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# STRATIGRAPHIC POSITION OF LATE NEOGENE PALAEOBOTANICAL SITES IN HUNGARY: MIOCENE OR PLIOCENE?

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ABSTRACT. According to bio- and magnetostratigraphic considerations, some late Neogene palaeobotanical sites in Hungary, originally described as of Pliocene age, should be assigned to the Upper Miocene (Pannonian sensu Lörenthey, or Pannonian and Pontian sensu Stevanović). For the time being, the only significant palaeobotanical sites of certainly Pliocene age are the outcrops of the alginite formation at Pula and Gérce.

KEY WORDS: Pliocene, Pannonian, late Neogene, palaeobotany, stratigraphy, Hungary

## INTRODUCTION

Several late Neogene palaeobotanical sites became known in Hungary in the last decades (Fig. 1). The localities, described as Lower Pliocene, Upper Pliocene, or simply Pliocene, have often yielded characteristic "Pannonian" associations. The "Pannonian" is a regional stage in the Paratethys area, but this term is used in three different meanings, arousing the feeling of lostness in non-initiates. The understanding of Pannonian stratigraphy and geological events, however, has been greatly improved in the last decade due to introduction of new stratigraphic methods, such as radiometric dating, magnetostratigraphy, and seismic stratigraphy, and due to revision of earlier lithostratigraphic and biostratigraphic conceptions. Being aware of the new results, here we scan the palaeobotanical localities, and try to decide whether they are really of Pliocene age. In general, this question can hardly be answered by direct correlation, because of the isolated evolution of the Paratethys. This phenomenon has stimulated endless debates on Neogene stratigraphy in the Paratethys region. For instance, the Pontian volume of the series Chronostratigraphie und Neostratotypen, edited by Stevanović et al. (1990), has the subtitle $Pl_1$, while the Pannonian volume of the same series, edited by Papp et al. (1985), assigns the Pontian stage to the Miocene. In spite of the uncertainities and different interpretations, we think we have enough available data to determine the age of some late Neogene palaeobotanical localities.

