

The flora of Tihany - Fehérpart (faciostratotype of the Intra-Carpathian Pontian), West Hungary

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The paper describes the flora of Tihany - Fehérpart (faciostratotype of the Intra - Carpathian Pontian), West Hungary, based on leaf-impressions. The leaves belong to angiospermous families, viz., Hamamelidaceae, Platanaceae, Betulaceae, Ulmaceae, Juglandaceae, Salicaceae, Smilacaceae and Cyperaceae. The flora indicates prevalence of warm temperate climate during its deposition.

Key-words—Leaf impressions, angiosperms, Tihany-Fehérpart flora, Pontian, West Hungary.

INTRODUCTION

FEHÉRPART is situated near the shore of the Lake Balaton, 1600m SSE of the harbour of Tihany. There is a 30 m high, vertical section consisting of silty and sandy layers which belong to the Pontian Stage (Upper Pannonian), probably to the Portaferian substage. It more or less corresponds to the "Congeria balatonica Beds" (Lörenthey, 1905, 1906).

The Fehérpart sequence consists of sediments of various granulometry and structure, mainly fine sands and silts. Leaf- remains have been found in two layers. One of them is very fine- grained sand which consists of very badly preserved leaves. Most of the leaves described here are from layer 6, which is well laminated.

SYSTEMATIC DESCRIPTION

Family - Hamamelidaceae

Liquidambar europaea A. Braun 1836
Pl.1, fig. 1

- 1836 *Liquidambar europaeum* A. Br. p.513.
1955 *Liquidambar europaea* A. Br. Berger, p. 97. Abb. 104-105.
1959 *Liquidambar europaea* A. Br. Andreánszky, p.69, Abb. 26,27.
1969 *Liquidambar europaea* A. Br. Knobloch, p.94, pl.44, figs. 3, 4-7. pl. 45, figs 1, 6, pl.46, figs 1, 4, pl.59, fig. 2.
1972 *Liquidambar europaea* A. Br. Zastawniak, p.42, pl.10, figs 10, 11, pl. 26, figs 3, 3a.
1980 *Liquidambar europaea* A. Br. Zastawniak, 64, pl.8, figs 14-16.

1983 *Liquidambar pseudoprotensa* Andreánszky. Unger 4. pl.28, fig. 2.

1986 *Liquidambar europaea* A. Br. Knobloch, p.18, pl.5, figs 4, 5.

1988 *Liquidambar europaea* A. Br. Kovar-Eder: 30. pl.2, figs 1-5.

Material—85.117.2, 85.118.1, 85.125.1, 85.126.1, 85.135.1, 85.139.1, 85.142.1, 85.149.1, 85.150.1, 85.156.1, 86.158.2, 85.161.1, 85.162.1, 85.166.1, 85.185.1, 85.187.1, 85.192.3, 85.204.2, 85.210.2.

Description—Leaves fragmentary, deeply lobed, 3-5 lobes, most of the fragments consist of either middle lobe or side lobes; margin toothed, teeth very characteristic, rounded, sinuses; venation actinodromous, 3 to 5 primary veins running into each lobe; secondary veins numerous, angle of divergence acute, veins turning up towards margin, probably forming loop with those of adjacent ones; tertiary veins random reticulate.

Remarks—This species is very common in the European Neogene. It is a riparian element. In Hungary, it is dominant in some Sarmatian floras (Büzk, 1971; Andreánszky, 1959).

Family - Platanaceae

Platanus leucophylla (Unger) Knobloch
Pl.1, figs 2,3

1850a *Populus leucophylla* Ung. Unger, p.417.

1952a *Platanus aceroides* Göpp. Berger, p.101. Abb. 86, 87, 88.

- 1955 *Platanus aceroides* Göpp. Berger. p.98. Abb. 107-117.
 1971 *Platanus leucophylla* Knobloch. p.18. pl.12. fig. 15.
 1972 *Platanus platanifolia* (Ett.) Knobl. Zastawniak. p.44. pl.12. figs 4. 5. pl.27. figs 1, 1a.
 1980 *Platanus leucophylla* (Ung.) Knobl. Zastawniak. p.66. pl.3. fig.7. figs 9/1-4. fig. 10/1.
 1988 *Platanus leucophylla* (Ung.) Knobloch. Kovar-Eder. p.31. pl.3. figs 1-6.
 1988 *Platanus leucophylla* (Ung.) Knobloch. p.4. pl.3. fig.1: pl.4. fig.8.

