The macroflora of Neogene sediments in the Elhovo Formation (Southeast Bulgaria)

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Abstract. The studied macroflora originates from the Neogene sediments in the basin of Toundzha River (Southeast Bulgaria). The age of the sediments was determined as Pontian-Pliocene on the basis of some remains of vertebrates. The identified macroflora comprises 33 species of fossil plants from 16 families. The families *Juglandaceae*, *Fagaceae*, *Salicaceae*, *Betulaceae*, and *Lauraceae* were widest represented. The taxa *Actinodaphne* cf. *dolichophylla*, *Alnus rotundata*, *Ocotea euxina*, *Pistacia miocaenica*, *Salix* cf. *haidingeri*, *Styrax pseudoofficinale*, and *Wisteria* cf. *falax* are described for the first time for the fossil flora of Bulgaria.

Key words: Bulgaria, Elhovo Formation, macropaleoflora, Neogene, Toundzha Basin

Introduction

The Tertiary sediments of Southeast Bulgaria are poorly studied in terms of paleobotany. Information about the composition and character of the paleoflora is exhausted by some fragmentary data on the composition alone, originating from the upper undivided part of the Elhovo Formation (Bozhinova 1991) and of the Izgrev member of the same Formation (Palamarev 1991). The sediment complex of the above-mentioned Formation belongs to the wider Toundzha Basin, whose paleogeographical evolution is important for the reconstruction of the paleogreographical development during the Neogene of the entire southern half of the country (Kojumdjieva & al. 1984). That is why data from this paleofloristic study will contribute to the elucidation of single features of the development of the basin and its paleoecological conditions.

Location, geology and stratigraphy of the fossil flora

The Neogene sediments of the Toundzha Basin are differentiated into Elhovo Formation with its two members (Izgrev and Douganovo) and an undivided part (Fig. 1). Generally, the Formation is represented by alternating clays, sands, conglomerates and coal strata.

The flora-bearing sediments were excavated along the road from Golyam Manastir village to Topolovgrad, southwards from the bridge over Sinapovska River. They were about 50 cm thick (Fig. 2), while the profile containing them was about 3 m thick and consisted of greenish, russet and pale-violet alevrite clays. They belonged to the upper, undivided part of the Elhovo Formation, with a general thickness of about 150-200 m (Kojumdjieva & al. 1984).

The age of the Formation was determined as Late Miocene (Pontian) by a diatom analysis (Temniskova-Topalova & al. 1996). Remains of vertebrate fauna were discovered in the sediments of the Formation and the following species were identified: *Deinotherium giganteum* Kaup., *Tetralophodon longirostris* Kaup., *Anancus arvernensis* Croizet & Jobert, and *Zygolophodon borsnonii* Hays (Bakalov & Nikolov 1962). On the basis of these finds it was assumed that the upper part of the Formation is Pontian-Pliocene in age (Kojumdjieva & al. 1984), while according to the above-cited authors,

