sólyom 1972).

The basement is formed by Triassic dolomites which are overlain by bauxite of varying thickness and extent. They are usually intermingled or even replaced by clays of various colours and sandy clays. Two browncoal seams, an upper and a lower one, are separated by freshwater sediments, so-called "interstones". In the Csordakút area up to even 5 seams are sometimes developed. At the same time a decrease of coal quality is experienced with the occurrence of clayey coals or even coaly clays in the seams. The "interstones" comprise freshwater limestones and carbonaceous marls. In the upper section they comprise grey, bluish-grey clay layers and clay marls separating the lower and upper coal seams. The upper coal seam is often dissected by freshwater and brackish clays, sandy clays and freshwater limestones into several
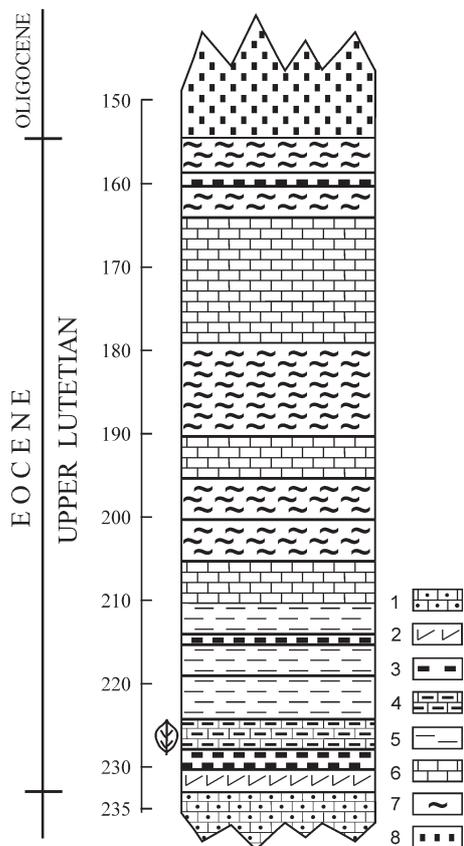
Fig. 2. Geological profile of the Csordakút 1 borehole. **1** — Triassic dolomites; **2** — bauxite; **3** — clay; **4** — freshwater limestone; **5** — coal, clayey coal; **6** — limestone; **7** — marl; **8** — sand, sandstone.

(even 4–6) sections. The lower seam is definitely of limnic origin whereas, the upper seam is paralic. The upper seam is overlain by freshwater sandy clays, and brackish molluscan clays, clay marls with a characteristic macrofauna. The next layers, which were formed in an environment becoming gradually open marine, are marls with foraminifers and molluscs (Sólyom 1972). The occurrence of *Nummulites subplanatus* Hantken and *N. variolarius* (Lamarck) Hantken indicates the first marine sediments of the Eocene transgression (Kecskeméti in Hably 1985a) and thus, the fossiliferous sediments are assignable to the Lutetian (Middle Eocene). (Furthermore, the sediments overlying the upper seam are regarded as the heteropic facies of the "operculine marl" based on its microfossil content.) The Eocene sediments are unconformably overlain by Oligocene sediments, such as variegated clays, clays, sandstones, conglomerates, etc. (Sólyom 1972). Plant fossils were collected from the freshwater limestone and clayey limestone layers of the so called "interstone" between the lower and upper coal seams.

Material and method

The collection at our disposal is stored in the Hungarian Natural History Museum, Budapest (Hungary). It comprises mainly leaves, and rarely fruits.

The fossils are preserved in limestones or clayey limestones, exclusively as impressions. The leaves are often poorly preserved, entire specimens with apex, base and leaf margin are relatively rare. The leaf margin is frequently destroyed which may suggest transport and/or decay of the plant material before final burial. However, it must be added that even fossiliferous matrix is relatively coarse-grained not favouring the preservation of finer details. Digital photos were processed with the software 'Adobe Photoshop'.

Abbreviations for collections used in the text: BP — paleobotanical collection of the Hungarian Natural History Museum, Budapest.

Systematics

Charophyta
Characeae

Chara sp.
Fig. 3.1

Material: BP.2001.781.1; BP.2001.792.1.
Description: 2–5 cm long fragments of algae. Leaf-like branchlets (~10) of equal length grow in whorls around the stem. Branchlets undivided, clustered at regularly spaced (3–4 mm) joints. Thorn-like projections on the branchlets not observable.
Determination and discussion: The structure of the fragment and some gyrogonites embedded in the fossiliferous matrix support the occurrence of Characeae. Species of *Nitella* (Characeae) display a similar structure but with forked branchlets (Wood & Imahori 1964, 1965), as well as

Ceratophyllum (Ceratophyllaceae) which bears also forked leaves. Species of *Chara* are widely distributed in habitats ranging from fresh to brackish water, inland to coastal, shallow to deep water environments.

Angiospermae
Dicotyledoneae
Lauraceae

Daphnogene sp.
Fig. 3.2,3

Material: BP.2001.687.1; BP.2001.689.1; BP.2001.693.1.
Description: A leafy twig (9.5 cm) with 5 attached and some isolated leaves. Simple leaves alternate, attached at distances of 1–1.5 cm. Leaves petiolate, petiole stout, 0.7–1 cm long. Lamina lanceolate, 5.5–6 cm long, 1.2–1.6 cm wide. Apex long acute, or attenuate, base acute, often cuneate. Margin entire. Venation acrodromous (?suprabasal). Midvein moderately thick and curved. A pair of secondaries nearly as thick as the midvein diverges from the midvein close to the base and run up into the upper third of the leaf. Higher order venation not preserved.
Determination and discussion: The morphology of the leaves is comparable to the lanceolate leaf forms of *Daphnogene cinnamomifolia* (Brongniart) Unger regarded as the sun leaves of the species (Kvaček & Walther 1974, 1998). In the flora of Csordakút broader leaves (suspected shade leaves) were not found, however, the total number of leaves recalling the morphology of *Daphnogene* is definitely low. Thus, far reaching conclusions should not be drawn. In the lack of cuticular structures we refrain from assigning the fossils to a species.

Fossil leaves of *Daphnogene* have frequently been recorded in the Paleogene floras of Europe, e.g. Late Eocene of Staré Sedlo (Knobloch et al. 1996) — *Daphnogene cinnamomea* (Rossmässler) Knobloch, *Daphnogene pseudopolymorpha* Knobloch et Kvaček — leaves with generally broad and rounded lamina; the Middle Eocene flora of Messel (Wilde 1989) *Daphnogene* leaves with usually broader lamina, etc.

The stratigraphic occurrence of *Daphnogene* leaves in the Paleogene-Neogene deposits of Hungary ranges up to the Late Miocene. Fossil leaves of *Daphnogene* are typical elements of the Hungarian Early and Late Oligocene, e.g. Nagybátony-Újlak, Eger-Kiseged, Eger-Wind, Csolnok, etc. (Kvaček & Hably 1991; Manchester & Hably 1997; Hably & Manchester 2000; Erdei & Wilde 2004) and Early Miocene (Ipolytarnóc, Hably 1985b) floras.

Lauraceae gen. et sp. indet.
Fig. 3.4

Material: BP.2001.683.1; BP.2001.722.1; BP.2001.807.1; BP.2001.828.1; BP.2001.862.1; ?BP.2001.731.1.
Description: Fragmentary leaves, length (fragmentary) more than 4 cm, width 1–1.5 cm. Apex long acute (when preserved), base not preserved. Margin entire. Venation camptodromous, with secondaries arising at angles of 40–60°. Secondaries curved when running toward the margin and forming loops.

Determination and discussion: Leaf morphology, entire margin and type of venation suggest leaves of Lauraceae.

Fagaceae

cf. *Eotrigonobalanus furcinervis*
(Rossmässler) Walther et Kvaček
Figs. 3.5,6,7

Material: BP.2007.132.1; BP.2007.137.1; BP.2001.678.1; BP.2001.788.1; BP.2001.795.1; BP.2001.882.1; ?BP.2001.786.1.
Description: Simple mostly fragmentary leaves. Petiole not preserved. Leaves lanceolate, length even 13 cm, width 1.4–3.4 cm. Apex attenuate, base cuneate (preserved in one specimen). Margin toothed, teeth small, acute. Venation craspedodromous. Midrib straight and moderately thick, secondaries curved upwards. Tertiary veins not observable due to poor preservation.
Determination and discussion: The fragmentary and poorly preserved leaves recall in morphology *Eotrigonobalanus*. The leaves of *Eotrigonobalanus furcinervis* display a wide morphological range (Kvaček & Walther 1989), namely lanceolate to ovate forms, entire to toothed margin, camptodromous to semicraspedodromous and craspedodromous venation.