Material—85.122.2, 85.144.1, 85.186.4, 85.192.2, 85.206.2.

Description—Leaves simple, symmetrical, about 8 cm in length and 7-9 cm in width, lamina palmately lobed, 3-lobed; base acute, cuneate or decurrent; margin simple, toothed; tooth acute, sinuses rounded, venation palinac-tinordromous; angle between midvein and primary veins about 20-25°, curving upward after reaching 0.5-0.8 cm above the base.

Remarks—*Platanus leucophylla* is a common element of the late Neogene flora of Europe. It is a typical element of the riparian forests and occurs very often with *Liquidambar*, *Alnus*, *Ulmus* and other riparian Arctotertiary elements. In Hungary, it occurs from Pannonian to Pliocene.

Family - Betulaceae

Alnus ducalis Gaudin emend. Knobloch
 Pl. 1, figs 4,5

- 1968 *Alnus ducalis* (Gaudin) Knobloch. p.127. pl.1. figs 2-4. pl.2. fig.1, pl.4. fig.6.
 1969 *Alnus ducalis* (Gaudin) Knobloch. p.69. pl.28. figs 1-3, 6; pl.29. figs 1-5. pl.31. figs 1, 2. pl.32. fig.5. pl.33. figs 4-5. pl.34. figs 1-2. pl.35. fig.5. pl.53. fig.9. pl.75. fig.4.
 1986 *Alnus ducalis* (Gaudin) Knobloch. Knobloch Velitzelos. p.13. pl.9. figs. 4,7.
 1986 *Alnus ducalis* (Gaudin) Knobloch. Velitzelos & Knobloch. p.26.
 1988 *Alnus ducalis* (Gaudin) Knobloch. Kovar-Eder. p.40. pl.5. figs 2-5.
 1988 *Alnus ducalis* (Gaudin) Knobloch. 13.

Material—85.126.1, 85.132.1, 85.138.1, 85.146.1, 85.147.1, 85.151.1, 85.152.1, 85.153.1, 85.155.1, 85.156.1, 85.160.1, 85.167.1, 85.168.1, 85.190.1, 85.191.1, 85.205.5, 85.214.1.

Description—Leaves simple symmetrical, obovate; base missing; upper half of lamina deeply divided into two; margin toothed, teeth simple, small; venation craspedodromous; midvein terminating at the dividing point; secondary veins curving up towards margin; tertiary veins random reticulate.

Remarks—The earliest record of *Alnus*. *A. ducalis* is from Hungarian Sarmatian. Andreánszky (1959) described *A. hoernesii* from the locality Sály (NW Hungary) based only on one specimen. All the other occurrences of this species are from Pannonian of Pontian age (Kovar. 1988).

Alnus gaudinii (Heer) Knobloch et Kvacek,
 Pl 1, figs 6-9

- 1976 *Alnus gaudinii* (Heer) Knobloch & Kvacek. p.33. pl. 6. figs 1-3; pl.6. figs 1.5. pl.13. fig.4. pl.15. figs 1-4, 7, 8, 10, 11, 13, 15, 17.
 1983 *Alnus gaudinii* Knobloch et Kvacek. Givulescu. p.84. text-figs. 1,2,4.
 1987 *Alnus gaudinii* (Heer) Knobloch & Kvacek. Palamarev-Petkova p.74. pl.21. fig.2.

Material—85.107.1, 85.114.2, 85.115.1, 85.124.1, 85.132.1, 85.141.2, 85.158.2, 85.165.2, 85.173.2, 85.174.1, 85.179.1, 85.184.1, 85.186.4, 85.188.1, 85.197.3, 85.201.1, 85.205.5, 85.206.2, 85.203.2, 85.211.1, 85.212.2, 85.217.2.

