

THERMOPHILOUS ELEMENTS FROM THE LATE MIOCENE FLORA OF PÉCS-DANITZPUSZTA (MECSEK MTS, HUNGARY) – CONFIRMED BY CUTICULAR ANALYSIS

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Abstract: The late Miocene (Pannonian) flora of Pécs-Danitzpuszta was first studied and published by HABLY & SEBE (2016). Recent collections, however, revealed additional foliage remains, some also providing epidermal details. A well-preserved leaf fragment assigned to *Laurophyllum* based on its micromorphology proves the presence of Lauraceae. A frequent element of European Miocene floras, *Laurophyllum pseudoprinceps*, is first described from the late Miocene (Pannonian) of Hungary. In addition, a leaflet of *Engelhardia orsbergensis* is also first reported as a thermophilous element in the Hungarian late Miocene.

Key words: cuticle, fossil flora, Lake Pannon, *Laurophyllum pseudoprinceps*, Pannonian

INTRODUCTION

The late Miocene flora of Pécs-Danitzpuszta yielding many thermophilous elements was studied by HABLY & SEBE (2016). Fossil taxa were identified based on macromorphological traits since preservation did not allow for cuticular studies. The reported taxa were as follows, cf. *Chara* sp., *Pinus* sp., Pinaceae gen. et sp., *Glyptostrobus europaeus* (Brongniart) Unger, *Tetraclinis salicornioides* (Unger) Kvaček, *Daphnogene pannonica* Kvaček et Knobloch, Lauraceae gen et sp. indet., *Quercus kubinyii* (Kováts ex Ettingshausen) Berger, *Myrica lignitum* (Unger) Saporta.

The importance of the flora is confirmed by the occurrence of leaf remains identified as *Daphnogene pannonica* Kvaček et Knobloch and Lauraceae gen. et sp., which have not been described from any other floras of the Hungarian Pannonian heretofore. A cupressaceous gymnosperm, *Tetraclinis salicornioides*, was also described as a new element in the Pannonian of Hungary. The frequent occurrence of lauraceous taxa and other thermophilous elements, e.g. *Myrica lignitum*, implies the warmest climate conditions among the Pannonian floras of

Hungary. The vegetation formed by taxa, such as *Quercus kubinyii*, *Tetraclinis salicornioides*, and laurel forests presumably occupied upland areas indicating a terrestrial Mecsek region emerging from the lake and the surrounding swamps 11–10 million years ago (HABLY & SEBE 2016).

MATERIAL AND METHODS

Specimens are deposited in the Hungarian Natural History Museum (HNHM-PBO). Epidermal details were studied using a Nikon Eclipse E600 microscope equipped for fluorescence microscopy. Epifluorescence was applied on the leaf material intact in the fossiliferous matrix and on cuticle fragments obtained from the specimen. Fragments were cleaned with hydrogen fluoride and covered with distilled water for study.

Geological settings

The sand pit of Pécs-Danitzpuszta, an outcrop of calcareous marls and overlying coarse sands of Lake Pannon, is located to the east of the city of Pécs (Fig. 1; the location of the sediments preserving the macroflora is 46.10139° N, 18.28667° E).

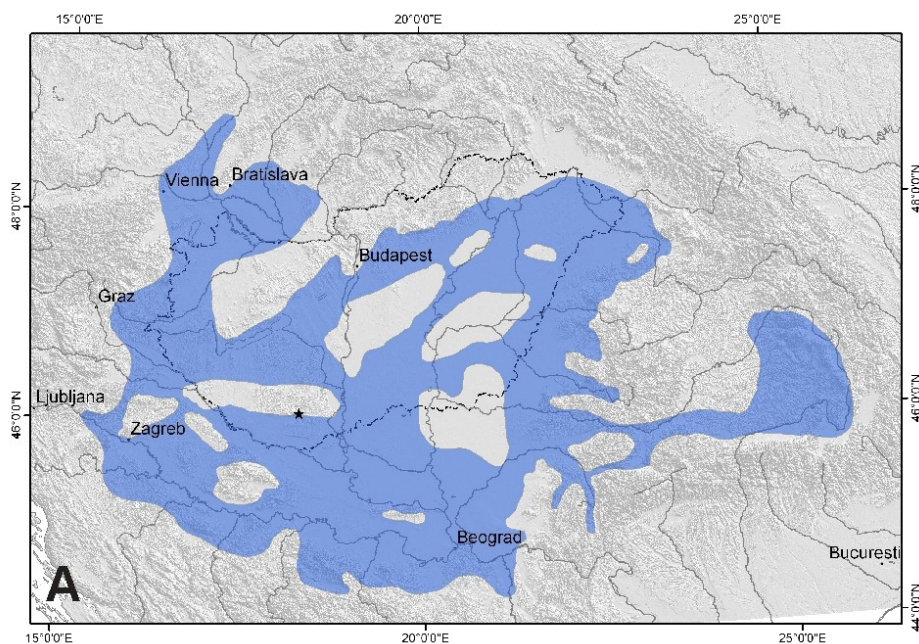


Fig. 1. Map showing the locality. Shading represents the extension of Lake Pannon (after Sebe in HABLY & SEBE 2016).