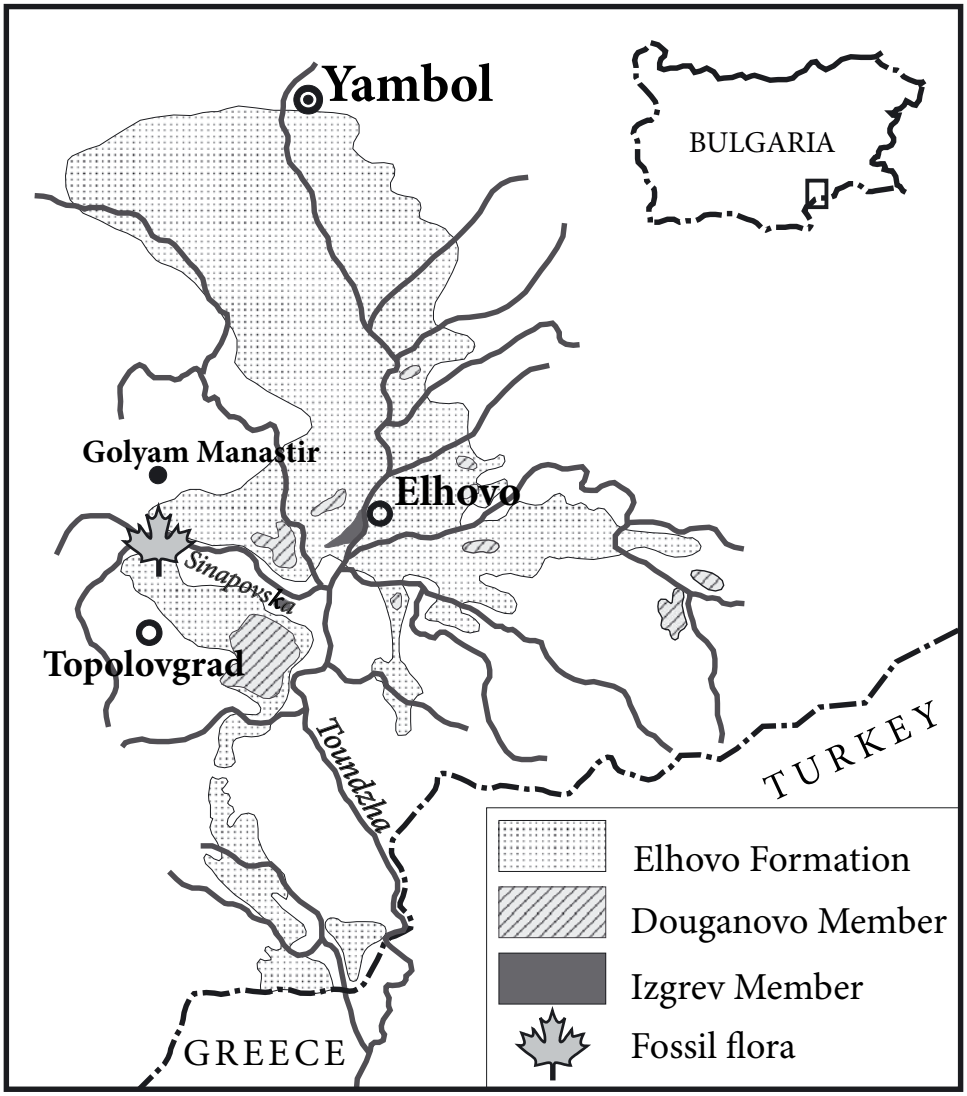

Fig. 1. Map of distribution of the Neogene sediments in the Toundzha basin and location of the fossil flora, after Kojumdjieva & al. (1984), with supplement.

the Formation in general was formed in the Meotian-Early Pliocene time interval.

The above-mentioned data invite the conclusion that the fossil flora probably dates to the transition from Late Pontian to Early Dacian.

Material and methods

The fossil material was collected in the upper undivided part of the Elhovo Formation, along the road from village of Golyam Manastir to town of Topolovgrad, southwards from the bridge over Sinapovska River.

The studied material consists of 121 rock fragments with plant macroremains and. the ichnophytological method (Zhilin 1969) was used for its determinaion. The morphological features of the leaf imprints were determined according to the scheme of Dilcher (1974).

Results

The macroflora comprises 33 fossil taxa. They refer exclusively to the angiosperms and comprise 16 families, arranged according to the scheme of Takhtajan (1987).

Magnoliophyta
Magnoliaceae
***Magnolia dianae* Ung.** (Plate I, Fig. 5).

1861. Unger, p. 28, Pl. 11, Figs 1-3; 1982. Kitanov, p. 35, Pl. 1, Fig. 2; 1988. Černjavska, Palamarev & Petkova, p. 30.

Material: 3 leaf imprints.

Note: Detailed description was published by Kitanov (1982) and the latest find has no morphological deviations.

