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Egerian macroflora from the Andornaktálya sandpit (Hungary)

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A b s t r a c t : The sandpit between Eger and Andornaktálya — exposing the upper part of Eger Formation — yielded a rich Egerian macroflora. Most of the 25 taxa are palaeotropical, like the rest of the Egerian floras. The species composition is almost identical with other Egerian floras (Kesztölc, Pomáz, Nagysáp), although the ratio of Lauraceae is conspicuously high here. Most of the flora represents remnants of a mesophyllous forest, i.e. zonal vegetation. *Spirematospermum wetzleri*, new species for the Hungarian Egerian, indicates marsh environment.

There is a disused sandpit between Eger town and Andornaktálya village, at the northern border of the latter (Fig. 1). Leaf imprints have been found here by scientists from of Department of Geology, Eötvös Loránd University, Budapest. The pit is about 250 m long and 150 m wide, stretching in N-W direction. Loose sand, about 60 m thick, is exposed. There are thin pelite beds in the lower part of the sand, some of them extremely rich in leaf fossils. The profile is topped by a thick pelite bed. Lithology of the sequence (Fig. 2) is very similar to the upper part of the nearby Wind-brickyard in Eger, suggesting the upper part of Eger Formation for Andornaktálya (SZTANO *et al.* in VARGA *et al.* 1989). Although the extremely poor nannoflora does not provide any stratigraphic datum, the species *Reticulofenestra hesslandii*, *R. ornata*, *R. bisecta*, and *R.* ex aff. *tokodensis* indicate an age not younger than Late Oligocene (NAGYMAROSY in VARGA *et al.* 1989).

Most of the plant fossils are leaf imprints, besides there are a few fruits and stem fragments in sandy layers.

The fossils recovered from coarse sediments in the outer wall of the pit are of medium or poor preservation; there is no organic matter or epidermis on any of the imprints. The main venation is shown in the sandstone, while imprints in the pelite preserved secondary and tertiary venation as well. It is very hard to collect complete specimens. Mostly leaf margins have been damaged while collecting, although bases and apices have been frequently destroyed, too.

Fossils from the pelite from within the quarry are well preserved. Secondary and tertiary venation and leaf margins were preserved, too. Collecting and preparation is problematic, because there is a lamina bearing leaf imprints in every millimetre of the thin pelite beds. As these are very thin and fragile, some of them have been destroyed during collecting and preparation.

Although the preservation of the leaves is not especially good, the locality has a great importance for plant biogeography, bearing a flora of the Eger Formation near the Wind-brickyard flora.

TAXONOMY

Cupressaceae

Tetraclinis salicornioides (Unger) Kvaček

1841 *Thuytes salicornioides* Unger; Unger, p. 11, Pl. 2, Figs 1-4.
1847 *Libocedrites salicornioides* (Unger) Endlicher; Endlicher, p. 275.
1855 *Libocedrus salicornioides* (Unger) Heer; Heer, p. 47, Pl. 21, Fig. 2.
1919 *Cupressinocladus salicornioides* (Unger) Sew.; Seward, p. 307.
1964 *Libocedrus salicornioides* (Unger) Heer; Kolakovski, p. 26, Pl. 1, Figs 12-14; Pl. 2, Fig. 1.
1969 *Libocedrites salicornioides* (Unger) Endlicher; Knobloch, p. 45, 63, Pl. 25, Fig. 3.
1971 *Hellia salicornioides* Unger; Ferguson, p. 55, Pl. 3d-g, Text-Fig. 10d-l.
1976 *Libocedrites salicornioides* (Unger) Endlicher; Knobloch and Kvaček, p. 16, Pl. 3, Figs 5-8; Pl. 15, Figs 16; Pl. 18, Fig. 3.
1978 *Libocedrites salicornioides* (Unger) Endlicher; Mai and Walther, p. 29, Pl. 14, Figs 14-18; Pl. 17, Figs 1-8.
1979 *Libocedrites salicornioides* (Unger) Endlicher; Hably, Pl. 2, Fig. 1; Pl. 3, Figs 3-4; Pl. 4, Fig. 2.
1980 *Libocedrites salicornioides* (Unger) Endlicher; Zastawniak, p. 43, Pl. 1, Figs 1, 1a.
1989 *Tetraclinis salicornioides* (Unger) Kvaček; Kvaček, p. 48, Pl. 1, Fig. 11; Pl. 2, Figs 2-14; Pl. 3, Figs 3, 4, Text-Fig. 1.

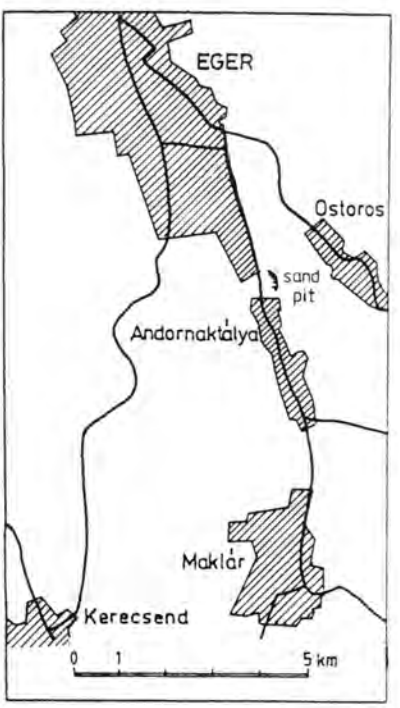

Fig. 1. Location of the plant locality of Andornaktálya

Material: 89.522.1.

Description: A single leaf whorl, 0.6 cm long, 0.5 cm wide.

Very rare in the Hungarian Oligocene. A single whorl has been found at Vértesszőlős. Missing from most Egerian localities. Frequent in the Tard Clay Formation, mass occurrences in the Lower Miocene at Ipolytarnóc.