Intra- and post-Pannonian movements heavily tectonised the succession, thus the boundary between the two rock types is vertical, and younger sediments occur dominantly towards the south and not only upwards (KONRÁD & SEBE 2010). The calcareous marls include grey and brown clay, light-coloured sand and gravel interbeds and gradually get silty upwards, towards the overlying coarse sands.

Plant remains are preserved in the uppermost, silty levels of the marls, where an increase of terrigenous sediment influx is observable. Abundant mollusc shells identified by Imre Magyar include *Lymnocardium schedelianum* (Fuchs), *L. majeri* (M. Hörnes), *Paradacna abichi* (R. Hörnes), *P. cf. syrmienne* (R. Hörnes), “*Pontalmyra*” *otiophora* (Brusina), *Caladacna steindachneri* (Brusina), *Congerina czjzeki* M. Hörnes, *C. banatica* R. Hörnes, *C. partschi* Czjzek, *Gyraulus tenuistriatus* Gorj.-Kramb., and various species of *Orygoceras* and *Socenia*. Molluscs refer to the *Lymnocardium schedelianum* zone, suggesting an age of ~11–10 Ma and sublittoral conditions (SEBE *et al.* 2015).

A detailed description of the geological settings of the locality is given by HABLY & SEBE (2016). The relatively old age within the Pannonian emphasizes the significance of the locality. The other two plant fossil sites in SW Hungary, Aranyosgadány and Pécs-Nagyárpád, are younger, approximately 8–7 Ma old based on mollusc biostratigraphy (MAGYAR 2013).

RESULTS

Systematic descriptions

Laurophyllum pseudoprinceps Weyland et Kilpper (Lauraceae)

1963 *Laurophyllum pseudoprinceps* Weyland et Kilpper; Weyland et Kilpperp. 100, text.-fig. 6, pl. 23, fig. 14–19.

1976 *Laurophyllum pseudoprinceps* Weyland et Kilpper; Knobloch et Kvačekp. 51, pl. 11, fig. 6, pl. 12, fig. 9, pl. 24, fig. 1, 3–6, pl. 26, fig. 1–8.

1999–2000 *Laurophyllum pseudoprinceps* Weyland et Kilpper; Erdei et Lesiak, p. 14, fig. 12–15.

2006 *Laurophyllum pseudoprinceps* Weyland et Kilpper; Kovar-Eder et Hably, p. 163, pl. 1, fig. 9–12, pl. 3, fig. 9, pl. 4, fig. 5–8.

Material: HNHM-PBO 2018.368.2. (see Figs 2, 3)

Description: Leaf fragmentary, width of the leaf lamina 3.0 cm, length of lamina fragment 3 cm, original length unknown, apex and base not preserved. Margin entire. Venation camptodromous, brochiodromous, midvein strong, secondaries thin, join each other forming loops.

Adaxial cuticle not preserved, abaxial cuticle strongly cutinized, ordinary epidermal cells polygonal, anticlinal walls thickened, highly undulate. Characteristic



Fig. 2. Leaf fragment of *Laurophyllum pseudoprinceps* (HNHM-PBO 2018.368.2.) (scale bar 1 cm).