Description—Leaves simple, symmetrical lanceolate or narrow ovate 9.7 - 5.2 cm in length and 2.3-4.0 cm in width, apex acute; base acute to cuneate, missing in some specimens; margin toothed, teeth simple, very small; venation semicraspedodromous; secondary veins about 10, angle of divergence acute, turning up and joining each other forming loops, very thin short veins running towards the margin and terminating into teeth; tertiary veins numerous quaternary venation forming polygonal dense network.

Remarks—*Alnus gaudinii* was described from Miocene, mostly from Upper Miocene floras (Heer. 1856; Knobloch et Kvacek, 1976). In the flora of Tihany, it is one of the dominant elements. Its preservation is not excellent because of the sandstone, but the dense network between the secondary veins as well as the teeth are very characteristic. *A. gaudinii* is a member of the riparian forest.

Plate 1

1. *Liquidambar europaea*, 85.204.2.
 2,3. *Platanus leucophylla*, 85.193.3, 85.192.3.
 4,5. *Alnus ducalis*, 85.168.2, 85.192.3.

- 6,7,8,9. *A. gaudinii*, 85.114.2, 85.186.4., 85.186.1, 85.169.1.
 10. *Ulmus ruszovensii*, 85.189.2.
 11. *Populus* sp., 85.112.2.