Magnoliaceae

Magnolia cf. **dianae** Unger

1861 *Magnolia dianae* Unger; Unger, p. 28, Pl. 11, Figs 1-4.
1959 *Magnolia dianae* Unger; Rásky, p. 454.
1959 *Magnolia dianae* Unger; Andreánszky, p. 57, Pl. 10, Fig. 4, Text-Fig. 15.
1963 *Magnolia dianae* Unger; Nagy and Pálfalvy, p. 228.
1965 *Magnolia dianae* Unger; Kristofovich and Bajkovskaia, p. 73, Pl. 18, Fig. 4; Pl. 20, Fig. 3.

Material: 89.535.1.

Description: Longitudinal half lamina. Original length 12.5 cm, width 6.2 cm. Midrib strong, venation camptodromous, secondary veins display an arc leaving the midrib. Margin entire.

The genus and this species sporadically occur in the Hungarian Egerian. There are single specimens in almost all localities, but no more.

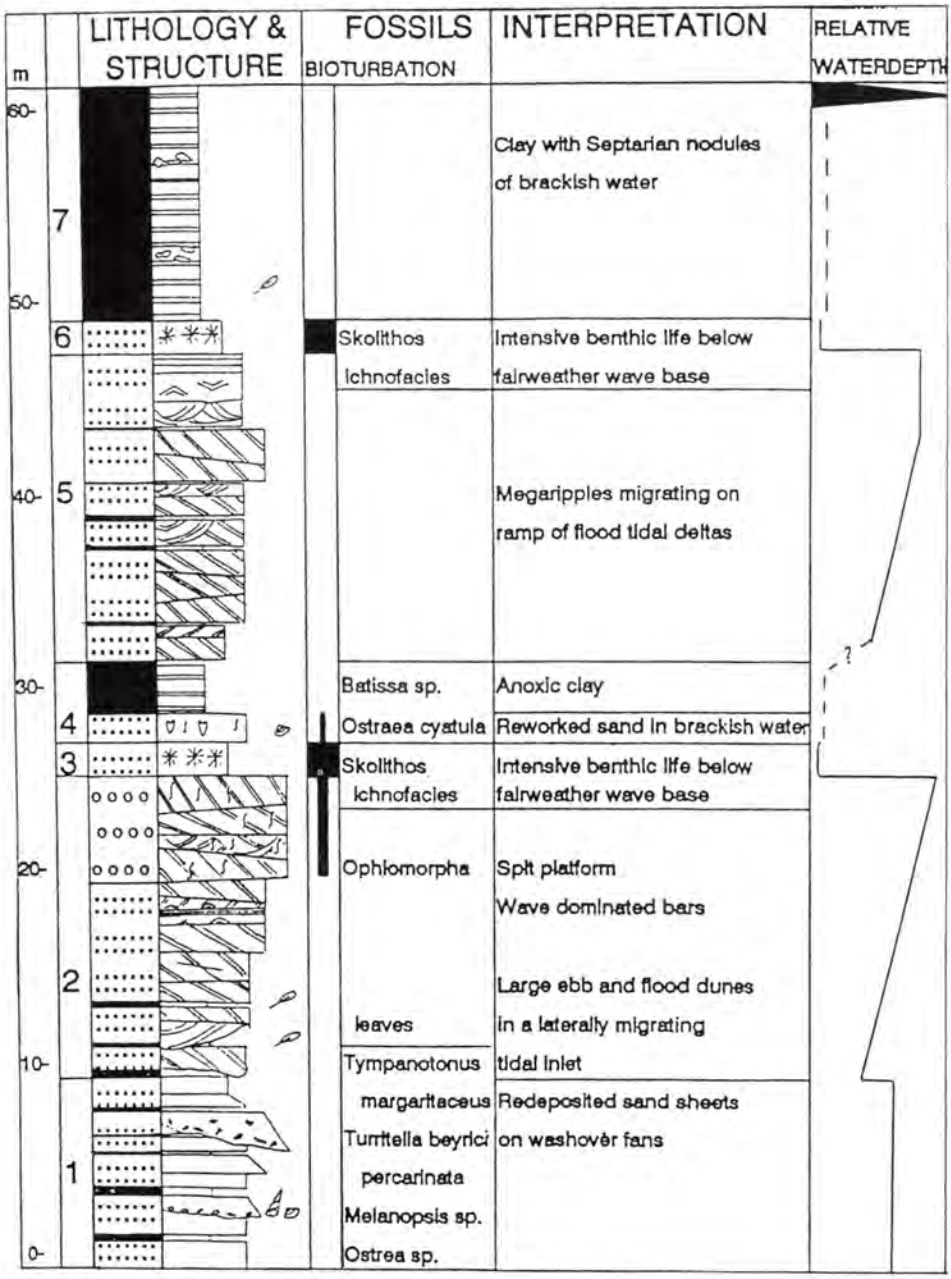

Fig. 2. Andornaktálya. On base of sedimentological features, seven facies can be distinguished (after SZTANO and TARI 1991)

Daphnogene cinnamomifolia (Brong. in Cuvier) Unger

1822 *Phyllites cinnamomifolia* Brong. in Cuvier; Brongniart, 2 Bd.
1850b *Daphnogene cinnamomifolia* Unger; Unger, p. 168, Pl. 39, Figs 7-9.
1873 *Cinnamomum rossmässleri* Heer; Engelhardt, p. 26, Pl. 5, Fig. 4.
1950 *Cinnamomophyllum polymorphum* (A. Br.) Kräusel et Weyland; Kräusel and Weyland, p. 70, Pl. 17, Figs 2-3; Pl. 18, Fig. 1.
1974 *Daphnogene cinnamomifolia* (Brong. in Cuvier) Unger; Kvaček and Walther, p. 199, Pl. 1, Figs 1-4; Pl. 2, Figs 1-5; Pl. 3, Figs 1-5.
1978 *Daphnogene cinnamomifolia* (Brong. in Cuvier) Unger; Mai and Walther, p. 43, Pl. 2, Figs 24-25; Pl. 20, Figs 5-9; Pl. 21, Figs 1-2.
1988 *Daphnogene cinnamomifolia* (Brong. in Cuvier) Unger; Hably, p. 39, Pl. 5, Figs 1-5; Pl. 6, Fig. 1.