Fossils of the species are widespread in the Paleogene of Europe (for details see Kvaček & Walther 1989; Knobloch et al. 1996). A further record of the species may be added from the Eocene flora of Ovce Polje, Macedonia (Mihajlovič & Ljubotenski 1994). In Hungary the species was widespread in the Early Oligocene floras of the Tard Clay Formation (Hably 1986; Hably & Manchester 2000), as at Eger-Kiseged, localities in Budapest — borehole Kiscell-1, Vörösvári street, Nagybátony-Újlak brickyard.

The species was an important element of the forest vegetation (both in intrazonal and zonal types) in the European Paleogene, from the Middle Eocene up to the Early Miocene (Mai & Walther 1985; Kvaček & Walther 1989). Its widespread occurrence attests to a wide ecological tolerance but this element was certainly not xerophytic (Mai 1970; Kvaček & Walther 1989).
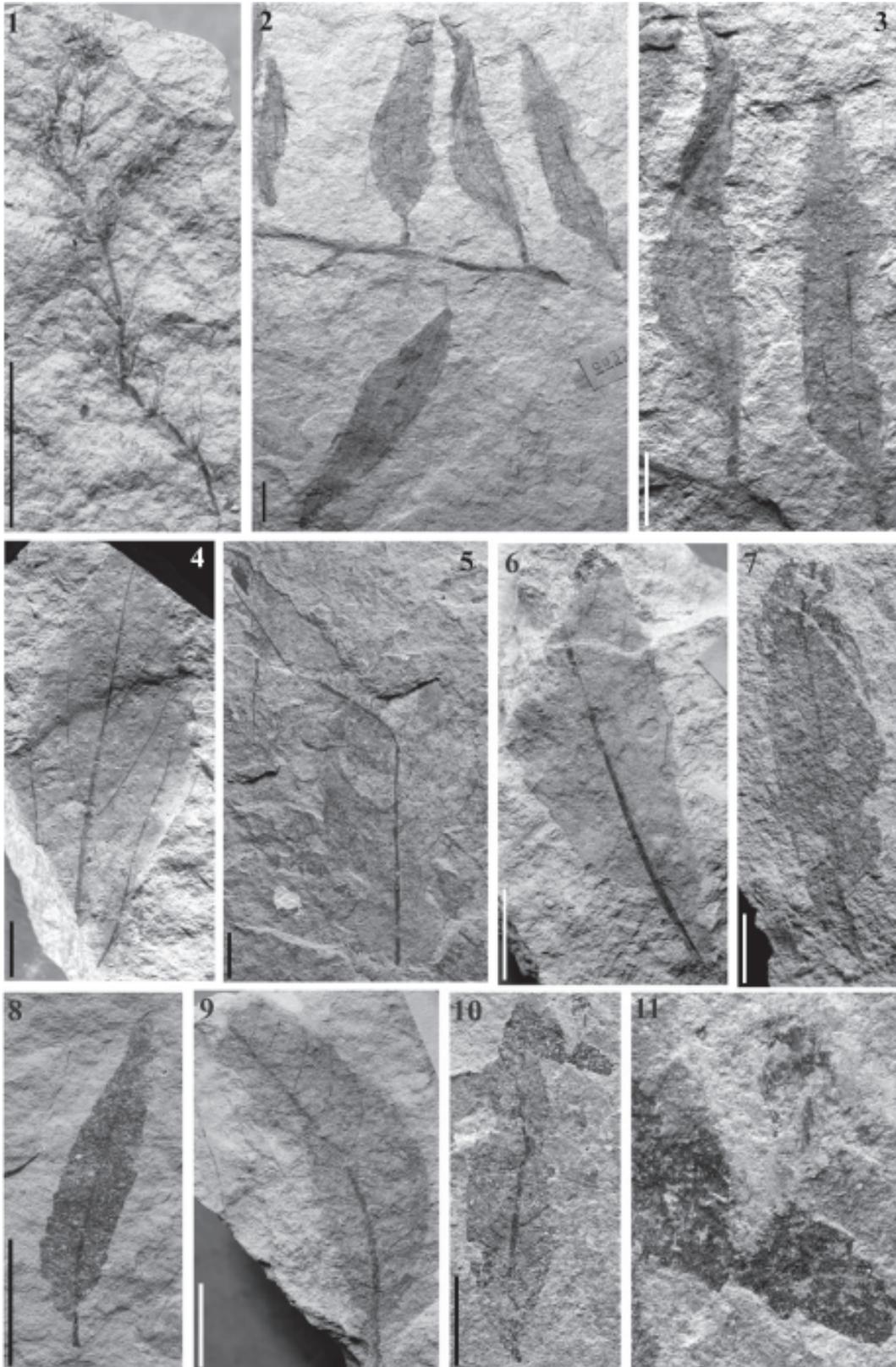
Ulmaceae

Cedrelospermum flichei (Saporta) Hably et Thiébaut
Fig. 3.8,9,10,11

2002 *Cedrelospermum flichei* (Saporta) Hably et Thiébaut, p. 81, pl. 4, figs. 6–7; pl. 7, figs. 1–9

Material: BP.2001.676.1; BP.2001.829.1; BP.2007.128.1; ?BP.2001.803.1.
Description: Simple, asymmetric leaves. Leaves petiolate, petiole short, 1.5–3 mm long. Leaves lanceolate, or narrow ovate, length 2.5–5 cm, width 0.5–1.3 cm. Base asymmetric and cuneate, apex acute, attenuate. Margin serrate, at the basal part of leaves entire. Teeth simple and acute or obtuse. Venation craspedodromous, midvein stout, secondaries arising at angles of 50–65° and entering the teeth. Some secondaries forked towards the margin.

Fig. 3. 1 — *Chara* sp. (BP.2001.792.1). **2, 3** — *Daphnogene* sp. (BP.2001.693.1). **4** — Lauraceae gen. et sp. (BP.2001.722.1). **5** — cf. *Eotrigonobalanus furcinervis* (Rossmässler) Walther et Z. Kvaček (BP.2007.137.1). **6** — cf. *Eotrigonobalanus furcinervis* (Rossmässler) Walther et Z. Kvaček (BP.2001.678.1). **7** — cf. *Eotrigonobalanus furcinervis* (Rossmässler) Walther et Z. Kvaček (BP.2001.882.1). **8** — *Cedrelospermum flichei* (Saporta) Hably et Thiébaut (BP.2007.128.1). **9** — *Cedrelospermum flichei* (Saporta) Hably et Thiébaut (BP.2001.676.1). **10, 11** — *Cedrelospermum flichei* (Saporta) Hably et Thiébaut (BP.2001.829.1). Scale bars are 1 cm.

Determination and discussion: The leaves are comparable to the leaves of *C. flichei* from the Hungarian Oligocene and Miocene (Hably & Thiébaut 2002). The species was described from the Early Oligocene of Hungary from the Tard Clay Formation, namely Nagybátony-Újlak (Budapest) and Eger-Kiseged (Bükk, NE Hungary), and from the Middle Miocene flora of Magyaregregy. Outside Hungary the species was recorded among others from the Oligocene of Cereste and Rott, the Miocene of Randecker Maar, etc. (Hably & Thiébaut 2002). Kovar-Eder et al. (2004) discuss an additional species *C. ulmifolium* (Unger) Kovar-Eder et Kvaček based on leaves from the Early-Middle Miocene locality of Parschlug and also assign *C. flichei* leaves from Magyaregregy to this species. Although the leaves from Parschlug are morphologically similar, it is probable that the Eocene and Miocene leaves represent different species. The characteristic fruits of *Cedrelospermum* quite frequently recorded in the Hungarian Early Oligocene have not been detected.

Based on the abundance of *Cedrelospermum* remains in lacustric deposits of volcanic areas together with the abundant production of fruits Manchester (1989, p. 274) considers its species to be early successional colonizers of open habitats.

Cedrelospermum ?flichei (Saporta) Hably et Thiébaut
Fig. 4.1,2

Material: BP.2007.219.1.