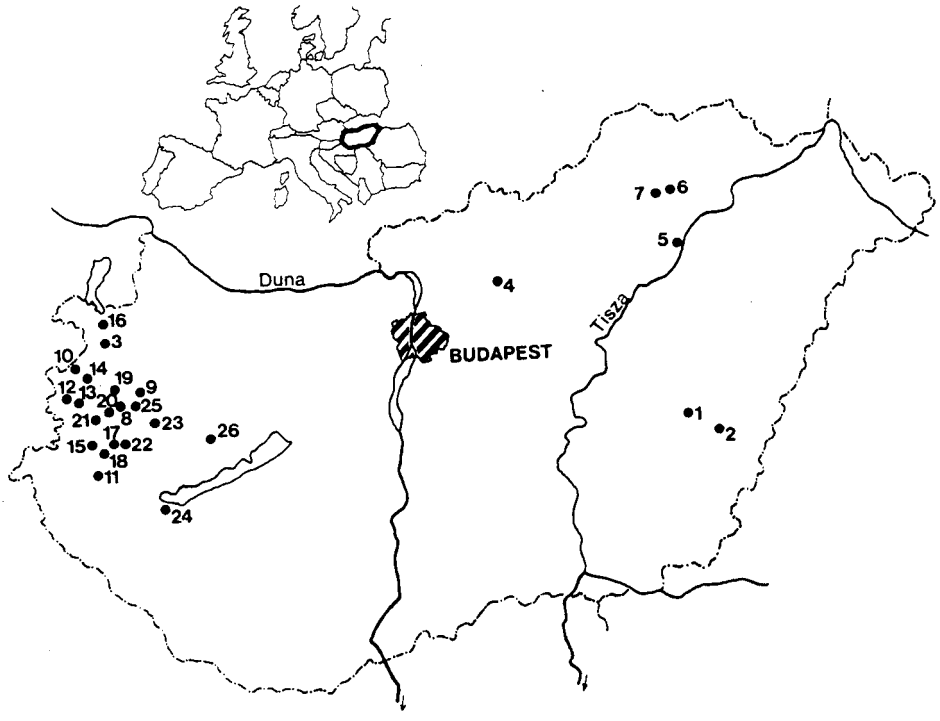


**Fig. 1.** The paleobotanical sites and other localities referred in the text. 1 – Dévaványa, 2 – Vésztô, 3 – Nagylózs, 4 – Rózsaszentmárton, 5 – Tiszapalkonya, 6 – Megyaszó, 7 – Alsódobsza, 8– Sótony, 9 – Kemenesmihályfa, 10 – Répcevics, 11 – Teskánd, 12 – Sé, 13 – Szombathely, 14 – Tömörd, 15 – Gersekarát, 16 – Hidegség, 17 – Olaszfa, 18 – Hegyhátszentpéter, 19 – Szeleste, 20 – Torony, 21 – Dozmat, 22 – Baltavár, 23 – Duka, 24 – Balatonszentgyörgy, 25 – Gérce, 26 – Pula

## INTERPRETATIONS OF THE PANNONIAN STAGE: A PERFECT BABEL

Reasons for introduction of the stratigraphic term "Pannonian" were given by Roth (1879) in a footnote of his work "Geologische Skizze des Kroisbach-Ruster Bergzuges und des südlichen Teiles des Leita-Gebirges" in which is written: "Es ergibt sich bei den geologischen Aufnahmen in Ungarn häufig der Fall, dass man gewisse Ablagerungen zwar sicher als jüngstes, über der sarmatischen Stufe folgendes Neogen feststellen kann, bei Ermanglung von weiteren positiven Daten aber sie nicht mit derselben Sicherheit einer der neuerer Zeit unterschiedenen Stufen Pontische (Congerien-), levantinische und thracische Stufe einzureihen im Stande ist. In solchen Fällen zeigt sich besonders das Bedürfniss, diese drei Stufen unter einem Sammelnamen zusammenzufassen. Da nun die Bezeichnung "Congerienschichten" hiefür aus verschiedenen Gründen wohl nicht zutreffend ist, so wählten wir die allgemeine, nicht präjudicirende Benennung "pannonische Schichten", welcher Sammelname sich aus dem Grunde empfehlen dürfte, da ja be-

kanntlich diese Ablagerungen im grossen pannonischen Becken eine starke Verbreitung besitzen und sehr schön entwickelt sind."

The term "Pannonian", as introduced by Roth, had not took root in the literature. Probably it would have been completely forgotten, but Lőrenthey (1900) brought it back to use — with a modified definition: "Für die Bezeichnung dieser Bildungen sind in der Literatur die Benennungen: "Inzersdorfer Schichten", "Congerienschichten", "Pontische Schichten", "Pontische Stufe" und "Pannonische Schichten" gebräuchlich. Da jedoch unter der Benennung "Inzersdorfer Schichten" nur solche Schichten zusammengefasst sind, welche dem unteren Theil unserer Pannonischen Stufe entsprechen, und "Pontische Stufe" sich wieder nur auf das oberste Niveau, auf den Horizont der *Congeria rhomboidea* bezieht, ist keine dieser Benennungen zur Bezeichnung aller, sondern nur einzelner Niveaus unserer Brackwasserpliozänbildungen geeignet. Die Benennung "Pontische Stufe" giebt auch noch insofern Grund zu Missverständnissen, als unter Pontischer Fauna gewöhnlich die heutige Fauna des Schwarzen Meeres verstanden wird. Auch "Congerienschichten" sind zur Bezeichnung der in Rede stehenden Bildungen nicht geeignet, da die Congerien auch schon in den Eozän- und Mediterranbildungen massenhaft vorkommen. Es bleibt also nichts übrig, als für die Bezeichnung unserer Brackwasserpliozänbildungen die alte Benennung "Pannonische Schichten" oder "Pannonische Stufe" und für die Süsswasserpliozänbildungen die Benennung "Levantinische Schichten" oder "Levantinische Stufe" anwenden."

Second redefinition of the term "Pannonian" followed in 1951, when Stevanović, on the proposal of Szádeczky-Kardoss (1938), introduced the term "Pannonian sensu stricto": "Pannonische Stufe in engerem Sinn; wird für die Unteren, auschliesslich im Pannonischen Becken vertretenen Congerienschichten vorgeschlagen", while "Pontische Stufe in engerem Sinn... wird für die Oberen Congerienschichten des Pannonischen Beckens und für die synchronen Bildungen des Dacisch-euxinischen Beckens ... vorgeschlagen".