Material: 89.505.1; upper: 89.562.1.; 89.567.1.; 89.570.1.; 89.575.1.; 89.577.1.; 89.578.1.; 89.579.1.; 89.597.1.; 89.600.1.; cf. 89.610.1.; 89.613.1.; 89.616.1.

Description: Leaves 5.3–13.5 cm long, 2.3–4.8 cm wide. Mostly found in the so-called upper bed; probably the pelitic bed preserved the large leaves better. Venation camptodromous, it forms a dense loop system leaving the basal veins. There are dense tertiary and quaternary venation between the midrib and the basal veins, and among the basal and secondary veins. Margin entire, base and apex acute, apex sometimes rounded.

It is a widespread species in the Hungarian Egerian. Significant amounts occur in almost all localities. Thermophylous palaeotropical element, forming the shrub level of subtropical forests associated with other *Daphnogene* species.

Daphnogene lanceolata Unger

1850a *Daphnogene lanceolata* Unger; Unger, p. 424.
1850b *Daphnogene lanceolata* Unger; Unger, p. 167, Pl. 34, Figs 1-7.
1873 *Daphnogene ungeri* Heer; Engelhardt, p. 27, Pl. 5, Fig. 5.
1873 *Eucalyptus oceanica* Unger; Engelhardt, ibid., p. 29, Pl. 5, Fig. 11.
1934 *Daphnogene lanceolata* Unger; Weyland, p. 83, Pl. 11, Fig. 6; Pl. 13, Fig. 7; Pl. 14, Fig. 8.
1950 *Cinnamomophyllum scheuchzeri* (Heer) Kräusel et Weyland; Kräusel and Weyland, p. 68, Pl. 11, Fig. 7; Pl. 16, Figs 1-6; Pl. 17, Fig. 1, Text-Fig. 25.
1963 *Cinnamomophyllum scheuchzeri* (Heer) Kräusel et Weyland; Mai, p. 71, Pl. 8, Figs 4-6.
1963 *Laurophyllum acutimontanum* Mai; Mai, ibid., p. 72, Pl. 8, Fig. 10, Text-Fig. 11a-e.
1964 *Cinnamomophyllum scheuchzeri* (Heer) Kräusel et Weyland; Walther, p. 48, Pl. 17, Figs 1-4.
1965 *Cinnamomophyllum bitterfeldense* Schneider; Schneider, p. 1241, Pl. 4, Figs 11-13.
1976 *Daphnogene lanceolata* Unger; Bůžek *et al.*, p. 100, Pl. 7, Figs 1-4; Pl. 19, Figs 3-7.
1978 *Daphnogene lanceolata* Unger; Mai and Walther, p. 40, Pl. 2, Figs 1-23; Pl. 19, Figs 1-15; Pl. 20, Figs 1-4.

Material: 89.504.2.; 89.505.1.; 89.507.2.; 89.508.1.; 89.509.1.; 89.513.1.; 89.514.1.; 89.516.1.; 89.518.1.; 89.519.1.; 89.520.1.; 89.524.1.; 89.527.1.; 89.531.1.; 89.533.1.; 89.534.2.; 89.535.1.; 89.537.1.; 89.547.1.; cf. 89.552.1.

Description: Lanceolate, narrow ovate leaves, 5.3–10.8 cm long, 1.1–3.2 cm wide. Venation suprabasal, imperfect, well-expressed camptodromous character in the upper third part. There are characteristic large specimens in the so-called upper flora at Andornaktálya. Their venation somewhat differs from that of the usual smaller specimens. The secondary venation is significantly richer, forming loops with each other and with the basal veins.

It is a widespread species in Europe. Characteristic of the Oligocene of Hungary, although no similarly rich, dominant occurrences are known. Thermophylous palaeotropical element. It has a similar role in the vegetation as *D. cinnamomifolia*.

Daphnogene bilinica (Unger) Kvaček et Knobloch

1847 *Ceanothus bilinicus* Unger; Unger, p. 145, Pl. 49, Fig. 9.
1950 *Cinnamomophyllum scheuchzeri* (Heer) Kräusel et Weyland; Kräusel and Weyland, p. 68, Pl. 11, Fig. 7; Pl. 16, Figs 1-6; Pl. 17, Fig. 1; Pl. 18, Figs 2-4, Text-Fig. 25-26.
1963 *Cinnamomophyllum polymorphum* (Al. Br.) Kräusel et Weyland; Weyland and Kilpper, p. 104, Pl. 25, Figs 28-29, Text-Fig. 10.
1964 *Cinnamomophyllum bilinicum* (Unger) Knobloch; Knobloch, p. 601.
1967 *Daphnogene bilinica* (Unger) Knobloch et Kvaček; Knobloch and Kvaček, p. 203.
1971 *Daphnogene bilinica* (Unger) Knobloch et Kvaček; Kvaček, p. 67, Pl. 2, Figs 1-4; Pl. 9. Figs 4-6, Text-Fig. 14.
1978 *Daphnogene bilinica* (Unger) Knobloch et Kvaček; Ticleanu and Givulescu, p. 140, Pl. 2, Figs 1-4, 8, 9; Pl. 3, Figs 6, 7.
1988 *Daphnogene bilinica* (Unger) Knobloch et Kvaček; Hably, p. 36, Pl. 3, Figs 1-5; Pl. 4, Fig. 6; Pl. 7, Fig. 3.
1990 *Daphnogene bilinica* (Unger) Knobloch et Kvaček; Hably, p. 12, Pl. 9, Figs 1-3; Pl. 10, Figs 1-3; Pl. 11, Figs 1-3; Pl. 12, Figs 1-2, Text-Figs 6, 8, 14, 16, 18-20, 23-26, 28, 30-34, 37, 39.