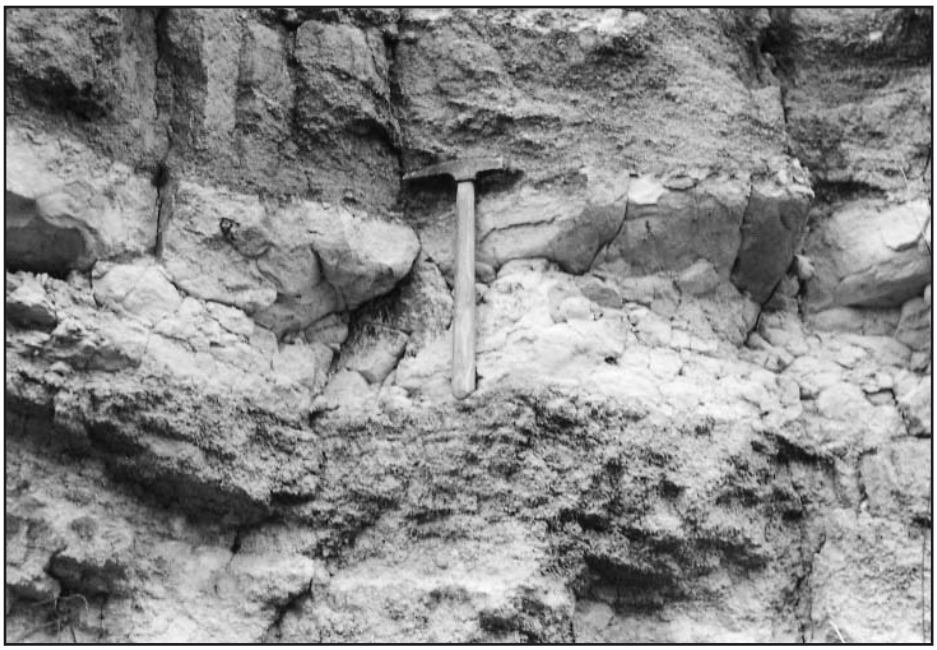

Fig. 2. Flora-bearing sediments excavated near the road from village of Golyam Manastir to town of Topolovgrad, southwards from the bridge over Sinapovska River.

Lauraceae

***Actinodaphne* cf. *dolichophylla* Takht.** (Plate I, Fig. 3).

1963. *A. dolichophylla* Takht., p. 201, Pl. 5, Fig. 7.

Material: 3 leaf imprints.

Description: Shape narrow elliptical; base and top missing, probably acute; leaf margin entire. Nervation brochidodromous; median vein slightly arched, thick at the base and strongly thinning out towards the top; secondary veins in 11-12 pairs, opposite and contiguous, arch-like, at an angle of 50-70° towards the median vein; intercalary veins observed among most secondary veins; tertiary veins forming irregular polygons of equal size. Size: length about 8.0 cm, width 2.5 cm.

Comparison: Fragmentation of the fossil material has made impossible its precise determination and that is why we have used the combination *Actinodaphne* cf. *dolichophylla.* According to Imkhanitskaja (Takhtajan 1974), in shape and nervation the fossil species resembles the contemporary Japanese species *A. longifolia* (Blume) Nakai.

Geographical and stratigraphic distribution: This fossil species has been so far known only from two local Georgian paleofloras, dated respectively to the Middle and Late Miocene (Takhtajan 1963).

***Lindera ovata* Kolak.** (Plate I, Fig. 2).

1957. Kolakovsky, p. 277, Pl. 14, Figs 4-5; Pl. 15, Fig. 1; 1967. *Lindera* cf. *L. ovata* Kolak; Petkova, p. 142, Pl. 5, Fig. 6; Pl. 12, Fig. 4; 1984. Kitanov, p. 51, Pl. 7: 1.

Material: 4 leaf imprints.

Note: Detailed description was published by Petkova (1967) and the latest find has no morphological deviations.

***Litsea primigenia* (Ung.) Takht.** (Plate II, Fig. 1).

1963. Takhtajan, p. 202, Pl. 6, Fig. 9; 1987. Palamarev & Petkova, p. 39, Pl. 9, Figs 2, 4; Pl. 10, Fig. 9; 1999. Palamarev, Kitanov & Bozukov, p. 31, Pl. 1, Fig. 11; 1850. *Laurus primigenia* Ung., p. 168, Pl. 40, Figs 1-4; 1932. Konjaroff, p. 98, Pl. 27, Figs 7-9.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Ocotea euxina* (Kolak.) Imchan.** (Plate II, Fig. 5)

1974. Imchanitzkaja in Takhtajan, p. 24, Pl. 7, Fig. 6; Pl. 9, Fig. 6; 1957. *Nectandra euxina* Kolak., p. 273, Pl. 15, Fig. 4, excl. Fig. 3.

Material: 1 leaf imprint.

Description: Shape elliptical; base acute normal, asymmetrical; top part missing; leaf margin entire. Nervation brochidodromous; median vein straight; secondary veins probably in 10-12 pairs (8 pairs preserved), contiguous, under an angle of 50° towards the median vein, straight, but close to the leaf margin sharply bending towards the upper ones; intercalary veins observed among most secondary veins; ter-

tiary veins form almost round areoles, equal in size. Size: length of the preserved fragment of the leaf blade 4.0 cm, width 2.1 cm.