Though the latter interpretation of the Pannonian was accepted by the International Union of Geological Sciences, Regional Committee on Mediterranean Neogene Stratigraphy, all the three versions are still in use in Hungary.

## THE MIOCENE/PLIOCENE BOUNDARY IN THE REGIONAL STAGE SYSTEM

According to the international convention, the Miocene/Pliocene boundary is 5.4 Ma. The Pannonian sensu Roth, by definition, includes the whole Pliocene.

According to the original interpretation by Lőrenthey, the Pannonian corresponds to the Lower Pliocene. Radiometric (Balázs & Nusszer 1987) and magnetostratigraphic (Elston et al. 1990) age determinations and seismic stratigraphic investigations, as well as the paleontological record (Kordos 1989), proved, however, that overwhelming part of the brackish water Pannonian lake sediments and the coeval freshwater, paludal, etc. formations still belong to the Miocene. It seems correct to regard the Pannonian lake as

upper Miocene in age. Consequently, the Pannonian sensu Lőrenthey and the Pannonian and Pontian sensu Stevanović also belong to the Miocene, that is, the Miocene/Pliocene boundary is more or less coeval with the upper boundary of the Pontian (Fig. 2).

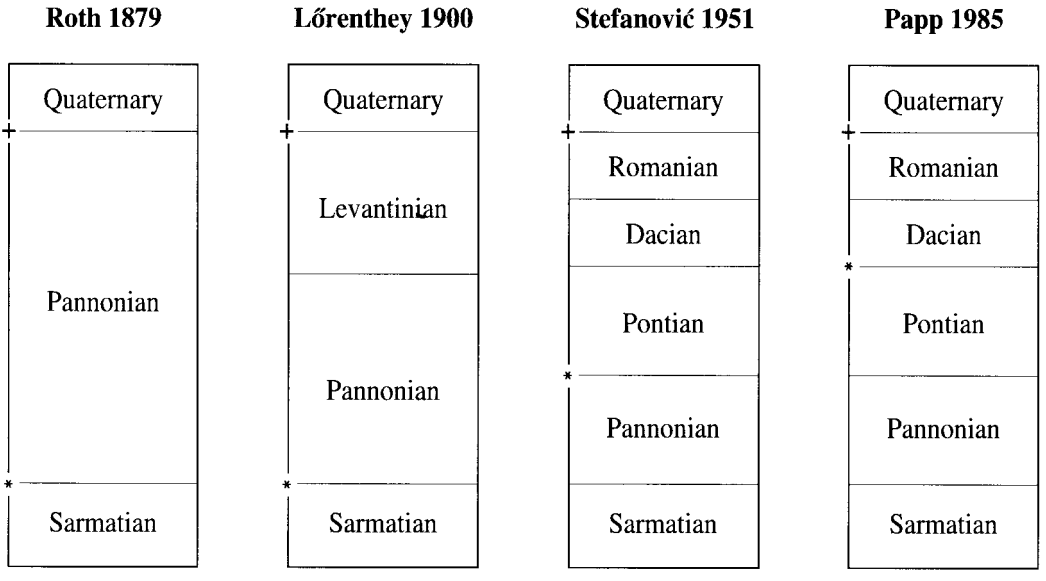


**Fig. 2.** The Late Miocene-Pliocene regional stages of the Central Paratethys and the Miocene/Pliocene boundary; +: Pliocene/Pleistocene boundary; *: Miocene/Pliocene boundary

## DISTRIBUTION OF THE PLIOCENE SEDIMENTS IN HUNGARY

If we consider the Pliocene sedimentary formations in Hungary, we should rely on positive paleontological or magnetostratigraphic evidences. Unfortunately, such evidences are rare. Molluscs of unambiguously Pliocene age are hardly known in the Alföld (Kecskemét; see Krolopp 1977). Presence of Upper Pliocene deposits (4.2–1.8 Ma) was proved in the Dévaványa and Vésztő boreholes by magnetostratigraphic method (Elston et al. 1990). This 700 m thick sequence, however, was non-fossiliferous. The Békés basin, where these two holes were drilled, is one of the youngest depressions of the Pannonian basin. Therefore, we can expect only thinner Pliocene sequences in other parts of Hungary. For instance, in northern and western Transdanubia the youngest brackish sediments have not developed; the basin was filled well before the end of the Miocene. According to Korpás-Hódi (pers. comm. 1993), the youngest Tertiary horizon inferred from magnetostratigraphic data was 7.4 Ma in the Nagylózs borehole. Where the uppermost brackish horizons have not developed, we can hardly expect Pliocene formations of considerable thickness.