Material: 89.505.1.; 89.506.2.; 89.513.1.; 89.515.1.; 89.519.1.; 89.523.1.; 89.525.1.; 89.526.1.; upper: 89.555.1.; 89.556.1.; 89.593.1.; 89.604.1.; 89.605.1.

Description: Leaves 5.6–6.3 cm long, 1.8–2.8 cm wide. Shape lanceolate or narrow elliptic. Margin entire, venation suprabasal, imperfect.

D. bilinica is not dominant at Andornaktálya; most of the leaves are fragmented. The species was widespread in Europe during the Tertiary. There are mass occurrences at Ipolytarnóc, and is a characteristic species of Egerian localities. Its ecological requirements are similar to other *Daphnogene* species, and it participates in the same associations.

Daphnogene sp.

Material: 89.518.1.; 89.528.1.; 89.541.1.; 89.543.1.; 89.550.1.; 85.553.1.; 89.554.1.; upper: 89.557.2.; 89.558.2.; 89.559.1.; 89.564.1.; 89.569.1.; 89.580.1.; 89.581.1.; 89.582.1.; 89.583.1.; 89.586.1.; 89.587.1.; 89.588.1.; 89.592.1.; 89.594.1.; 89.598.1.; 89.599.1.; 89.601.1.; 89.604.1.; 89.605.1.; 89.606.1.; 89.607.1.; 89.608.1.; 89.609.1.; 89.611.1.; 89.612.1.; 89.613.1.; 89.614.1.; 89.615.1.

Description: Fragments are grouped here, belonging to this genus beyond doubt, although the exact taxonomic position cannot be determined owing to the lack of species characters. These have a similar importance in reconstructing the climate and the flora as the species discussed above, since all members of the genus indicate identical ecological conditions.

Laurophyllum cf. **acutimontanum** Mai

1950 *Laurophyllum phoeboides* (Ettingshausen) Kräusel et Weyland; Kräusel and Weyland (ex parte), p. 58, Pl. 15, Figs 5-8.
1963 *Laurophyllum* (*Tetradenia*) *acutimontanum* Mai; Mai, p. 72, Pl. 8, Figs 7-9, 12; Pl. 9, Figs 1-4, Text-Figs 11f-h.
1964 *Laurophyllum princeps* (Heer) sensu stricto Walther; Walther, p. 45, Pl. 16, Figs 1-5.

1971 *Laurophyllum acutimontanum* Mai; Kvaček, p. 53, Pl. 2, Fig. 5; Pl. 6, Figs 4-6; Pl. 7, Figs 1-2, Text-Figs 3, 4.

1976 *Laurophyllum acutimontanum* Mai; Bůžek *et al.*, p. 96, Pl. 8, Figs 4, 5; Pl. 18, Figs 3-5.

Material: 89.520.1.

Description: 9.2 cm long, 1.3 cm wide simple leaf. Shape of lamina very narrow elliptic, base cuneate, apex acute, margin entire. Venation camptodromous, midrib strong. Morphologically it is very similar to *L. acutimontanum*, but without cuticular analysis we cannot determine the specimen to species.

Laurophyllum sp.

Material: 89.519.1.; 89.522.1.; 89.528.1.; 89.532.2.; 89.537.1.; 89.538.1.; 89.540.1.; cf. 89.541.1.; 89.543.1.; 89.544.1.; cf. 89.546.1.; 89.548.1.; cf. 89.549.1.; 89.550.1.; 89.551.1.; 89.552.1.; 89.554.1.; upper: 89.558.2.; 89.562.2.; 89.565.1.; 89.566.1.; 89.573.1.; 89.576.1.; 89.579.1.; 89.594.1.; 89.596.1.; 89.599.1.; 89.601.1.; 89.605.1.; 89.606.1.; 89.607.1.; 89.608.1.; 89.610.1.; 89.611.1.; 89.612.1.; 89.614.1.

Description: Leaves lanceolate, apex acute, generally fragmented base, margin entire. The most characteristic genus at Andornaktálya after *Daphnogene*, found in great numbers. Species cannot be determined, due to missing epidermis.

"Laurus" princeps Heer

1856 *Laurus princeps* Heer; Heer, p. 77, Pl. 89, Figs 16-17; Pl. 90, Figs 17, 20; Pl. 97, Fig. 1.

1868 *Laurus heliadum* Unger; Ettingshausen, p. 6, (194-195), Pl. 32, Fig. 1.

1876 *Laurus canariensis* Webb. *pliocenica* Saporta et Marion; Saporta and Marion, p. 116, Pl. 27, Figs 6, 7; Pl. 28, Figs 1-8.

1922 *Laurus canariensis* Webb. *pliocenica* Saporta et Marion; Depape, p. 169, Pl. 10, Figs 1-5.

1934 *Laurus princeps* Heer; Weyland, p. 72, Pl. 11, Fig. 4; Pl. 13, Fig. 4, Text-Figs 4, 5.

1958 *Laurus primigenia* Unger aff. *L. canariensis* Webb.; Grangeon, p. 147, Text-Pl. 24, Fig. 3.

1973 *Laurophyllum* cf. *princeps* (Heer) Nemejc et Knobloch; Nemejc and Knobloch, p. 711, Pl. 7, Figs 2, 3.

Material: cf. 89.520.1.; upper: 89.565.1.; 89.577.1.; cf. 89.581.1.; 89.609.1.

Description: Leaves 5.7–7.3 cm long, 2.4–2.7 cm wide. Shape ovate, venation camptodromous, margin entire. Apex and base acute.

Palaeotropical, thermophylous element. There is a large amount of the species in the Lower Miocene flora of Ipolytarnóc. It is not especially characteristic of the Egerian floras. Its presence increases the warm, subtropical character of the flora.