Comparison: *O. euxina* is close in the shape of its leaf blade and nervation to the recent American species *O. coriaceae* (Sw.) Britt. distributed in the West Indies, South Florida, Mexico and Central America, and *O. patens* (Sw.) Nees distributed on the Caribbean Islands (Imchanitzkaja in Takhtajan 1974).

Geographical and stratigraphic distribution: This fossil species has been so far known only from the Pontian sediments in Georgia (Kolakovsky 1957).

***O. heeri* (Gaud.) Takht.** (Plate II, Fig. 4).

1963. Takhtajan, p. 199; 1987. Palamarev & Petkova, p. 36, Pl. 10, Figs 3, 6, 8; 1858. *Oreodaphne heeri* Gaud. in Gaudin & Strozzi, p. 35, Pl. 10, Figs 5-9; Pl. 11, Figs 1-7; 1932. Konjaroff, p. 167, Pl. 56, Figs 5, 5a.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Persea pliocenica* (Laur.) Kolak.** (Plate III, Fig. 5).

1957. Kolakovsky, p. 276, Pl. 16, Figs 2-3; 1984. Kitanov, p. 51, Fig. 7: 1; 1987; Palamarev & Petkova, p. 36, Pl. 9, Fig. 3; Pl. 12, Figs 2-4; 1904. *P. indica* (L.) Spreng. *pliocenica* Laur., p. 152, Fig. 26.

Material: 2 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Fagaceae

***Quercus neriifolia* (A. Braun) A. Braun** (Plate IV, Fig. 3).

1850. A. Braun in Unger, p. 403; 1962. Hadžiev & Palamarev, p. 7; 1987. Palamarev & Petkova, p. 71, Pl. 20, Figs 2-3, 7; 1845. *Salix neriifolia* A. Braun, p. 170.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Q. kubinyi* (Kovats ex Ett.) Czeczott** (Plate III, Fig. 2; Plate VI, Fig. 5).

1951. Czeczott, p. 372, Fig. 7; 1988. Palamarev & Kitanov; p. 189, Pl. 4, Fig. 8; Pl. 5, Figs 2, 4-9; Pl. 6, Figs 4-7; 1852. *Castanea kubinyi* Kovats ex Ett., p. 6; 1929. *Q. drymeja* auct. Stojanoff & Stefanoff, p. 51, Pl. 8, Figs 11-13; text-Fig. 13, Figs 3-4, non Ung.

Material: 5 leaf imprints.

Note: Detailed description was published by Palamarev & Kitanov (1988) and the latest find has no morphological deviations.

***Q. pliovariabilis* Kolak.** (Plate III, Fig. 4).

1964. Kolakovsky, p. 88, Pl. 31, Fig. 1; 2004. *Q.* cf. *pliovariabilis* Kolak.; Tsenov, p. 16, Pl. 2, Fig. 5; 1932. *Castanea atavia* Ung.; Konjaroff, p. 125, Pl. 32, Fig. 2 (sine descr.); 1980. *Castanopsis pliovariabilis* (Kolak.) Kolak. in Iljinskaja, p. 24; 1999. Bozukov, p. 4, Pl. 1, Fig. 5.

Material: 6 leaf imprints.

Note: Detailed description was published by Bozukov (1999) and the latest find has no morphological deviations.

Betulaceae

***Alnus gaudinii* (Heer) Knobl. & Kvaček** (Plate VI, Fig. 1).

1976. Knobloch & Kvaček, p. 33, Pl. 6, Figs 1, 3; Pl. 7, Figs 1, 5; Pl. 13, Fig. 4; Pl. 15, Figs 1-4, 7-8, 11, 13, 15, 17; Pl. 16, Figs 1-5; Pl. 19, Fig. 15; Pl. 20, Fig. 10; text-Figs 11-12; 1998. Palamarev, Ivanov & Kitanov, p. 14; 1859. *Rhamnus gaudinii* Heer, p. 79, Pl. 124, Figs 4-15; Pl. 125, Figs 1, 7, 13; pars 1932. Konjaroff, p. 98, Pl. 29, Figs 4-5; p. 173, Pl. 59, Fig. 3 (non Pl. 23, Fig. 6; Pl. 29, Fig. 3 = sp. indet.).