Description: Leaf fragmented. Shape asymmetric, lanceolate, length (fragmentary) 8.8 cm, width 1.2 cm. Apex acute, attenuate. Margin serrate along most of its length, teeth simple, prominent. Teeth apices obtuse but getting slightly acute close to the apex. Venation craspedodromous, midvein stout and slightly curved. Secondaries, hardly observable due to poor preservation, arise at angles of 50–60° and end in the teeth.

Determination and discussion: The leaf shows different characters from *Cedrelospermum flichei* (Saporta), which Hably et Thiébaut described from the Early Oligocene of Hungary (Hably & Thiébaut 2002), by having a relatively large, lanceolate leaf form and prominent teeth contrasting the smaller and broader lamina of *C. flichei*.

The lanceolate leaf with simple and mostly obtuse teeth is more comparable to the leaves of *Tremophyllum* sp. from Messel, one specimen of which was found attached with the fruits of *Cedrelospermum leptospermum* (Ettingshausen) Manchester (Wilde & Manchester 2003). Since we had only one fragmentary example we hesitated to identify our specimen with the leaves of *Tremophyllum* sp. sensu Wilde & Manchester (2003). The latter were also compared to some North American leaves found associated and attached to fruiting branches of *Cedrelospermum* (Wilde & Manchester 2003). Our leaf matches *C. lineatum* (Lesquereux), which Manchester described from North America, by having prominent simple teeth along most of its length and a more asymmetric leaf base. By its larger size it differs from both North American species. The leaves of *Tremophyllum tenerrimum* (Weber) Rüffle from the Oligocene of Rott (Rüffle 1963) differ in having smaller and broader lamina and less pronounced teeth.

Cedrelospermum leaves and fruits, *C. flichei* and *C. aquense* Saporta, have been documented from the Early Oligocene Tard Clay floras (Hably & Thiébaut 2002). This is one of the earliest leaf records of the genus.

Myricaceae

cf. *Myrica longifolia* Unger
Fig. 4.3

Material: BP.2001.859.1.

Description: Leaf narrow elliptic, petiolate. Length of lamina 5.8 cm, width 0.8 cm, base acute and decurrent, apex acute. Margin seems to be irregularly toothed, both acute and rounded teeth occur. (Margin and venation hardly observable due to poor preservation.) Midrib stout, secondary venation dense, veins arise at angles of 70–80°.

Determination and discussion: Leaves described as *M. longifolia* are widespread in the Early Cenozoic of Europe — for example in the Eocene of Geiseltal (Rüffle 1976), the Early Oligocene of Häring — here even dominant (Ettingshausen 1853), Haselbach (Weisselster Becken; Mai & Walther 1978), Monte Promina (Ettingshausen 1855), etc. Rüffle (1976) gives a quite large synonym list and a thorough discussion on the species.

The leaf is quite elongate (l/w >7) similar to the forms described by Mai & Walther (1978) from Haselbach. Rüffle (1976) and Mai & Walther (1978) evaluated these leaves as xerophytic forms of the fossil species. Moreover, Rüffle (1976) defined *M. longifolia* as a "trockenatlantische *Myrica* Art".
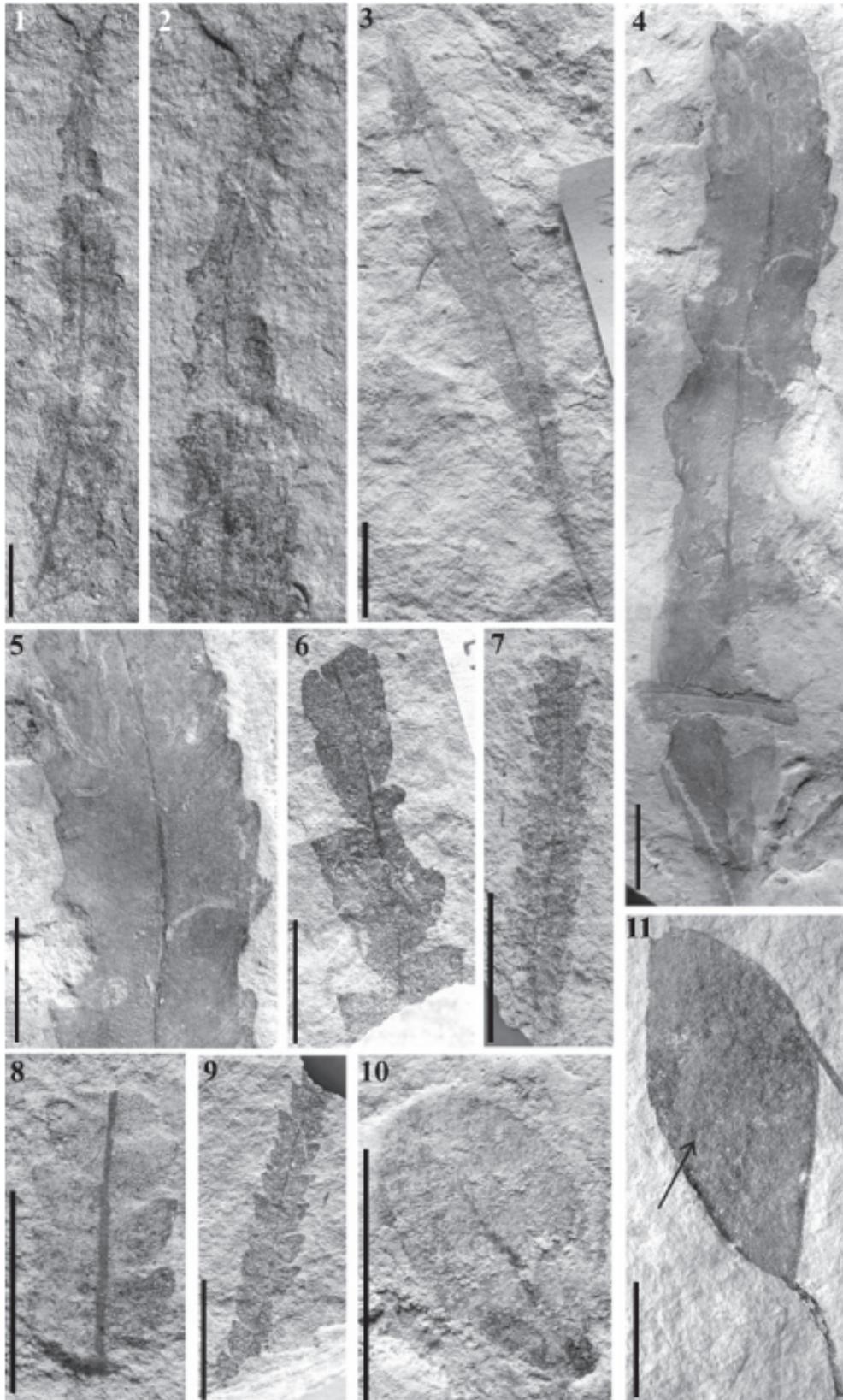
Myrica sp.
Fig. 4.4,5

Material: BP.2001.820.1;?BP.2001.848.1; ?BP.2001.843.1.

Description: Leaves all fragmented, length of the specimen BP.2001.820.1 (fragmentary) 11.5 cm, width 1.9 cm (13.6 and 3.4 cm in ?BP.2001.848.1). Apex not preserved, base decurrent. Margin irregularly toothed, teeth acute or obtuse. Venation dense, semicraspedodromous, midrib moderately thick, secondary veins dense, arising at angles of 70–80°, running to the teeth or terminating between teeth.

Determination and discussion: The leaf is much larger than the leaves of *M. longifolia*. Its macromorphology shows similarity to *M. lignitum* (Unger) Saporta occurring in younger floras, however, due to the lack of cuticular structures the comparison remains tentative. Nevertheless, *M. lignitum* proved by cuticular structure (see Kovar 1982) has so far been recorded mostly from younger floras, such as the Late Oligocene flora of Linz (Kovar 1982), the Miocene floras of Parschlug (Austria; Kovar-Eder et al. 2004), and based on macromorphology from numerous localities (see also Knobloch & Kvaček 1976).