Laurus sp.

Material: 89.520.1.; cf. 89.521.1.; upper: 89.607.1.; 89.608.1.; 89.609.1.

Description: Mostly fragments, a single measurable specimen is 7.2 cm long, 3.6 cm wide. Besides the camptodromous venation and entire margin no other specific character revealed.

All members of the genus are characteristic thermophylous elements of subtropical forests.

Platanaceae

Platanus neptuni (Ettingshausen) Bůžek, Holy et Kvaček

1866 *Sparganium neptuni* Ettingshausen; Ettingshausen, p. 31, Pl. 7, Figs 9-15.

1866 *Sparganium extinctum* Ettingshausen; ibid., p. 31, Pl. 7, Fig. 8.

1869 *Ceratopetalum haeringianum* Ettingshausen; Ettingshausen, p. 6, Pl. 40, Figs 27-28; Pl. 41, Figs 4, 5.
1869 *Bombax chorisiaefolium* Ettingshausen; ibid., p. 11, Pl. 42, Figs 2, 4, 5.
1869 *Quercus arctocarpites* Ettingshausen; ibid., p. 63, Pl. 55, Fig. 19.
1885 *Ceratopetalum cundraticense* Engelhardt; Engelhardt, Pl. 11, Fig. 2.
1898 *Equisetites ettingshauseni* Engelhardt; Engelhardt, p. 85, Pl. 9, Figs 6, 8, 11, 30, 31, 36, 37.
1898 *Viburnum oligocenicum* Engelhardt; ibid., p. 96, Pl. 9, Fig. 61.
1898 *Ampelopsis bohemica* Engelhardt; ibid., p. 101, Pl. 10, Figs 23-26.
1898 *Elaeodendron grandifolium* Engelhardt; ibid., p. 107, Pl. 10, Fig. 30.
1898 *Phyllites quercoides* Engelhardt; ibid., p. 116, Pl. 11, Fig. 29.
1898 *Phyllites amphirocioides* Engelhardt; ibid., p. 116, Pl. 11, Figs 47, 68, 79.
1967 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Bůžek *et al.*, p. 205, Pl. 1, Figs 1-6; Pl. 2, Figs 1-9.
1973 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Knobloch, p. 281, Figs 1, 2, 4.
1975 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Knobloch *et al.*, p. 88, 89, 91.
1978 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Kvaček and Walther, p. 91, Text-Fig. 5.
1978 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Bůžek *et al.*, Pl. 3, Fig. 6.
1979 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Hably, Pl. 8, Figs 1-5; Pl. 9, Figs 2, 3, 5, 6; Pl. 10, Figs 1-5; Pl. 11, Figs 1-3.
1980 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Hably, p. 300, Pl. 1, Figs 1-8; Pl. 2, Figs 1-9; Pl. 3, Figs 1-6; Pl. 4, Figs 1-5; Pl. 5, Figs 1-6; Pl. 6, Figs 1-4; Pl. 7, Figs 1-4; Pl. 8, Figs 1-4; Pl. 9, Figs 1-4; Pl. 10, Figs 1-4.
1982 *Platanus neptuni* (Ettingshausen) Bůžek, Holý et Kvaček; Hably, p. 93, Pl. 1, Figs 4, 6, 9, 10, 11; Pl. 2, Figs 1, 2; Pl. 5, Figs 1-6; Pl. 6, Figs 1-6; Pl. 7, Figs 2-4; Pl. 8, Fig. 1.

Material: cf. 89.518.1.; upper: cf. 89.564.1.; 89.587.1.(3)

Description: Leaves 8.3–11.3 cm long, 3.1–3.7 cm wide. Shape narrow ovate, apex and base acute, venation camptodromous, margin toothed, except in the lower third of the leaf. Small teeth, characteristic of the species. There is large amount of specimens on the bedding planes, overlapping one another, consequently, margins are hard to examine. There are questionable fragments besides the measurable specimens. Well-preserved, complete imprints have been collected from thin clay seams, from the so-called upper bed.

P. neptuni is a thermophylous palaeotropical element. It was a dominant, important tree in the Late Oligocene forests in Hungary. It occurs in all localities, and usually more frequent than at Andornaktálya. Certainly, it had a significant role in forming the canopy level of the subtropical forest, but fossilization conditions were less favourable (sandstone is unfavourable for preservation).

Juglandaceae

Palaeocarya orsbergensis (Wessel et Weber) Jähnichen, Friedrich et Takáč

1856 *Banksia orsbergensis* Wessel et Weber; Wessel and Weber, p. 146, Pl. 25, Fig. 9a.
1856 *Hakea lanceolata* Wessel et Weber; Wessel and Weber, p. 147, Pl. 25, Fig. 13.
1865 *Engelhardtia detecta* Saporta; Saporta, p. 201, Pl. 12, Fig. 4.
1914 *Myrica banksiaefolia* Jablonszky; Jablonszky, p. 263, Pl. 10, Figs 4, 5.
1957 *Schinus oligocaenicum* Andreánszky et Novák; Andreánszky and Novák, p. 49, Pl. 2, Figs 6-7; Pl. 3, Fig. 9.