Material: 5 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***A. rotundata* Goepp.** (Pl. V, Fig. 5).

1855. Goeppert, p. 12, Pl. 4, Fig. 4; 1954. Hantke, p. 43, Pl. 1, Figs 17-20.

Material: 1 leaf imprint.

Description: Shape elliptical; base missing (probably acute normal); top part acute; leaf blade dentate,

dents sparse, very small and sharp. Nervation craspedodromous; median vein straight; secondary veins in 8-9 pairs, contiguous, under an angle of 60° towards the median vein, straight; no intercalary veins were observed; tertiary veins not preserved. Size: length of the preserved fragment of the leaf blade 6.0 cm, width 5.1 cm.

Comparison: Hantke (1954) compared this fossil species to *A. incana* (L.) Moench. now distributed in Europe and the Caucasus.

Geographical and stratigraphic distribution: This fossil species has been so far known only from the Upper Miocene sediments in North Germany.

***Carpinus grandis* Ung.** (Plate V, Fig. 3).

1845. Unger, p. 220; pars 1856. Heer, p. 40, Pl. 72, Figs 2-11, 14, 16-24 (non Figs 12-13, 15 = *Carpinus* sp. fruct.); Pl. 73, Figs 2-4; pars 1932. Konjaroff (30), p. 54, Pl. 20, Figs 2, 4 (non Fig. 3 = *Carpinus* sp. fruct.); Pl. 24, Figs 3, 5 (non fig. 4 = *Carpinus* sp. fruct.); 1999. Bozukov, p. 10, Pl. 4, Fig. 2.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Juglandaceae

***Carya denticulata* (Weber) Iljinsk.** (Plate IV, Fig. 5).

1964. Iljinskaja in Kolakovsky, p. 95, Pl. 36, Figs 3-6; 1999. Bozukov, p. 48, Pl. 3, Fig. 3; 1932. *C. serraefolia* (Goepp.) Krausel; Konjaroff, Pl. 23, Fig. 7; 1852. *Juglans denticulata* Weber, p. 211, Pl. 23, Fig. 10.

Material: 2 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Pterocarya paradisiaca* (Ung.) Iljinsk.** (Plate VI, Fig. 3).

1962. Iljinskaja, p. 104; 1988. Palamarev & Kitanov, p. 194, Pl. 10, Fig. 2; 1929. *P. caucasica* C. A. Mey.; Stojanoff & Stefanoff, p. 34, text-Fig. 8, Fig. 1; Pl. 5, Fig. 1; 1849. *Prunus paradisiaca* Ung., p. 7, Pl. 14, Fig. 22.

Material: 8 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Fabaceae

***Gleditsia lyelliana* (Heer) Hantke** (Plate V, Fig. 4).

1980. Hantke in Gregor & Hantke, p. 167, Pl. 9, Fig. 5; 1999. Palamarev, Kitanov & Bozukov, p. 36; pars1859. *Podogonium lyellianum* Heer, p. 117, Pl. 136, Figs 22-48 (non Figs 10-25 = *Gleditsia knorrii* (Heer) Gregor); 1937. *P. latifolium* Heer; Konstantinoff, p. 266, Pl. 4, Fig. 14.

Material: 3 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Robinia regeli* Heer** (Plate VI, Fig. 2).

1859. Heer, p. 99, Pl. 132, Figs 20-26, 34-41; 1987. Palamarev & Petkova, p. 113, Pl. 30, Fig. 7.

Material: 1 carpoid imprint.

Note: For the first time in Bulgaria a species was determined by a carpoid imprint. A fragment of a bean was preserved, 3 cm long and 1.5 cm wide. Detailed data on the species are published in Palamarev & Petkova (1987).

***Sophora europaea* Ung.** (Plate VI, Fig. 6).

1850. Unger, p. 187, Pl. 43, Figs 1-5; pars 1967. *Podogonium knorii* Heer; Petkova, p. 145, Pl. 6, Fig. 6 (non Fig. 4; Pl. 16, Fig. 6 = *Gleditsia lyeliana* Hantke); 1999. Palamarev, Kitanov & Bozukov, p. 36, Pl. 4, 3.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Wisteria* cf. *falax* (Nath.) Tanai & Onoe** (Plate II, Fig. 6).