Comptonia difformis (Sternberg) Berry
Fig. 4.6

1821 *Asplenium diforme* Sternberg, p. 33, pl. 24, fig. 1
1828 *Comptonia acutiloba* Brongniart, pp. 141, 143, 209
1971 *Comptonia acutiloba* Brongn. — Bůžek, pl. 9, figs. 1–8

Fig. 4. 1, 2 — *Cedrelospermum* sp. (BP.2007.219.1). **3** — cf. *Myrica longifolia* Unger (BP.2001.859.1). **4, 5** — *Myrica* sp. (BP.2001.820.1). **6** — *Comptonia difformis* (Sternberg) Berry (BP. 2007.135.2). **7** — *Comptonia schrankii* (Sternberg) Berry (BP. 2001.734.1). **8** — *Comptonia schrankii* (Sternberg) Berry (BP.2001.711.1). **9** — *Comptonia schrankii* (Sternberg) Berry (BP.2001.864.1). **10** — Leguminosae gen. et sp. (BP.2001.828.1). **11** — *Leguminocarpon* sp. (BP.2007.134.2), the seed is indicated by an arrow. Scale bars are 1 cm.

Material: BP.2001.832.1; BP.2007.135.2.

Description: Leaves (all fragmented) lanceolate, petiole, basal and apical parts not preserved. Entire length more than 3 cm, width 1.2 cm. Lobes alternate or opposite, sessile to midrib, shape of lobes varying. Apices of lobes acute. Margin entire. Midrib moderate, secondaries arise at angles of 70–80° and curve upwards.

Determination and discussion: For priority of "*acutiloba*", synonym lists and a review of fossil *Comptonia* remains see Bůžek (1971), Rüffle (1976) and J. Kvaček (2004). The species has been recorded mainly in older Cenozoic floras up into the Miocene, as in the North Bohemian Basin (Chomutov; Bůžek 1971), the Eocene flora of Geiseltal (Rüffle 1976), the floras of the Haselbach Series (Weisselster Basin), the Hungarian Early and Late Oligocene (H-borehole, Eger-Wind; Andreánszky 1955), etc. Leaf fragments from Csordakút are slender, for example the specimens from Geiseltal (*C. difformis* (Sternberg) Berry) are 3–4 cm wide (Rüffle 1976). *Comptonia* specimens from Messel have similar dimensions (width max. 1 cm) to those from Csordakút but the lobes are toothed (Wilde 1989). In the Early Oligocene flora of Santa Giustina (Principi 1916) *Comptonia* leaves are more available. Slender leaves have toothed lobes. Remains recorded as *C. acutiloba* (or *C. dryandroides* Unger, etc.) comprise various leaf forms, thus the group certainly needs revision. Below we give some remarks on the macromorphology of fossil *Comptonia* leaves recorded from the Paleogene deposits of Hungary.

Linear lobate leaves of *C. dryandroides* Unger partly recalling *C. difformis* (*Myrica acutiloba* var. *dentata* Andreánszky in Andreánszky 1955) were documented in the Late Oligocene Eger-Wind locality, in the upper level flora (Kvaček & Hably 1991) but its lobes are often finely toothed. Lower Oligocene deposits of Hungary also yielded leaves of *C. acutiloba* (*C. difformis*): from the H-boreholes (Budapest, Vörösvári út) two types are available, one (BP.78.254.3) is morphologically well comparable to the specimen from Csordakút, the other type (BP.78.154.3) has more regular lobes and a broader (2.3 cm) lamina. Both are entire margined. Two specimens comparable to those from Csordakút (entire margin, similar dimension) are also available from Eger-Kiseged (North Hungary, BP.2004.491.1, BP.2004.722.1) A *Comptonia* specimen recorded from Nagybátony-Újlak (Budapest) has entire-margined lobes but differs in its broader lamina (3 cm).

According to Rüffle (1976) leaves of the species are often accompanied by *Myrica longifolia* Unger. *C. difformis* is mostly compared with the modern *C. peregrina* (Linnaeus) Coulter, however, leaves of the modern species are considerably smaller (Bůžek 1971). Today the genus is monotypic spread in warm temperate regions of North America, often on dry sands (Krüssmann 1960). Considering the relict character of modern *Comptonia*, the extrapolation of its ecological requirements to the fossil is problematic.

Comptonia schrankii (Sternberg) Berry
Fig. 4.7,8,9

1822 *Aspleniopteris schrankii* Sternberg, p. 29, pl. 21, fig. 2
1906 *Comptonia schrankii* (Sternb.) Berry, p. 514

1975 *Comptonia schrankii* (Sternb.) Berry — Palamarev & Petkova, p. 212, Pl. 2, fig. 1

Material: BP.2001.683.1; BP.2001.711.1; BP.2001.734.1; BP.2001.795.1; BP.2001.864.1; ?BP.2001.824.1; 2007.131.1; ?BP.2001.808.1.

Description: Leaves (all fragmented) lanceolate, basal and apical parts not preserved. Lobes alternate or opposite, and sessile to midrib. Original length even more than 4.5 cm, width 0.3–0.7 cm, shape of lobes regular. Apices of lobes acute. Margin entire. Midrib stout, secondaries arise at angles of 75–90°.

Determination and discussion: The smaller size of the leaves and regular lobes distinguish these leaves from *C. difformis*. However, some transitional leaf forms indicate the need for revision. Furthermore, leaves of *C. difformis* and *C. schrankii* fall in the morphological variability of leaves of modern *Comptonia peregrina* (Berry 1906: figs. 1–6).

C. schrankii has been recorded among others from the Paleogene of Bulgaria (Palamarev & Petkova 1975), from Häring in Tyrol (*Dryandra brongniartii* Ettingshausen, Ettingshausen 1853), the Eocene Somod (= Drieňovice, Slovakia; Hably pers. com.; BP.97.217.1, BP.97.219.1, BP.97.220.1). From Hungary specimens with similar morphology are available from the Early Oligocene Eger-Kiseged locality (BP.2004.301.1, BP.2004.302.1). *C. difformis* specimens from the Late Oligocene of Austria (Linzer Raum; Kovar 1982: p. 79, Taf. 11, figs. 14, 15) display similar traits (width 0.5–0.7 cm) to our specimens, but apices of lobes seem to be obtuse. Leaves comparable to *C. schrankii* also appear in the Early Oligocene flora of Santa Giustina (Hably, pers. com.).

Leguminosae
Leguminosae gen. et sp.
Fig. 4.10

Material: BP.2001.828.1.

Description: Leaflet small, 1.3 cm long and 0.7 cm wide, narrow obovate, ?sessile. Base acute, apex rounded. Margin entire. Venation camptodromous, midvein stout at the base, tapering toward the apex. Higher order venation not observable due to poor preservation.

Determination and discussion: The macromorphology of the leaflet recalls Leguminosae.

Leguminocarpon sp.
Fig. 4.11

Material: BP.2007.134.2.

Description: Fruit dehiscent, stipitate, single seeded. Bent at the junction of valves and stipe, valves 3.5 cm long, 1.6 cm wide, shape of valves elliptic. Apex and base acute (almost obtuse), stipe fragmented but at least 1 cm long, 0.8 mm wide, valve venation not observable. Seed indistinct, seems slightly oblong, 9 mm long and 8 mm wide but preservation could cause distortion of shape.

Determination and discussion: Among fossil legumes *Podocarpium podocarpum* (A. Braun) Herendeen (Herendeen 1992a,b), occurring frequently in Neogene flo-

ras, shows similarity to our fossil in having dehiscent, stipitate single-seeded fruits, equipped with long or even longer stipe. However, different characters are the elliptic, more elongate shape of *Podocarpium*, the acute base and apex of its valves, the mostly straight or less bent junction of valves and stipe and smaller dimension.

The fruit structure indicates a relationship to the Leguminosae family, to the Caesalpinioideae or Papilionoideae subfamily. The angle formed at the junction of the stipe and valves, and the fruit apex shape are not useful characters since they are variable in many genera, also in single-seeded ones (Herendeen 1992a; Herendeen & Crane 1992). Single-seeded stipitate fruits occur in Caesalpinioideae and Papilionoideae, in the tribes of Caesalpinieae, Cercideae, Detarieae, Mimoseae, Swartzieae, Sophoreae and in several unrelated genera, such as *Gleditsia*, *Apuleia*, *Adenolobus*, *Brenierea*, *Griffonia*, *Copaifera*, *Peltogyne*, *Zenkerella*, *Ormosia,* etc. Since characters, such as the position of placentation and pattern of valve venation which are important to distinguish fruits of these genera (Herendeen 1992a) are indistinctly observable in our fossil its comparison with modern legume taxa is limited.