1959 *Anacardites* cfr. *Schinus molle* L.; Andreánszky, p. 151, Text-Fig. 174, Pl. 45, Fig. 5.
1959 *Myrica lignitum* (Unger) Saporta; Rásky, p. 454.
1963 *Schinus oligocaenicum* Andreánszky et Novák; Andreánszky, p. 100, Pl. 2, Fig. 13.
1976 *Engelhardtia detecta* Saporta; Knobloch and Kvaček, p. 27, Pl. 10, Figs 2-7; Pl. 11, Fig. 3; Pl. 12, Figs 1, 2, 8; Pl. 17, Fig. 12; Pl. 19, Fig. 6; Pl. 20, Fig. 2.
1977 *Engelhardtia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther; Jähnichen *et al.*, p. 323, Pl. 9, Fig. 4.
1981 *Engelhardtia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther; Pálfalvy, p. 492.
1984 *Palaeocarya orsbergensis* (Wessel et Weber) Jähnichen, Friedrich et Takáč; Jähnichen *et al.*, p. 110, Pl. 1, Figs 1-6; Pl. 2, Figs 1, 2; Pl. 3, Figs 1, 3; Pl. 4, Figs 1-6; Pl. 5, Figs 1-7.
1985 *Engelhardtia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther; Hably, p. 106, Pl. 20, Fig. 5; Pl. 24, Figs 3-6; Pl. 25, Figs 1-8; Pl. 26, Figs 1-6; Pl. 27, Fig. 5.

Material: upper: 89.556.1.; cf. 89.561.1.; 89.609.1.

Description: Two, almost complete specimens, 9.1 cm and 11.5 cm long, 1.0 and 1.5 cm wide, respectively. Shape lanceolate, apex acute, rounded, base asymmetrical. Margin toothed, small, barbed teeth, arched upwards.

Very widespread species in the European Tertiary as well as in Hungary. It ranges from the Eocene to Late Miocene here. There are mass occurrences in the Tard Clay Formation and at Ipolytarnóc, and significant localities in the Egerian, occurring in masses in a few localities; otherwise, there are at least a few specimens everywhere. It is a thermophylous palaeotropical element. Mostly associated with *Daphnogene*, *Laurus*, *Laurophyllum*, and *Platanus neptuni*.

"Rhamnus" warthae Heer

1872 *Rhamnus warthae* Heer; Heer, p. 23, Pl. 5, Figs 2, 3; Pl. 6, Figs 3, 4, 5.
1872 *Juglans heerii* Ettingshausen; Heer, p. 24, Pl. 5, Fig. 4a.
1887 *Rhamnus warthae* Heer; Staub, p. 360, Pl. 38, Figs 1, 2.
1887 *Juglans heerii* Ettingshausen; Staub, p. 281, Pl. 27, Fig. 1.
1887 *Laurus primigenia* Unger; Staub, p. 303, Pl. 28, Fig. 6; Pl. 29, Fig. 1; Pl. 34-35, Fig. 1d.

Material: 89.557.2.; cf. 89.564.1.

Description: An almost complete, measurable specimen, 9.8 cm long, 3.1 cm wide. Shape elliptic, venation camptodromous, there are rich loop networks at the terminations of secondary veins. The margin is damaged, with very rare and small teeth.

Many imprints have been found in the Wind-brickyard named by ANDREÁNSZKY (1966) as *Symplocos* and *Elaeocarpus palaeolanceolatus*. STAUB (1887) published the species under the names *Laurus primigenia*, *Juglans heerii*, *J. ungeri*, *J. bilinica* from the Upper Oligocene Zsil (Jiu) valley flora (Romania). New Egerian localities (Kesztölc, Nagysáp) also yielded the species, described as *Symlocos* sp. (HABLY 1988, 1989). It is a significant accessory element at Pomáz. The species is restricted to the inner Carpathian region. Known localities are in the Upper Oligocene of Hungary and Transylvania. Since there are no localities of the same age in Yugoslavia and Bulgaria, farther connections cannot be traced. The well-known, published floras of the north (Bohemia, Germany) do not contain this species, not even as a synonym. We suggest, that "*Rhamnus*" *warthae* was an endemic species of the inner Carpathian region, appearing in the Upper Oligocene. (Its taxonomic position is unknown; *Rhamnus* is preserved for priority's sake.) It clearly belongs to a family of a thermophylous tropical-subtropical family.

Ulmaceae

Ulmus pyramidalis Goeppert

1845 *Ulmus bronni* Unger partim; Unger, Pl. 26, Fig. 1.
1845 *Ulmus longifolia* Unger; ibid., Pl. 26, Figs 5, 6.
1855 *Ulmus pyramidalis* Goepp.; Goeppert, p. 28, Pl. 13, Figs 10-12.
1859 *Carpinus pyramidalis* (Goepp.) Heer; Heer, p. 177, Pl. 87, Fig. 7f; Pl. 150, Figs 27, 28.
1866 *Ulmus pyramidalis* Gaudin; Ettingshausen, p. 49, Pl. 15, Figs 5-9, 21.
1866 *Ulmus bronni* Unger; ibid., p. 62, Pl. 17, Figs 9, 10.
1866 *Ulmus longifolia* Unger partim; ibid., p. 62, p. 18, Figs 7, 9-11.
1866 *Ulmus plurinervia* Unger; ibid., p. 63, Pl. 18, Figs 12-13.
1866 *Ulmus minuta* Goepp.; ibid., p. 64, Pl. 18, Figs 21, 22.
1866 *Ulmus brauni* Heer; ibid., p. 64, Pl. 18, Figs 23, 25(?), 26, 27(?).
1866 *Planera Ungeri* Ettingshausen partim; ibid., p. 65, Pl. 18, Figs 14-16, 18(?), 19(?).
1971 *Ulmus pyramidalis* Goepp.; Bůžek, p. 56, Pl. 19, Figs 3-18; Pl. 20, Figs 1-17; Pl. 21, Figs 1-8.

Material: 89.505.1.; 89.506.2.; 89.510.5.; 89.511.1.; 89.512.1.; 89.513.1.; 89.517.1.; 89.520.1.; 89.522.1.; 89.523.1.; 89.524.1.; 89.535.1.; 89.536.1.; cf. 89.545.1.; 89.550.1.; upper: 89.556.1.; 89.557.2.; 89.558.2.; 89.559.1.; 89.563.1.; 89.565.1.; 89.566.1.; 89.571.1.; 89.572.1.; 89.573.1.; 89.584.1.; 89.585.1.; 89.587.1.; 89.593.1.; 89.594.1.; 89.598.1.; 89.601.1.; 89.607.1.; 89.608.1.; 89.613.1.