To sum up, thick Pliocene sediments have not developed, or were eroded in Hungary, except for the youngest basins in the southeastern part of the Alföld.

## STRATIGRAPHIC POSITION OF "PLIOCENE" PALAEOBOTANICAL SITES

### RÓZSASZENTMÁRTON

First data on a "Pliocene" palaeobotanical site in Hungary was reported by Pálfalvy in 1952. From the waste stockpile of an opencast lignite mine at the southern slopes of the Mátra Mts., he listed about 20 taxa, including *"Cinnamomum", Zelkova,* and *Engelhardtia*. Beside these thermophyllous genera, a number of Arctotertiary elements, such as *Alnus, Populus, Ulmus, Fagus,* and *Salix* were also abundant. The association, including also *Glyptostrobus*, other gymnosperms, and *Nelumbium*, indicates partly a paludal, partly a riparian vegetation. Fossils of *Potamogeton* and *Trapa*, described from a nearby site, suggest aquatic environment.

The molluscs, found together with the plant fossils, provide basis for age determination. The mollusc fauna includes brackish genera, such as *Congeria* and *Lymnocardium*, freshwater forms (*Viviparus sadleri, Hyriopsis* sp.), and terrestrial ones (*Helicidae* sp.). They indicate that the lignite-bearing sequence was deposited in the littoral environment of the Pannonian lake, therefore its age must be Upper Miocene. Indeed, magnetostratigraphic analysis of the Tiszapalkonya borehole fixed the age of the Bükkalja Lignite Formation between 9 and 5.5 Ma (Elston et al. 1990).

### MEGYASZÓ

Silicified trunks were described by Horváth (1954) from Megyaszó. He determined *Liquidambar, Betula, Malus, Ulmaceae, Zelkova,* and *Populus* by xylotomic method, and found a *Carpinus* leaf impression.

The author thought that the fossils had been removed and redeposited at least two times, therefore he was very careful with the age determination. After all, he suggested Lower Pannonian (sensu Lőrenthey) age, and Andreánszky (1955) agreed with this proposal. This age is justified by stratigraphic and paleogeographical considerations. The Hernád valley and the whole region became a land surface by the beginning of the Late Pannonian (sensu Lőrenthey). By that time the Pannonian lake drew back from the area, leaving behind only Lower Pannonian (sensu Lőrenthey) lacustrine sediments (see the Alsódobsza outcrop, Bartha 1971). Presence of Pliocene sediments can hardly be expected in the area; therefore, the age of the fossils is very probably Upper Miocene.

### WESTERN HUNGARY (VAS COUNTY)

Horváth (1961, 1963, 1964, 1971–72) mentioned a number of "Upper Pliocene" or "Pliocene" localities from western Hungary: Sótony, Kemenesmihályfa, Répcevis, Teskánd, Sé, Szombathely, Tömörd, Gersekarát, Hidegség, Olaszfa, Hegyhátszentpéter,

Szeleste. Most of these sites yielded only sporadic material. Horváth's collection contains material from Torony and Dozmat as well.

In general, the described sites indicate mass occurrence of the genus *Salix*. Beside willow, some outcrops yielded only monocots, such as *Phragmites* and *Typha*. Reports on occurrences of *Acer, Alnus, Populus, Betula, Carpinus, Quercus, Platanus,* and *Liquidambar* are based only on a few and scattered specimens. Thus, no reconstruction of the overall vegetation can be made. Predominance of the Arctotertiary elements, however, is conspicuous, and abundance of *Salix* indicates that riparian and swamp associations played a prevailing role at that time.

These localities were regarded as Upper Pliocene ("Levantinian") by Horváth (1961, 1963, 1964, 1971–72), except the Torony material which he assigned to the Lower Pliocene (Pannonian sensu Lőrenthey), since it contained an association characteristic of the Pannonian lignite formations.

Unfortunately, none of these outcrops yielded other fossils indicative of age. We need to consider indirect stratigraphic data.