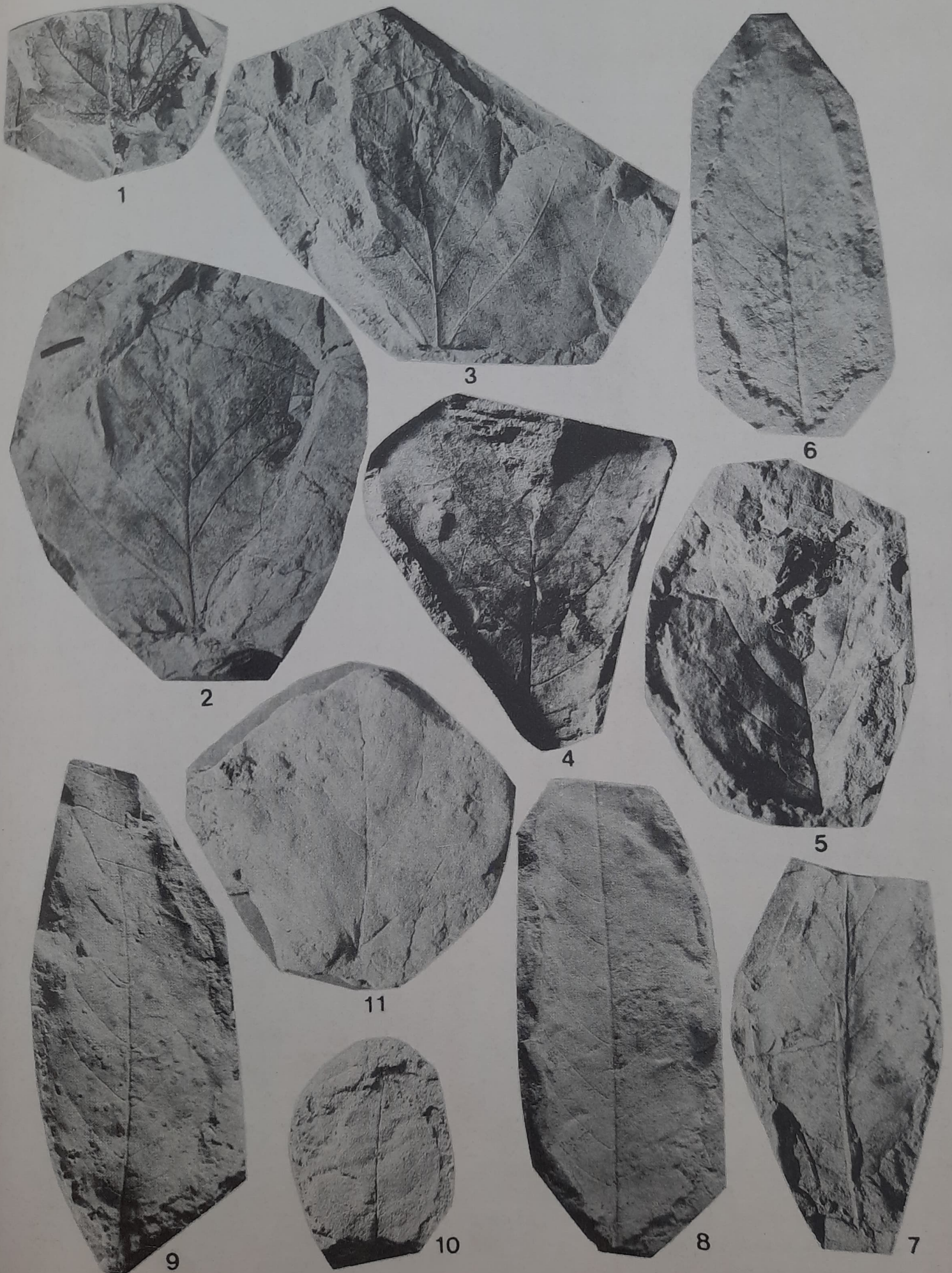


Plate 1

Family - Ulmaceae*Ulmus ruszovensis* Hummel
pl.1, fig.10

- 1847 *Ulmus plurinervia* Ung. Unger. 95. pl.25 figs 1-4.
 1983 *Ulmus ruszovensis* Hummel. Hummel. p.58. pl.36. figs 1-5a.
 pl.37. figs 1-6a. pl.38. figs 1-4a. fig.24: 1-14. fig. 25.
 1856 *Ulmus plurinervia* Ung. Kováts. p.26. pl.4. figs 8-12.
 1988 *Ulmus ruszovensis* Hummel. Knobloch. p.5. pl.7. fig.5.
 1991 *Ulmus ruszovensis* Hummel. Fischer & Hably. p. 29. pl.1. figs
 2-7. pl.2. figs 4, 12-15.

Material– 85.189.1., 85.122.2.

Description–Leaf simple, symmetrical, wide ovate. 3.2 cm in length, 2.2 cm in width; base missing; apex acute; margin toothed, teeth simple, small; venation craspedodromous; midvein strong; secondary veins often bifurcating at the margin and running into teeth. angle of divergence about 40-50°.

Remarks–Small leaves of *Ulmus* described as *U. plurinervia* occur in many Upper Miocene and Pliocene floras (Kováts, 1856; Kovar-Eder, 1988). In Hungary, the genus is well known from the Sarmatian floras as well as from the Pliocene flora of Gérce (Fischer & Hably, 1991) where it is dominant. In the Pontian flora of Tihany it must have also been a member of the riparian forest.

Family - Juglandaceae*Juglans acuminata* A. Br.
Pl.2, figs 1,2

- 1845 *Juglans (Carya) acuminata*. A. Br. Braun. p.170. nomen nudum.
 1850a *Juglans acuminata* A. Br. Unger. S. 468.
 1955 *Juglans acuminata* A. Br. Berger. p.93. Abb. 75. 76.
 1959 *Juglans acuminata* A. Br. Heer. p.88. pl.128. pl.129. figs. 1-8.
 1959 *Juglans acuminata* A. Br. Andreánszky. p.118. pl.34. fig. 3.
 1959 *Cedrela sarmatica* Kovacs. Andreánszky. p.155. pl.45. fig.1. pl.46. figs 1,2,6.
 1971 *Juglans acuminata* A. Br. ex Unger. Büzek. p.42. pl.9. figs 9-15 pl.10. figs 1-6. pl.11: figs 1-3.
 1988 *Juglans acuminata* A. Br. Kovar-Eder. p.44. pl.9. figs 1-8.

Material–85.114.2, 85.127.1, 85.128.1, 85.148.1, 85.158.2, 85.159.1, 85.186.4, 85.188.1, 85.197.3, 85.198.1, 85.205.5, 85.209.2, 85.211.1, 85.212.2, 85.215.2, 85.216.1.

Description–Leaflets simple, symmetrical, lanceolate. 10-14 cm long, 3.5-4.0 cm wide; apex acute or attenuate; base cordate; margin entire; venation camptodromous; midvein strong; secondaries arising from midvein at a distance of 1.0-1.2 cm from each other in the middle of lamina, closely placed at the basal and apical parts; intersecondaries present.