Description: Leaves 3.2–8.8 cm long, 1.7–4.4 cm wide. There are several medial fragments besides the measurable specimens, determined by their venation and teeth. Venation craspedodromous, midrib strong, rigid secondary veins, with tertiary venation between. Teeth compound, two size groups. Secondary veins terminate in the main apices; auxiliary veins terminate in the side apices.

Ulmus pyramidalis is a characteristic, dominant species in the Egerian of Hungary. It is the single Arctotertiary species occurring in all localities, mostly in dominating quantities including the Egerian.

Fagaceae

cf. **Quercus apocynophyllum** Ettingshausen

1862 *Quercus lyellii* Heer; Heer, p. 40, Pl. 12, Figs 2-9; Pl. 13, Figs 1-4; Pl. 14, Fig. 12b; Pl. 15, Figs 1, 2; Pl. 17, Figs 4, 5.
1868 *Apocynophyllum reussi* Ettingshausen; Ettingshausen, p. 216, Pl. 37, Fig. 1.
1869 *Quercus apocynophyllum* Ettingshausen; Ettingshausen, p. 34, Pl. 2, Fig. 15.
1964 *Quercus* cf. *pinnativenulosa* Muell.; Andreánszky and Kovács, p. 30, Fig. 24.
1966 *Quercus palaeofourrnieri* Andreánszky et Kovács; Andreánszky, p. 56, Fig. 41.
1966 *Quercus salicina* Saporta; Andreánszky, p. 58, Figs 42, 44.
1979 *Quercus apocynophyllum* Ettingshausen; Rüffle and Palamarev, p. 35, Figs 1-7, Pl. 1-4.

Material: upper: cf. 89.557.2.

Description: A single basal fragment of uncertain determination. The conspicuously thick midrib, the entire margin and the camptodromous venation characterize this species.

Complete imprints determined beyond any doubt have been found at Pomáz. It is characteristic of formations older than Egerian in NW Europe. Thermophylous palaeotropical element, forming the canopy level of subtropical forests.

cf. **Castanopsis toscana** (Bandulska) Kräusel et Weyland

1931 *Tristanica toscana* Bandulska; Bandulska, p. 668, Pl. 40, Figs 9-11.

1954 *Castanopsis toscana* (Bandulska) Kräusel et Weyland; Kräusel and Weyland, p. 135, Text-Fig. 14, Pl. 29, Figs 3-9.
1971 *L* sensu Ferguson; Ferguson, p. 207, Text-Fig. 37, Pl. 34-36.
1976 *Castanopsis toscana* (Bandulska) Kräusel et Weyland; Knobloch and Kvaček, p. 39, Pl. 4, Fig. 1; Pl. 16, Figs 10-11; Pl. 17, Fig. 16; Pl. 20, Figs 11, 15.
1982 *Castanopsis toscana* (Bandulska) Kräusel et Weyland; Kovar, p. 65, Pl. 9. Figs 1-5.
1988 cf. *Castanopsis toscana* (Bandulska) Kräusel et Weyland; Hably, p. 41, Pl. 8, Figs 5-6; Pl. 9, Fig. 1.

Material: upper: 89.594.1.; 89.611.1.

Description: Leaves 5.2–6.5 cm long, 2.4–3.3 cm wide. Margin entire, venation camptodromous, dense, arched secondary veins leaving the midrib.

It is an accessory element in the Egerian floras of Hungary. There are many specimens at Kesztölc only. It is a thermophylous, palaeotropical element.

Betulaceae

Carpinus sp.

Material: 89.529.1.; 89.530.1.; 89.539.1.

Description: Leaves 2.6–3.5 cm long, 2.0–2.2 cm wide. Shape ovate, apex acute, base cordate, venation craspedodromous, margin toothed.

There is large number of similar imprints in the Egerian Pomáz flora: these are small ones with cordate base. The leaves are very similar to the recent *Carpinus cordata*, but differ from *C. subcordata* described by Nathorst.

Leguminosae

Leguminocarpon sp.

Material: 89.522.1.; 89.595.1.

Description: Median fragments of two pods, one with a counter-part. Length unknown, width about 0.7 cm. Imprints of the small, rounded seeds are well observed in both specimens. There is a large number of pods in the Egerian of Hungary, especially at Pomáz and in the Wind-brickyard at Eger. These localities are characterized by large fruits, while the Andornaktálya specimens are similar to the narrow ones found at Kesztölc. Although in other localities there are several leaf imprints besides the fruits, no leaves of the Leguminosae family have been found at Andornaktálya. Probably the coarse-grained sediment was not a favourable preserving medium for the fine leaves, but resistant fruits fossilized.

Myricaceae

cf. **Myrica** sp.

Material: upper: 89.593.1.

Description: Leaves lanceolate, apex acute, base damaged. Margin toothed, teeth are characteristic of the genus *Myrica*. Fragmentation and obscure venation make taxonomic determination of the single specimen uncertain.

Dicotylophyllum sp.

Material: 89.542.1.

Description: A dicotyledonous leaf, undetermined owing to poor preservation.

Zingiberaceae

Spirematospermum wetzleri (Heer) Chandler

1859 *Gardenia wetzleri* Heer; Heer, p. 192, Pl. 141, Figs 81-103.
1925 *Spirematospermum wetzleri* (Heer) Chandler; Chandler, p. 17, Pl. 1a-c.

1963 *Spirematospermum wetzleri* (Heer) Chandler; Rüffle, p. 170, Pl. 2, Fig. 11; Pl. 17, Fig. 7.
1969 *Spirematospermum wetzleri* (Heer) Chandler; Knobloch, p. 48, 146, Pl. 13, Fig. 5; Pl. 57, Figs 5, 6.
1971 *Spirematospermum wetzleri* (Heer) Chandler; Bůžek, p. 91.
1978 *Spirematospermum wetzleri* (Heer) Chandler; Mai and Walther, p. 138, Pl. 48, Figs 14-18.
1985 *Spirematospermum wetzleri* (Heer) Chandler; Mai and Walther, p. 127, Pl. 31, Figs 33-35.