Leguminosae gen. et sp. vel Anacardiaceae gen. et sp.
Fig. 5.1

Material: BP.2001.839.1.
Description: Leaflet slightly asymmetric, narrow obovate, 2 cm long and 1 cm wide, probably sessile. Base asymmetric, acute, apex rounded. Margin entire. Venation camptodromous, midvein moderately thick, slightly curved. Higher order venation not observable due to poor preservation.
Determination and discussion: Leaflet morphology refers to an affinity with Leguminosae or Anacardiaceae.

Rhamnaceae

?*Zizyphus zizyphoides* (Unger) Weyland
Fig. 5.2

Material: BP.2001.714.1; (counterpart BP.2001.720.1).
Description: Leaf simple petiolate leaf 9.3 cm long and 2.9 cm wide, petiole 1.7 cm long. Leaf lanceolate, apex acute, base acute and slightly asymmetric. Margin serrate, teeth acute, in the apical part of the lamina teeth more rounded, margin even seems to be crenate. Sinuses angular. Venation imperfect basal acrodromous. Midrib moderately thick and straight. Besides the pair of stout secondary veins arising at the base, secondaries and tertiary veins form a fine network. Tertiary veins arising from the basal secondaries run toward the margin forming loops. Although faintly observable some small veins originating from where the loops seem to enter the teeth.
Determination and discussion: The morphology of the leaf (acrodromous venation, teeth) corresponds more or less to *Z. zizyphoides*. The imperfect acrodromous venation, however, contrasts with the generally perfect acrodromous venation in the leaves of this species. The margin seems to be more serrate than crenate and the leaf size is quite large as compared to the leaves of *Z. zizyphoides*.

Z. zizyphoides has frequently been recorded, e.g. in the Early Oligocene of Häring (*Ceanothus zizyphoides* Unger, Ettingshausen 1853), Sotzka (*Ceanothus zizyphoides* Unger, Unger 1847), Eocene of Macedonia (Ovce Polje; Mihajlovic & Ljubotenski 1994), Paleogene of Bulgaria (Palamarev & Petkova 1975), the Eocene flora of Akhaltsikhe (Georgia; Avakov 1989), etc. In the Hungarian Paleogene its frequent occurrence is known from the Early Oligocene Tard Clay floras (Andreánszky 1963; Hably 1979), and it was also described in the Eocene flora of Tatabánya (Hably 1985b).

?*Zizyphus* sp.
Fig. 5.3

Material: BP.2001.738.1.
Description: Leaf small petiolate, lanceolate. Length 3.4 cm, width 0.7 cm. Apex and base acute. Margin serrate with acute teeth along the entire margin. Sinuses acute. Venation perfect basal acrodromous with a pair of distinct secondary veins almost reaching the leaf apex. Higher order venation not preserved.
Determination and discussion: The morphology of this leaf recalls *Zizyphus zizyphoides*. A distinct trait contrasting leaves of the species is the pair of basal secondaries that run nearly into the leaf apex.

Elaeocarpaceae

Sloanea nimrodi (Ettingshausen) Kvaček et Hably
Fig. 5.4,5,6,7

1869 *Cissus nimrodi* Ettingshausen, p. 3, pl. 40, figs. 3–4, 6–10
2001 *Sloanea nimrodi* (Ettingshausen) Kvaček et Hably — Kvaček, Hably & Manchester, p. 117, pl. 4, figs. 6–7

Material: BP.2001.715.1; BP.2001.771.1; BP.2001.781.1; ?BP.2001.713.1; BP.2007.128.1; BP.2007.135.2.
Description: Leaves simple, petiolate, lamina 2.5–5.2 cm long (or more) and 1.5–3.8 cm wide, petiole 1.3–1.5 cm long. Leaves narrow or wide obovate to elliptic, base acute to nearly obtuse, apex rounded to obtuse. Margin entire in the lower half of the lamina, in the upper part subentire, crenulate or toothed. Teeth obtuse. Venation craspedodromous/semicraspedodromous. Midrib moderately thick and straight. 5(–6) pairs of secondaries, the lowermost pair basal or suprabasal, almost opposite, run nearly straight and opposite, the higher pairs alternate, course curved. The uppermost pair (observable in the specimen BP.2001.715.1, Fig. 5.5) nearly rounded curving back towards the midrib. Secondaries craspedodromous, often fork near the margin and exmedially give off a vein entering a tooth. Tertiary veins perpendicular to the secondaries, percurrent, higher order venation reticulate, areoles well developed.
Determination and discussion: The gross morphology of the leaves is closely comparable to the leaves of *Sloanea*. *Sloanea elliptica* (Andreánszky) Kvaček et Hably described from the Early Oligocene of Hungary and Slovenia (Kvaček et al. 2001) shows different characters, namely a definitely larger size of leaves, more elongated lamina, higher number of secondaries (6–8). *S. artocarpites* (Ettingshausen)
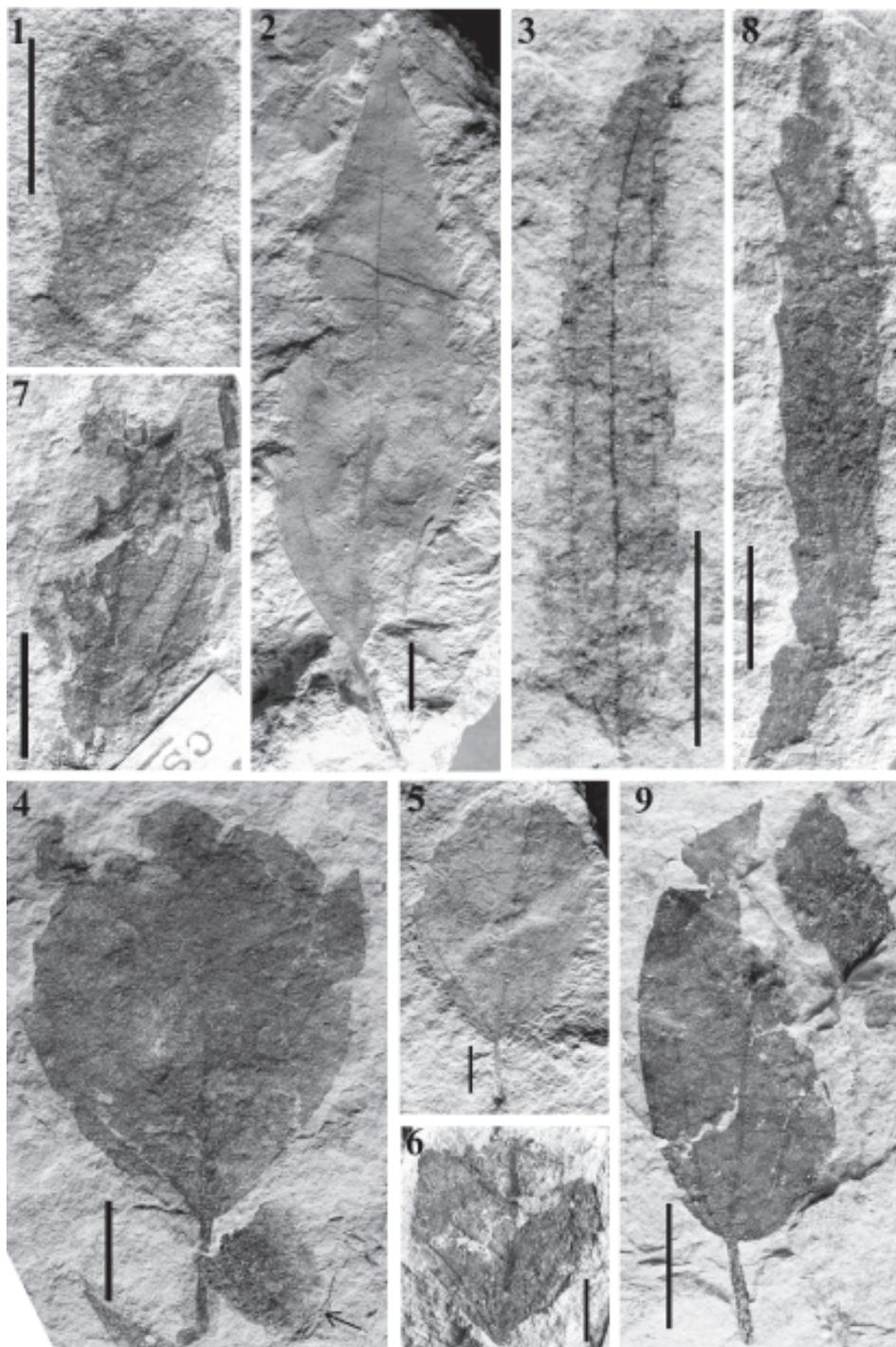
Fig. 5. **1** — Leguminosae gen. et sp. vel Anacardiaceae gen. et sp. (BP.2001.839.1). **2** — ?*Zizyphus zizyphoides* (Unger) Weyland (BP.2001.714.1). **3** — ?*Zizyphus* sp. (BP.2001.738.1). **4** — *Sloanea nimrodi* (Ettingshausen) Z. Kvaček et Hably (BP.2007.135.2), the fruit of *Sloanea* sp. is indicated by an arrow. **5** — *Sloanea nimrodi* (Ettingshausen) Z. Kvaček et Hably (BP.2001.715.1). **6** — *Sloanea nimrodi* (Ettingshausen) Z. Kvaček et Hably (BP.2001.771.1). **7** — *Sloanea nimrodi* (Ettingshausen) Z. Kvaček et Hably (BP.2007.128.1). **8** — Berberidaceae gen. et sp. (BP.2001.870.1). **9** — *Dicotylophyllum* sp. 1 (BP.2001.796.1). Scale bars are 1 cm.