Remarks–The leaflets are also similar to *Cedrela sarmatica* É. Kov., described from the Hungarian Sarmatian. It is a common element in the Hungarian Sarmatian and in the Pontian of Tihany also. It occurs in many Upper Miocene localities in Paratethyan area. It is a riparian element found in association of *Platanus leucophylla*, *Liquidambar europaea*, etc.

Family - Salicaceae*Populus* sp.
Pl. 1, fig. 11

Material – 85.112.2.

Description–Leaf simple, symmetrical, wide ovate, 5.9 cm long and 5.8 cm in width; base, apex and the margin not well preserved; venation camptodromous; midvein prominent; first pair of secondary veins arising from the base, other secondary veins arising from the same point are thin, separated by a distance of 2.4, 1.1, 1.0 cm from each other on the left side and 1.8, 1.5, and 1.0 cm on the right side; tertiary veins arising from first pair of secondary veins strong, curving up towards margin.

Remarks– In its shape, size and venation pattern the present fossil leaf is different from *P. populina*. Since the leaf is badly preserved it is not possible to identify it upto specific level.

The genus *Populus* is often found in the Upper Miocene Floras. In Hungary *Populus populina* have been collected from the Badenian (Nógrádszálka). *P. tremula* is another species described from the Pliocene of Gérce (Fischer & Hably, 1991). *Populus* is a typical riparian element and occurs in the deep river side area.

Populus cf. *P. populina* (Brongniart) Knobloch

- 1822 *Phyllites populina* Brongniart. p. 237. pl.14. fig.4.
 1959 *Tilia sarmatica* Andreánszky. Andreánszky. pl.44. fig.1.
 1959 *Populus latior* A. Br. Andreánszky. p.125. pl.35. figs 3,5.

Plate 2

1,2. *Juglans acuminata*, 85.205.2, 85.158.2.
 3,4. *Populus mutabilis*, 85.158.2, 85.158.1.

5,6. *Smilax weberi*, 85.205.5, 85.209.2.
 7. *Phragmites*, 85.152.1.