Material: 89.532.1.

Description: Fruit 7.0 cm long, 1.5 cm wide. Seeds 0.4–0.5 mm long, elongate. One end acute, another rounded.

The species is very widespread from the Late Eocene to the Pliocene in Europe and Asia. There are a few unpublished Pannonian localities in Hungary. The Andornaktálya specimen from the sandy layers is the first find in the Hungarian Upper Oligocene. *Spirematospermum wetzleri* is a characteristic member of swamp vegetations.

Monocotyledonae

Material: 89.542.1.

Description: Small, monocotyledonous leaf imprint; no characters except dense, parallel venation.

FLORISTIC EVALUATION

The Egerian flora of Andornaktálya contains a single species of Gymnospermatophyta phylum, a *Tetraclinis salicornioides* specimen.

The flora mostly consists of the members of the phylum Angiospermatophyta. Dicotyledons are dominant, monocotyledons are very restricted.

The Lauraceae family is the most widespread beyond any doubt, displaying the highest diversity, too. Clearly, these species lived under optimal conditions. Although Lauraceae dominate almost all Hungarian floras, their unusually high proportion at Andornaktálya is surprising.

A special method for interpreting leaf floras has been developed by GREGOR (1982) for Neogene floras. His method is applicable for Hungarian Egerian floras, too, since the Egerian and the older Neogene floras are very similar in morphology and species composition.

GREGOR (1982) established 23 categories for leaf types, based on leaf margin, shape, laurophylous character, not completely free from taxonomic composition. The categories are marked by letters from **a** to **x**.

a = cinnamomoid
b = lauroid
c = diospyroid
d = taxodicoid
e = myricoid
f = juglandoid
g = aceroid
h = leguminosoid
i = quercoid
k = tilioid
l = populoid
m = carpinoid
n = cornoid
o = rosoid
p = salicoid
q = hidrophytoid
r = typhoid
s = smilacoid
t = ginkgoid
u = comptonioid
v = viscoid
w = pinoid
x = palmoid

Number of specimens is used by the method, considering dominant types. Abundance is indicated by numerals.

1 most frequent elements (more than 101 specimens),
2 frequent element (11–100 specimens),
3 rare elements (2–10 specimens),
4 single specimen.

A table is made for each locality, showing each element type by a number determined by the abundance. This table has been prepared for the Andornaktálya flora. This method gives good results for localities yielding more than 100 specimens.

Locality	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**k**	**l**	**m**	**n**	**o**	**p**
Andornaktálya	1	2			3				3			2			

The locality is characterized considering the most frequent and the frequent elements; it is an **a b e i m** locality, containing cinnamomoid, lauroid, myricoid, quercoid, and carpinoid elements.

GREGOR (1982) provides the characterization of the groups **a** to **x**, indicating their evergreen or deciduous nature. Applying this method to the Egerien forest of Andornaktálya the following characters are determined:

a = cinnamomoid = evergreen
b = lauroid = evergreen
e = myricoid = evergreen (including *Platanus neptuni*, *Palaeocarya oerbergensis*)
i = quercoid = deciduous and evergreen
m = carpinoid = deciduous

We suggest, that the zonal vegetation at Andornaktálya had mostly likely be formed by a laurophylous, evergreen, subtropical forest, mixed with a few deciduous, but thermophylous species.

PALAEOCLIMATE

The climate is unambiguously determined by the floral composition of this zonal vegetation. The specimens are from a forest vegetation far from the waterside, with a few exceptions. An uncertain *Myrica* specimen and *Spirematospermum wetzleri* indicate swamp vegetation only, but these are insignificant compared to the number of species and specimens of the mesophytic, subtropical forest.

There is a large amount of *Ulmus pyramidalis*; it is not a member of the mesophytic forest, but lived in the riparian vegetation. It is the single Arctotertiary element of some abundance in the flora. Its mass occurrence, as in other Egerian localities, is not due to climate deterioration (since palaeotropical species lived under optimal conditions), but these lived as members of the so-called intrazonal communities outside zonal communities.

The evaluation based on species composition has been completed by an interpretation based on leaf statistics, considering leaf size only. DOLPH and DILCHER (1980) studied interrelationships between leaf parameters and climate on recent material; they concluded that only leaf size shows any direct dependence on climate.

We calculated leaf size by the equation of CAIN and CASTRO (1959):

$$A = 2/3\ (L \times W)$$

where A = leaf size (surface area), L = leaf length, W = leaf width.

The following values were obtained for the Andornaktálya flora:

leptophyllous	<0.25 cm^2	1 specimen
microphyllous	2.25–20.25 cm^2	74 specimens
notophyllous	20.25–45.0 cm^2	7 specimens
mesophyllous	45.0–182.25 cm^2	1 specimen

The microphyllous leaf type is dominant, like in all other Egerian floras. Statistics supports our climatological interpretation based on determined species: the zonal climate was wet, rainy, and subtropical.

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EXPLANATION OF PLATES

Plate I.

1. *Daphnogene lanceolata*, 89.533.3. ×1.5
2. *Daphnogene cinnamomifolia*, 89.562.1. ×1
3. *Carpinus* sp., 89.539.1. ×1.5
4. *Magnolia* cf. *dianae*, 89.535.2. ×1

Plate II.

1. *Platanus neptuni*, 89.587.1. ×1
2. *Rhamnus warthae*, 89.557.2. ×1
3. *Ulmus pyramidalis*, 89.573.1. ×1.5
4. *Spirematospermum wetzleri*, 89.532.2. ×1

PLATE I.

1

2

3

4

PLATE II

1

2

3

4