Kvaček et Hably described from the Oligocene of North Bohemia is differentiated from *S. elliptica* by slightly developed and sharper dentation of the margin and a less distinct subbasal pair of secondaries (Kvaček et al. 2001). Leaves of *Sloanea peolai* (Principi) Hably, Tamás et Cioppi (Hably et al. 2007) described from the Oligocene flora of Chiavon (Italy) differ from our leaves by having a lanceolate shape with small teeth on the margin. Leaves of *S. nimrodi* (Ettingshausen) Kvaček et Hably recorded from the Late Eocene of North Bohemia are of smaller dimension than *S. elliptica* (Z.

Kvaček et al. 2001), in this respect resembling our fossils. The type specimen of the species (Pl. 4, figs. 6–7 in Z. Kvaček et al. 2001) shows a more elongated lamina in contrast to our fossils, however, studying other *S. nimrodi* specimens in the collection of Ettingshausen's type and original material from Bilina (*Cissus nimrodi*, figured on Pl. 40, figs. 6–10 in Ettingshausen 1869; Pl. 10, figs. 1–6 in Hably et al. 2001) leaves with obovate lamina, and wide obtuse apex were also found. The specimens from Csordakút are of distinctly obovate shape with rounded apex. These features may represent the natural variability of the leaves since elongate leaves also occur.

The earliest record of *Sloanea* so far, *Sloanea nimrodi* has been recorded in North Bohemia from the Late Eocene/?Early Oligocene flora of Kučlín (Z. Kvaček et al. 2001). Thus, the specimens from Csordakút proves an even earlier occurrence of the genus.

Sloanea sp. (fruit)
Fig. 5.4

Material: BP.2007.135.2.
Description: Impression of a fruit fragment, the capsule (or isolated valve?), elliptic, 1.4 cm long, 1.1 cm wide. Pedicel not preserved. On external surface (at sides of the impression) hardly observable structure — ?spines. Due to poor preservation it is not clear whether the complete capsule or an isolated valve, the external or the inner surface is fossilized.

Determination and discussion: The fruit remain is associated with a *Sloanea* leaf. The morphological traits of the impression recall that of *Sloanea* fruits, such as *Sloanea eocenica* (Rásky) Kvaček, Hably et Manchester described from the Early Oligocene of Hungary (Nagybátony-Újlak, Z. Kvaček et al. 2001). The size of the fossil, however, is smaller. The morphology of the spines covering the valves, which may serve as distinguishing character among species is very indistinct in our fossil. Other *Sloanea* fruits recorded from Suletice-Berand or Markvartice (Late Oligocene), namely *Sloanea* sp. (Z. Kvaček et al. 2001) are slightly smaller than *S. eocenica*. Due to the lack of detailed morphology of the fossil from Csordakút a comparison remains tentative.

?Berberidaceae gen. et sp.
Fig. 5.8

Material: BP.2001.777.1; BP.2001.870.1.
Description: Fragmentary remains of leaves, 2.2–5.9 cm (fragmentary) long, 0.8–1 cm wide. Leaves ?coriaceous, very narrow elliptic, base not preserved, apex acute-attenuate. Margin toothed with distinct, regularly spaced acute teeth. Teeth concave at the apical and basal sides. Sinuses rounded. Midvein stout, higher order venation not preserved.
Determination and discussion: The few observable traits of the leaf fragments recall Berberidaceae. The teeth appear sharper, more regular and distinct than in leaves of Myricaceae.

Dicotylophyllum sp. 1
Fig. 5.9

Material: BP.2001.796.1; (counterpart BP.2001.878.1).
Description: Fragment of a petiolate leaf. Petiole stout, 0.9 cm long. Leaf obovate, 3.5 cm (fragmentary) long and 1.7 cm wide. Base rounded slightly asymmetric, apex not preserved. Margin entire. Venation basal acrodromous. The basal pair of secondaries run almost straight into the upper half of the lamina. Tertiary veins arising from the basal secondaries run towards the margin forming loops.
Determination and discussion: The leaf fragment resembles leaves described as *Matudaea*, (e.g. cf. *Matudaea menzelii* Walther, Early Oligocene flora of the Tard Clay Formation; Kvaček & Hably 1998), however, acrodromous venation occurs in a great number of angiosperm families, including Lauraceae, Hamamelidaceae, Rhamnaceae, Melastomataceae, etc. Due to the lack of cuticular structure and diagnostically valuable traits the systematic affinity remains obscure.

Dicotylophyllum sp. 2 (?Juglandaceae)
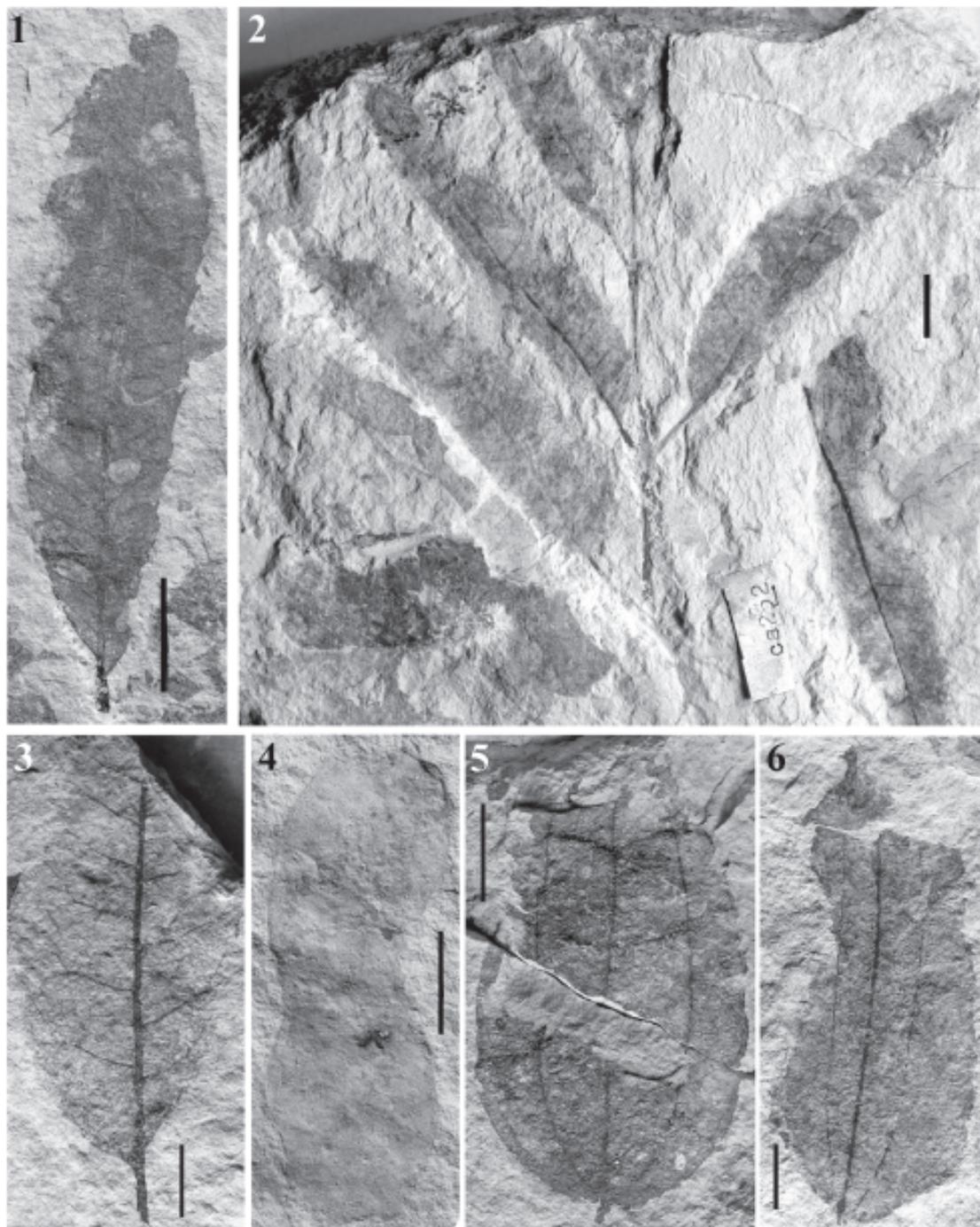Fig. 6.1