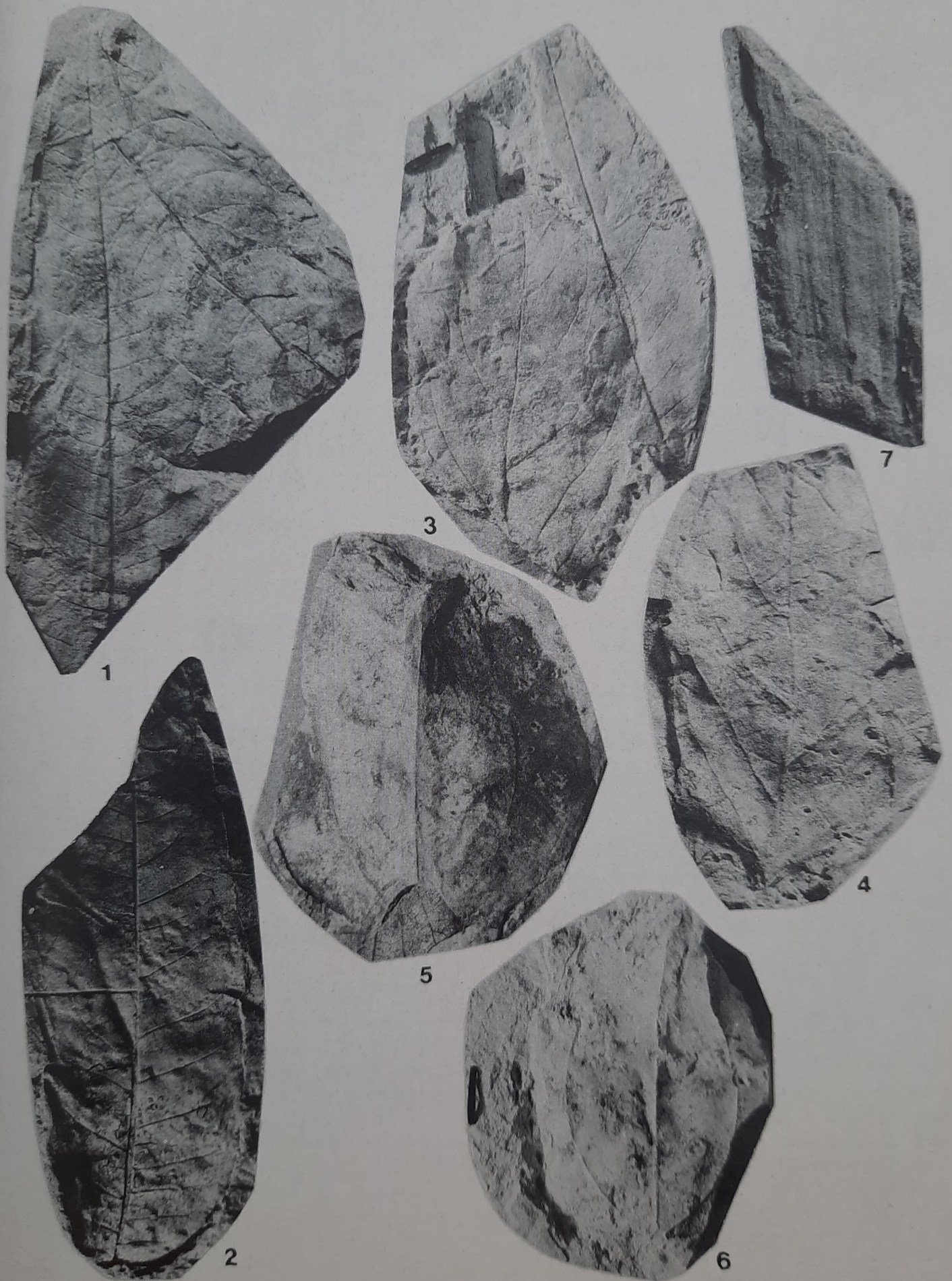


Plate 2

1988 *Populus populina* (Brongniart) Knobloch. Kovar-Eder. p.53. pl.10, figs 13-15.

1988 *Populus populina* (Brongniart) Knobloch. p.16. pl.9, figs 2.6, pl.13, fig.6, pl.3a. 8.

Material– 85.204.2.

Description– Leaf orbiculate. 4.0 cm long. 3.6 cm in width; base missing. apex rounded. margin not preserved; venation pattern not well preserved; midvein and two pairs of secondaries can be noticed: secondary veins curving upward, irregular.

Remarks– This specimen strongly differs from *Populus* sp. described above and *Populus mutabilis* in its shape and venation pattern. It is similar to *P. populina* but the margin and the details of venation are not discernible. Like other *Populus* species it is also a member of riparian forest occurring in the river side area.

Populus mutabilis Heer

Pl.2, figs 3,4

1856 *Populus mutabilis* Heer, p.19. pl.61, figs 1,13.

Material– 85.158.2.

Description– Leaves simple, symmetrical, elliptical, lamina 7.8 cm in length and 4.2 cm in width; apex acute; base decurrent; margin entire; petiole present, short, about 0.2 mm in length; venation camptodromous; midvein strong; secondary veins 5 pairs, distance between two secondaries 1.0, 1.5, 1.6, 1.5 cm at the base; angle of divergence 50°; a pair of thin vein is given off just before the first pair of secondary veins, joining secondary veins to form loops.

Remarks– Only one specimen was found in the Tihany locality with counterpart. It shows close similarity with *P. mutabilis* Heer (1856, p.61, figs 1, 13). Like other *Populus* it was growing in the riparian forest.

Family - Smilacaceae

Smilax weberi Wess. & Web.

Pl.2, figs 5,6

1857 *Smilacites grandifolius* Unger. Unger. p.129. pl.40, fig.3.

1855 *Smilax grandifolia* (Ung.) Heer. Heer. p.82. pl.30, fig.8.

1856 *Smilax weberi* Wessel. Wessel & Weber. p.127. pl.21, fig.1.

1971 *Smilax weberi* Wessel. Büzek, p.89. pl.44, figs 1-5. pl.45, figs 1-4, text-fig.14.