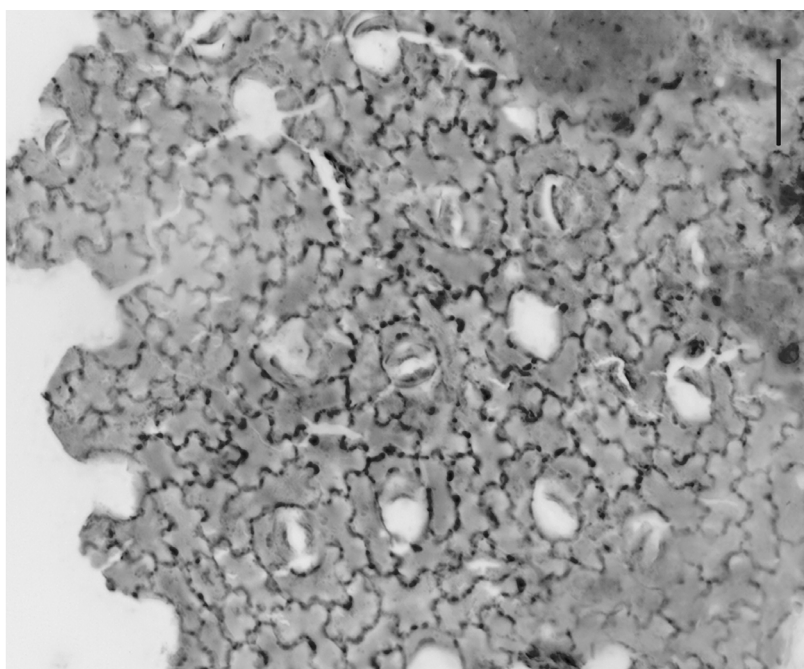


Fig. 3. Abaxial cuticle of *Laurophyllum pseudoprinceps* (HNHM-PBO 2018.368.2.) (scale bar 50 μ m).

bead-like thickenings observable. Stomata randomly arranged, paracytic (amphibrachyparacytic). Diameter of stomata 20–35 μm , outer stomatal ledges thickened.

Discussion: Trichome bases or oil cells usually observable on *L. pseudoprinceps* cuticles were not recognized in this case probably due to poor preservation. Modern affinity of the species is unclear (KVAČEK *et al.* 2011), however, based on stomatal structure a relation to the genus *Ocotea* was also assumed (BŮŽEK *et al.* 1996). Although the species was a common element of Miocene floras in Europe, members of Lauraceae were very rare elements in the late Miocene flora of Hungary. In addition to Pécs-Danitzpuszta, *L. pseudoprinceps* was described from the early late Miocene flora of Sopron-Piuszpuszta (dispersed cuticles; ERDEI & LESIAK 1999–2000) and *Daphnogene* belonging to Lauraceae have been found only at the Rudabánya locality (HABLY 2013). From the western margin of the Pannonian Basin, the flora of Mataschen comprises five species of Lauraceae described and confirmed by cuticle (KOVAR-EDER & HABLY 2006), including *L. pseudoprinceps*. The appearance of lauraceous elements confirms that a thermophilous flora existed during the late Miocene in higher elevated and marginal areas of the Pannonian Basin.

cf. *Engelhardia orsbergensis* (Wessel et Weber) Jähnichen, Mai et Walther
(Juglandaceae)

Material: HNHM-PBO 2018.367.1. (see Fig. 4)

Description: Apical fragment of a leaflet, lamina 2.6 cm wide. Apex acute, margin serrate, teeth small, tooth apex acute, acuminate. Apical side of teeth shorter than basal side. Venation not visible.

Discussion: This is the first record of the leaves of *Engelhardia orsbergensis* in the late Miocene of Hungary, but the fruit, *Engelhardia macroptera* (Brongniart) Unger had already been published from the late Miocene of Rózsaszentmárton in northern Hungary by PÁLFALVY (1952, 1981). *Engelhardia orsbergensis* appeared in the Hungarian Cenozoic during the Eocene (HABLY 1985a), and became dominant in the early Oligocene flora of the Tard Clay. In the late Oligocene it was a significant member of some floras, *i.e.* Kesztlöc (HABLY 1988), Pomáz (HABLY 1994), and became dominant in the extreme thermophilous, early Miocene flora of Ipolytarnóc (HABLY 1985b). Its latest, relict occurrence is known from the Pliocene flora of Gérce (HABLY & KVAČEK 1997). *Engelhardia orsbergensis* was a widespread element of warmer floras of Europe during the Oligocene and Miocene.

Flora, vegetation and palaeoclimate

The frequent occurrence of the members of Lauraceae in the flora of Pécs-Danitzpuszta is noteworthy. The species *Daphnogene pannonica* has not been recorded from any other localities in Hungary (HABLY & SEBE 2016). Moreover,

the genus *Daphnogene* was extremely rare in the Hungarian Pannonian floras, a single specimen assigned to the genus was documented from Rudabánya (HABLY 2013). The specimen described here as *Laurophyllum pseudoprinceps* is the first record of the species in the Pannonian of Hungary. The occurrence of lauraceous elements implies that laurel forests covered higher, elevated areas of the Mecsek Mts during the early Pannonian. Members of Lauraceae require mild climate with only shorter frost periods, freezing temperatures may persist no longer than 1–2 days. The youngest occurrence of plant remains in the Pannonian of the Mecsek Mts is recorded from Aranyosgadány (7–6 Ma; MAGYAR 2013), the oldest remains are from Pécs-Danitzpuszta (10–11 Ma). This implies that the area was elevated from the lake and its surrounding swamps, and served as a refuge of thermophilous taxa similarly to basin marginal areas (HABLY 2013).