Material: BP.2007.135.2.
Description: Simple petiolate leaf of 6 cm length and 1.6 cm width. Petiole stout, 3 mm long. Leaf narrow elliptic, apex ?obtuse, base asymmetric, acute. Margin toothed, teeth acute, regularly spaced along the margin. Sinuses rounded. Venation craspedodromous, midvein moderately thick. Secondaries, min. 15 pairs, arise at angles of 50–60° from the primary vein and run mostly straight to the teeth. Close to the teeth secondaries slightly curved. Tertiary veins percurrent, observable only at the basal part of the lamina.
Determination and discussion: This leaf shows similarity to *Dryophyllum callicomifolium* (Andreánszky) Kvaček et Hably (Z. Kvaček & Hably 1991) in the slender shape and form of teeth. This species occurs in the lowermost level of the Late Oligocene Eger-Wind assemblage and the Early Oligocene Tard Clay floras. However, the slightly asymmetric base and the more or less straight secondaries distinguish our leaf from both *Dryophyllum callicomifolium* and *Eotrigonobalanus* (cuneate, often decurrent base, curved secondaries) and raise an affinity to Juglandaceae.

Dicotylophyllum sp. 3
Fig. 6.2,3

Material: BP.2001.804.1; BP.2001.727.1.
Description: Compound leaf, imparipinnate, with 7 attached, and one isolated leaflet. Leaflets petiolate, petiolule 0.7–1 cm. Leaflets opposite, asymmetric and lanceolate, 6.3–6.5 cm long and 1–1.4 cm wide. Isolated leaflet of bigger dimension, fragmentary, 3 cm wide, length much more than 6 cm. Base of leaflets distinctly asymmetric, acute or nearly obtuse. Margin serrate. Teeth simple and acute or acuminate. Sinuses angular. Venation camptodromous-semicraspedodromous. Midvein moderately thick, a great number of secondaries, more than 15 pairs, arise at angles of 70–80°. Between secondaries intersecondary veins observable. Adjacent secondaries often join close to the margin and a vein branches off the loop and ends in the teeth.

Fig. 6. **1** — *Dicotylophyllum* sp. 2 (BP.2007.135.2). **2, 3** — *Dicotylophyllum* sp. 3 (BP.2001.804.1). **4** — *Carpolithus* sp. (BP.2001.708.1). **5** — *Smilax* sp. 1 (BP.2001.774.1). **6** — ?*Smilax* sp. (BP.2001.739.1). Scale bars are 1 cm.

Determination and discussion: Compound leaves with petiolate leaflets occur in numerous families (e.g. Simaroubaceae, Oleaceae, Meliaceae etc.). Due to the lack of epidermal structure the systematic affinity of these leaves remains obscure.

Carpolithus sp.
Fig. 6.4

Material: BP.2001.708.1 (counterpart BP.2001.804).

Description: Fruit 4.4 cm long and 1.7 cm wide, ?bilateral symmetric, the central part (seed?) rounded 1 cm long and 1.3 cm wide. No venation of the central or lateral parts observable.

Determination and discussion: The detailed morphology is not observable. At first glance it resembles a winged fruit, however, the homogeneous texture of the central and lateral parts and the distinct margin of the lateral parts contrast this. Its structure may recall Leguminosae.

Monocotyledoneae
Smilacaceae

Smilax sp. 1
Fig. 6.5

Material: BP.2001.716.1; BP.2001.774.1.

Description: Simple petiolate leaves. Petiole (preserved in BP.2001.716.1) thick, 0.6 cm long. Leaves ovate, 3.5–4.5 cm long and 2.7–3 cm wide. Base rounded, apex rounded and slightly emarginate (preserved only in BP.2001.716.1). Margin entire. Venation perfect, basal acrodromous with 5 primary veins originating from the base at the attachment of the petiole. Three central veins almost equally thick, the two veins close to the margin slightly thinner. Veins run forming strongly developed, curved arches and join at the apex. Finer veins forked, percurrent and arise at angles of 80–90° from the primary veins.

Determination and discussion: Fossils of this genus have been frequently described from the Paleogene. Our specimens differ from those of *Smilax* sp. 1 and sp. 2 described from the Eocene of Staré Sedlo (Knobloch et al. 1996) in having primary veins diverging from one point at the base, at the attachment of the petiole to the lamina and in having a rounded base, slightly emarginate apex and ovate leaf form. From the Middle Eocene of Messel (Wilde 1989) three species of *Smilax* (with cf.) were recorded based on macro- and cuticular structures. Our leaves displaying ovate shape, rounded base and apex thus differing from the narrow ovate leaves from Messel.

Other Paleogene records of *Smilax* mostly differ by a characteristic cordate leaf base (e.g. Kovar 1982), however, the co-occurrence of oval and hastate/cordate forms may reflect the variability of leaves of the same species, for example, *Smilax weberi* Wessel in Wessel et Weber in the Late Oligocene Eger-Wind flora (Andreánszky 1966; Kvaček & Hably 1991).

?*Smilax* sp.
Fig. 6.6

Material: BP.2001.739.1 (BP.2001.730.1).

Description: Leaf lanceolate, lamina 9.1 cm long and 2.9 cm wide and slightly asymmetric, base obtuse. Apex probably acute. No teeth observed, however, margin heavily damaged. Venation perfect basal acrodromous with 5 primaries originating from one point at the base. Higher order venation not preserved.

Determination and discussion: The specimen with elongate lamina and asymmetric leaf base may also represent *Smilax*.

Discussion

Taphonomy

The flora is preserved in lacustric facies in freshwater (?brackish), sometimes clayey limestones overlying the first coal seam. The main factors presumed to play an essential role in the transport of plant material into the place of burial are water and wind. However, winged fruits and seeds as potential evidence of wind transport are totally missing from the assemblage. This may be attributable to various facts, for example, wind played a minor role in transport — a relatively closed vegetation around the lake impeding wind transport, a low proportion of taxa producing winged fruits. Leaves are always randomly oriented, spaced at nearly regular distances from each other without overlapping suggesting calm depositional settings.

Flora and vegetation

The fossil plant assemblage from Csordakút comprises mostly remains of angiosperms. In addition, algae are represented by numerous "stem"-like fragments of fresh-(brackish) water Characeae. Angiosperms documented macromorphologically belong to Lauraceae (*Daphnogene* sp.), Ulmaceae (*Cedrelospermum* div. sp.), Fagaceae (cf. *Eotrigonobalanus furcinervis*), Myricaceae (*Myrica* sp., *Comptonia* div. sp.), Leguminosae (leaves and fruit), Rhamnaceae (?*Zizyphus zizyphoides*), Elaeocarpaceae (*Sloanea nimrodi*, *Sloanea* sp. fruit) and Smilacaceae (*Smilax* div. sp.).

The absence of gymnosperms in the fossil assemblage may reflect their subordinate role in the vegetation, or it is attributable to the depositional setting, perhaps gymnosperms flourished far from the depositional basin.