As to the surface exposures, presence of Pliocene formations has never been proved in the area, except the few alginite occurrences. The age of the famous Baltavár mammal fauna is Messinian (Upper Miocene), and the fossil-bearing beds are overlain by Holocene sediments here.

The subsurface materials display a similar pattern. Paleomagnetic measurements were performed on core samples of two drillings in the area: Szombathely-II and Duka-II (Lantos et al. 1992). The total thickness of the sediments younger than 6 Ma proved to be less than 24 m. Pre-Quaternary formations in the Duka-II borehole, located in the axis of the Kisalföld basin, are all older than 8 Ma. In the Szombathely-II borehole, a very thin sequence was assumed to be of Pliocene age. The top of the Pannonian sensu Lőrenthey, however, is also older than 8 Ma there.

We conclude that Pliocene sediments had not developed, or rather, were eroded in the area. Therefore, the age of the fossil plant bearing fluvial sediments, similarly to that of the Torony lignite, is probably Upper Miocene. The significant difference between the two groups of fossils is due to the edaphic influence on the floras, suggesting riparian and swamp paleoenvironments, respectively, and does not necessarily involve age difference.

## BALATONSZENTGYÖRGY

The plant remnants, found in the brickyard SSW of Balatonszentgyörgy, were described by Pálfalvy (1977). (The pollen material was determined by E. Nagy). The megaflora consists of nearly 30 species. *Glyptostrobus* makes up more than 50% of the material. Ratio of *Phragmites, Salix, Myrica, Typha,* and *Juglans acuminata* ranges from 1 to 10 percent, while other species are very rare. The fossils indicate a predominating paludal association, completed with some representatives of a riparian vegetation. The assemblage is dominated by one single species; low diversity is common in the Pannonian sensu Lőrenthey intrazonal associations.

The age of the Balatonszentgyörgy brickyard can be relatively accurately determined on the basis of molluscs. The layers overlying the plant-bearing beds contain *Lymnocardium decorum* and other characteristic forms of the *Congeria balatonica – Lymnocardium decorum* zone (Bartha & Soós 1955, Pálfalvy 1977). According to mammal stratigraphic, radiometric, and paleomagnetic evidence, this zone is older than 7.5 and younger than 8.5 Ma, that is, Upper Miocene (Müller & Magyar 1992).

### GÉRCE AND PULA

The leaf imprints, found in the alginite pit between the villages of Sitke and Gérce by E. Horváth, were ascribed to the Pliocene (Fischer & Hably 1991, Kvaček et al. 1994). Species composition of the locality differs from that of the Pannonian (s. Lőrenthey) lignite formation, as well as those of the riparian and swamp vegetations discussed above. This difference is due to the fact that the Gérce locality yields not edaphic, but zonal association, depending on zonal climatic conditions. This flora is much more diverse than the above ones. *Quercus kubinyii, Ulmus ruszovensis, Zelkova zelkovaefolia* are very common, but several other species of *Quercus, Buxus pliocenica, Platanus leucophylla, Acer subcampestre, Parrotia pristina, Populus* cf. *tremula,* cf. *Juglans acuminata* (Fischer & Hably 1991), and *Tsuga, Torreya, Ginkgo, Pinus, Carpinus* div. sp., *Celtis* sp., *Crataegus* sp., *Engelhardtia orsbergensis, Populus populina, Pterocarya paradisiaca, Rosa* sp., *Salix* sp., *Sassafras ferretianum, Ampelopsis* sp. (Kvaček et al. 1994) were also found.

The leaf imprints, found under similar conditions in Pula, have not been published yet.

The Pliocene age of the Gérce and Pula alginites has been determined by independent methods. K/Ar age of the basalt, underlying the alginite formation, is 4.55 Ma and 4.25 Ma in the Hercseg-hegy locality between the villages of Sitke and Gérce, and in Pula, respectively (Balogh et al. 1986). Mammal fossils also prove Pliocene age of the alginite formation.

## CONCLUSIONS

According to stratigraphic considerations, several palaeobotanical sites in Hungary, originally described as of Pliocene age, should be assigned to the Upper Miocene (Pannonian sensu Lőrenthey (1900), or Pannonian and Pontian sensu Stevanović (1951)). They yielded relatively poor edaphic (riparian and swamp) associations. In contrast, the Gérce and Pula alginite, being the only unambiguously Pliocene formation in the study, provided a diverse zonal association.

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