Despite the low diversity of the assemblage the climate can be outlined as subtropical without considerable frost periods based on the occurrence of thermophilous elements. Quantitative climate analysis adopting the Coexistence Approach method (MOSBRUGGER & UTESCHER 1997) was applied to Neogene and Palaeogene fossil floras of the Pannonian domain (ERDEI *et al.* 2007). The authors estimated a mean annual temperature (MAT) of 16 °C, mean temperature of the coldest month (CMT) of 5 °C, mean temperature of the warmest



Fig. 4. Leaf fragment of cf. *Engelhardia orsbergensis* (HNHM-PBO 2018.367.1.) (scale bar 1 cm).

month (WMT) of 24 °C, and a mean annual precipitation (MAP) of 1000 mm for the time slice 11–10 Ma (ERDEI *et al.* 2007).

An extremely thermophilous flora was documented from the early Pannonian locality in Mataschen (Styria, Ausztria) (KOVAR-EDER & HABLY 2006). The flora comprises five species of Lauraceae, four species of Theaceae and two species were assigned to the family Hamamelidaceae. Although *Mastixia* was not represented in the flora, its composition recalls that of the “Younger Mastixioid” floras, which presumably required a climate with a MAT of 15–19 °C, a MAP of 1280–1950 mm, and a CMT above 0 °C, only short frost periods must have occurred.

Another “Younger Mastixioid” flora was documented from the early Pannonian flora of Hungary, from Rudabánya (10 Ma). The presence of this thermophilous flora type supported by the fossil record of *Mastixia* in Rudabánya (HABLY & ERDEI 2013) indicates that the climate was frostless and warm enough for the survival of the mastixioid flora in a refuge area.

CONCLUSIONS

New thermophilous elements were described from the early Pannonian (late Miocene) flora of Pécs-Danitzpuszta, in the Mecsek Mts. The significance of Lauraceae is further supported by the record of *Laurophyllum pseudoprinceps* confirmed also by cuticular studies. The occurrence of *Engelhardia orsbergensis* is proved by its leaflet remain. This species appeared during the warm periods of the early Cenozoic of Europe, and it is a relict species in the late Miocene of the Mecsek Mts. The area must have served as a refuge for many species as attested also by the occurrence of *Tetraclinis salicornioides*, which is the only record of the genus in the late Miocene of Hungary (HABLY & SEBE 2016). Further support of a Mecsek refuge area is provided by the record of *Quercus kubinyii*, which nearly disappeared from the Pannonian Basin during the Pannonian and its occurrence is evidenced by only a couple of records from marginal areas and the Mecsek Mts. These pieces of evidence support that the Mecsek Mts was an elevated area, an upland in the Pannonian Basin about 11–10 million years ago and hosted subtropical forests composed also of members of Lauraceae. The area served as a refuge for many species, some of which survived up to the Pliocene.

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Összefoglaló: Pécs–Danitzpusztáról, a Mecsek-hegység késő-miocénjéből, a pannóniai korszakból új termofil növényfajok kerültek elő. A flórában eddig is fontos szerepet betöltő Lauraceae

család további fajjal, a *Laurophyllum pseudoprinceps*-szel egészült ki, amelynek jelenlétét kutikula-vizsgálat is alátámasztja. Mellette az *Engelhardia orsbergensis* levélkemaradványa is előkerült, amely makromorfológiai módszerekkel azonosítható. Ez a faj is a terciér meleg periódusaiban jelent meg Európa-szerte, a mecseki késő miocénben már relikturnak tekinthetjük. A terület ebben a korszakban minden bizonnyal refúgium terület volt számos növényfaj számára. Ezt támasztja alá a *Tetraclinis salicornioides* előfordulása, amelynek ez az egyetlen késő miocén lelőhelye Magyarországon. Ugyancsak ezt erősíti a *Quercus kubinyii* itteni előfordulása is, amely a pannóniai korszakban csaknem teljesen kiszorult a Pannon-medencéből a peremterületekre és a tóból kiemelkedő magaslatokra, és a Mecsekben kívül csak kevés előfordulását ismerjük a pannonból. A Mecsek egy, a Pannon-tóból kiemelkedő terület lehetett 10–11 millió évvel ezelőtt, amelyen fenyőerdőkkel védett babérerdők éltek szubtrópusi körülmények között, és ahol több faj még egy ideig menedéket talált.

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