Although the evaluation of taxon frequencies or the role of individual taxa in forming the vegetation is greatly hindered due to the great number of undeterminable specimens, taxa of both zonal and intrazonal vegetation types are recognizable. A lacustric environment is unequivocally proved by the frequent occurrence of Characeae. *Myrica* and *Comptonia* were members of the intrazonal vegetation (swamp) surrounding the lake. *Eotrigonobalanus* characterized by a wide ecological tolerance was probably the member of both zonal and intrazonal vegetation types. The zonal associations comprised Lauraceae, *Sloanea*, *Eotrigonobalanus* and *Zizyphus*. Open habitats are suggested by the occurrence of *Cedrelospermum* and Leguminosae. A "subxerophytic" character of the zonal vegetation is supported by some evidence namely the occurrence of small-leaved Leguminosae and coriaceous leaves with teeth on the margin. Other taxa suggesting a "subxerophytic" vegetation, like *Zizyphus zizyphoides* are documented by a single, uncertain specimen or are even absent as conifers with scale-like foliage.

Comparisons with Early Paleogene assemblages of Hungary

The Eocene flora of Tatabánya (Hably 1985a; Erdei & Wilde in prog.) was fossilized in marine clays, clay marls contrasting the lacustric environment of Csordakút. A similar feature of the Tatabánya assemblage is the absence of gymnosperms (a single fragmentary specimen in Tatabánya). Taxa shared by the Csordakút flora are Lauraceae, ?*Zizyphus zizyphoides*, Leguminosae, (Anacardiaceae). Remains of palms recorded in Tatabánya are missing in Csordakút, whereas *Daphnogene*, *Eotrigonobalanus*, *Sloanea* and Myricaceae were not found in Tatabánya. Furthermore, the

Tatabánya assemblage is dominated by a lanceolate leaf-type (?Lauraceae) characterized by an entire, slightly wavy leaf margin and presumably coriaceous texture which did not appear in Csordakút. Flora and vegetation disparities may reflect the different facies of the two localities. In contrast to the Eocene assemblages with the scarcity of gymnosperms, the Early Oligocene floras of the Tard Clay Formation are well-characterized by conifers (Z. Kvaček & Hably 1998), like *Doliostrobus taxiformis* (Sternberg) Kvaček var. *hungaricus* (Rásky) Kvaček et Hably, *Tetraclinis salicornioides* (Unger) Kvaček as well as *T. brachyodon* (Brongniart) Mai et Walther, *Calocedrus suleticensis* (Brabenec) Kvaček, moreover, cycads were recorded (*Ceratozamia floersheimensis* (Engelhardt) Kvaček; Z. Kvaček 2002). Winged fruits appearing with high diversity in the Tard Clay floras have not been found in Csordakút.

Shared taxa are *Eotrigonobalanus furcinervis*, ?*Zizyphus zizyphoides*, *Daphnogene*, *Myrica*, *Comptonia*, *Cedrelospermum*, Leguminosae and *Sloanea*.

Cedrelospermum frequently recorded by *C. flichei* in the Early Oligocene Tard Clay floras, seems to occur with at least two species during the Eocene. These are *C. flichei* and *Cedrelospermum* sp. indicating morphological similarity to leaves of *Tremophyllum* sp. from the Eocene flora of Messel (Wilde & Manchester 2003).

Similarly, *Sloanea* is quite widespread in the Hungarian Early Oligocene with one species, *S. elliptica* (valid name according to priority *S. olmediaefolia*, Hably & Kvaček 2007, in prog.). It appears with an additional species in Csordakút, *S. nimrodi*, new to the Hungarian fossil record. *S. nimrodi* suggests a floristic relation to the Late Eocene of North Bohemia (Kučlin).

The Eocene flora of Lábatlan (Kovács 1959, 1961) needs a revision to provide a precise comparison. Zlatko Kvaček studied the assemblage during a study trip to Budapest in 1989 and gave some remarks on the flora (Knobloch et al. 1996). He recognized two leaf types dominating the assemblage, one with an affinity to Juglandaceae and another resembling the leaf form of *Apocynophyllum helveticum* Heer. Remains of *Eotrigonobalanus* were not proved. Except for some taxodiaceous twigs Z. Kvaček did not find common elements with the Eocene assemblage of the Staré Sedlo layers in Bohemia. To give floristic similarities between the Lábatlan and Csordakút floras the fossil collection from Lábatlan should be revisited. However, it may be noted that the subordinate role of conifers parallels other Eocene assemblages from Hungary.

Comparisons to the Paleogene floras of Europe

Since leaves of the Csordakút assemblage are fossilized as impressions without organic matter resulting in a great number of indeterminable specimens a precise systematic comparison with other coeval floras of Europe is rather limited. However, some remarks on floristic relations should be made.

Numerous coeval floras of Central Europe, the Early Paleogene floras of eastern Central Europe, southeastern Europe, such as the Early Oligocene flora of Häring in Tyrol (Ettingshausen 1853), Tard Clay floras (Hably 2006) and the

Eocene–Early Oligocene floras of Serbia and Macedonia (Mihajlovič & Ljubotenski 1994), often indicate a "subxerophytic" character of the vegetation which is poorly manifested in the Csordakút assemblage. The Eocene-Early Oligocene floras of Serbia and Macedonia display the "subxerophytic" character with *Zizyphus zizyphoides* and leaflets of Leguminosae, as in the Late Eocene flora of Ovče Polje (Macedonia; Mihajlovič & Ljubotenski 1994). Additional shared elements are *Comptonia*, *Daphnogene* and *Eotrigonobalanus*. A shared feature of our flora and the coeval Girbou assemblage in Romania (Petrescu et al. 1976) is the absence of gymnosperms.

The coeval floras from Central/Western Europe are indicative of a lower degree of floristic similarity which is also manifested in their generally non-xerophytic character. The Late Eocene flora of Staré Sedlo in Bohemia (Knobloch et al. 1996) or the Eocene floras of the Weisselster-Becken, Messel and Geiseltal in Germany (Rüffle 1976; Rüffle et al. 1976; Mai & Walther 1978; Wilde 1989) share *Daphnogene*, *Comptonia*, *Eotrigonobalanus* (missing in Messel) and *Smilax* with the Csordakút flora, though these were not proved by epidermal structures in the Hungarian Eocene.

In this context, *Sloanea nimrodi* present in Csordakút also occurs in the Eocene flora of Kučlin (Bohemia).

Conclusions

The Middle Eocene (Lutetian) fossil plant assemblage from Csordakút (N Hungary, Gerecse Mountains) has been investigated. Fossil remains, mostly leaves and rarely fruits are preserved as impressions in lacustric facies, in freshwater limestones. Owing to the often fragmented state of leaves and absence of organic matter the systematic determination of a great number of specimens was hindered. Algae are represented by abundant remains of Characeae, including both vegetative fragments and gyrogonites. Remains of angiosperms include Lauraceae (*Daphnogene* sp.), Fagaceae (cf. *Eotrigonobalanus furcinervis*), Ulmaceae (*Cedrelospermum* div. sp.), Myricaceae (*Myrica* sp., *Comptonia* div. sp.), Leguminosae (leaves and fruit), Rhamnaceae (?*Zizyphus zizyphoides*), Elaeocarpaceae (*Sloanea nimrodi*, *Sloanea* sp. fruit), Smilacaceae (*Smilax* div. sp.). Taxa of both zonal (Lauraceae, *Sloanea*, *Eotrigonobalanus* and *Zizyphus*) and intrazonal (Characeae, *Myrica*, *Comptonia* and *Eotrigonobalanus*?) associations are recognizable. Open habitats are referred to by the occurrence of *Cedrelospermum* and Leguminosae. The "subxerophytic" character of the flora unequivocal in the Early Oligocene Tard Clay assemblages and Early Paleogene floras of Serbia/Macedonia is indefinitely supported by a few pieces of evidence, namely the occurrence of small-leaved Leguminosae, ?*Zizyphus zizyphoides* and coriaceous leaves with distinct teeth on the margin (e.g. Berberidaceae). Nevertheless, winged fruits are definitely subordinate in the assemblage. The absence of gymnosperms indicates a floristic relationship with the coeval floras of Tatabánya (extremely few remains of gymnosperms, N Hungary) and Girbou in Romania. *Sloanea nimrodi*, a new element for the Hungarian fossil record may reflect floristic relation to the Early Paleogene flora of Kučlin (Bohemia).

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