1975 *Smilax weberi* Wessel. Christensen, p.21. pl.5, figs 1-8; pl.6, figs 2,4,5,6; text-figs 6A-F; text-figs 7,8.

1976 *Smilax weberi* Wessel. Knobloch & Kvacek, p.85. pl.39, figs 1,3,6,7; pl.40, figs 1-3, 50,51.

1985 *Smilax weberi* Wessel. Hably, p.118. pl.35, figs 1-2; pl.36, fig.2.

1988 *Smilax weberi* Wessel. Hably, p.45, pl.10, fig.98.

Material– 85.205.2., 85.209.2.

Description– Leaves wide ovate, 6.8-8.4 cm in length, 4-6-6.8 cm in width; apex acute; base peltate; margin entire; venation campylodromous; five primary veins originating at single point and running towards apex; further details of venation not visible.

Remarks– *Smilax* is not very common in Pannonian or Pontain floras. Givulescu (1988) mentioned its occurrence in Chiuzbaia (Romania) of the Pontian age. There are some records of the leaves of this genus from the Sarmatian also (Andreánszky, 1959; Knobloch, 1986). It seems that Pontian Tihany was its northern limit. *Smilax* is an important genus of some Upper Oligocene floras of Hungary (Hably, 1990) as well as of Romania (Zsil Walley, Staub M. 1887). It indicates humid warm climate. In the Ponturian flora of Tihany *Smilax* lived in a thermophyllous riparian habitat.

Family - Cyperaceae

Phragmites oeningensis A. Braun

Pl. 2, fig. 7

1855 *Phragmites oeningensis* A. Braum. Heer. p.64. pl.22, fig.5, p.24. pl.27, fig. 2b, pl.29, fig.3e.

1856 *Bambusium trachyticum* Kov. Kováts, p.16. pl.1, fig.10.

1969 *Bambusium trachytium* Knobloch, p.145. pl.75, figs 1.8, pl.76 figs 3,7,8.

Material– 85.152.1.

Description– Leaf fragmentary. 3.5 long. 1.2 cm in width; venation parallelodromous; other details not seen.

Remarks– Such leaf fragments are very common in the European Tertiary from Eocene to Pliocene. Its occurrence indicates swampy or riparian vegetation.

FLORISTICS AND PALEOEOCOLOGICAL EVALUATION

The Pontusian flora of Tihany exclusively consists of Angiosperms. The most dominant family is Betulaceae which includes two species of *Alnus* with high frequency (*Alnus gaudinii* 22, *Alnus ducalis* 17) followed by Hamamelidaceae (*Liquidambar europaea* 19) and Juglandaceae (*Juglans acuminata* 16). The diversity is highest among Salicaceae which represents three species of *Populus* and one species of *Salix*. The important elements of the flora are *Platanus leucophylla* (5), *Ulmus ruzovensis*, (2) *Nyssa* sp. (2), *Smilax weberi* (2) and *Phragmites oeningensis* (1). They belong to the riparian vegetation or to the gallery forest. *Phragmites*, *Salix*, *Alnus* and *Populus* were living just at the river side and other taxa such as *Liquidambar*, *Platanus*, *Ulmus*,

Juglans were growing a little farther and form the gallery forest. Thus at the river side area the riparian forest consisted of *Alnus gaudinii* and *Alnus ducalis* as dominant elements and *Salix varians*, *Populus* sp., *Nyssa* sp. as associated elements. *Liquidambar europaea*, *Plantanus leucophylla*, *Juglans acuminata*, *Ulmus ruzovensis* were growing in gallery forests near water courses. *Smilax* probably occurred in both forests as liana. All these species are Arctotertiary elements.

CLIMATOLOGICAL CONCLUSION

Plant species need special environments. Some of them depend on the climate, the others like *Phragmites* depend on the edaphic conditions. From climatological point of view these last ones are of no use because they do not give any information about the climate either. The species, like *Liquidambar europaea*, *Juglans acuminata*, *Nyssa* sp., *Alnus ducalis*, *A. gaudinii*, *Smilax weberi* are indicative of warm temperature climate. All these taxa collectively suggest prevalence of warm temperate climate during the deposition of the sediments.

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