1961. *W. fallax* (Nath.) Tanai & Onoe, p. 45, Pl. 10, Fig. 6; Pl. 14, Figs 2-4; 1883. *Sophora fallax* Nath., p. 58, Pl. 10, Figs 11-12; Pl. 12, Figs 1-2.

Material: 1 leaf imprint.

Description: Shape ovate; base cordate: top part missing (probably obtuse); leaf margin entire. Nervation brochidodromous; median vein straight; secondary veins in 8 pairs, opposite, seldom contiguous, at an angle of 50° towards the median vein, straight, slightly arched; intercalary veins observed between some secondary veins; tertiary veins not

preserved. Size: length of the preserved fragment of the leaf blade 2.1 cm, width 1.6 cm.

Comparison: Tanai (1976) compared this fossil species to *W. floribunda* (Willd.) DC now distributed only in Japan. The only available leaf imprint, however, makes it impossible to maintain with certainty that it belongs to this fossil species. That is why we have used the combination *W.* cf. *falax*.

Geographical and stratigraphic distribution: This fossil species has been so far known only from the Late Miocene and Early Pliocene sediments in Japan (Tanai op.c.).

Ericaceae

***Arbutus guriense* Usnadze** (Plate III, Fig. 1).

1955. Usnadze, p. 51, Pl. 9, Fig. 1; 1966. *Ilex georgica* Kolak.; Petkova & Kitanov, p. 16, Pl. 5, Fig. 1; Pl. 8, Fig. 3; 1999. Bozukov, p. 52, Pl. 1, Fig. 2.

Material: 1 leaf imprint..

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Styracaceae

Styrax *pseudooficinale* Baik. (Plate II, Fig. 2).

1965. Baikovskaja in Kryshtofovich & Baikovskaja, p. 120, Pl. 36, Figs 5-6; text-Fig. 40.

Material: 1 leaf imprint.

Description: Shape elliptical; base acute normal; top part acute; leaf margin entire. Nervation brohidodromous; median vein slightly undulate; secondary veins in 6 pairs, contiguous, under an angle of 45° towards the median vein, arched; no intercalary veins were observed; tertiary veins not preserved. Size: length of the leaf blade 3.9 cm, width 1.8 cm.

Comparison: Baikovskaja (Kryshtofovich & Baikovskaja 1965) compared this fossil species to the contemporary *S. officinalis* L. distributed in the Eastern Mediterranean.

Geographical and stratigraphic distribution: This fossil species has been so far known only from the Middle Miocene sediments at the frontier between the East Ukraine and Russia (the mouth of Don River) (Kryshtofovich & Baikovskaja op. c.).

Aceraceae

***Acer subcampestre* Goepp.** (Plate V, Fig. 1).

1855. Goeppert, p. 32, Pl. 22, Figs 16-17; 1992. Palamarev & Bozukov, p. 62, Pl. 1, Fig. 3.
1999. Bozukov, p. 58.

Material: 1 leaf imprint.

Note: Detailed description was published by Bozukov (1999) and the latest find has no morphological deviations.

Altingiaceae

***Liquidambar europaeum* A. Braun** (Plate IV, Fig. 2.)

1836. A. Braun in Buckland, p. 513; 1932. Konjaroff, Pl. 56, Fig. 8; 1982. Kitanov, p. 37.

Material: 1 leaf imprint.

Note: Detailed description was published by Stefanoff & Jordanoff (1935) and the latest find has no morphological deviations.

Sapindaceae

***Sapindus falcifolius* (A. Braun) A. Braun** (Plate II, Fig. 3).

1851. A. Braun in Stizenberger, p. 87; 1961. Palamarev, p. 186, Pl. 6, Figs 4-5; text-Fig. 20; 1999. Palamarev, Kitanov & Bozukov, p. 37; 1836. *Juglans falcifolius* A. Braun in Buckland, p. 513.

Material: 2 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Ulmaceae

***Ulmus pyramidalis* Goepp.** (Plate III, Fig. 3).

1855. Goeppert, p. 28, Pl. 13, Figs 10-12; pars 1932. *U. carpinoides* Goepp.; Konjaroff, p. 125, Pl. 33, Fig. 3 (non Fig. 4 = *U. carpinoides* Goepp. s. str.); p. 129, Pl. 42, Fig. 8; p. 222, Pl. 64, Fig. 7; 1998. Palamarev, Ivanov & Kitanov, pp. 14-15.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Zelkova zelkovifolia* (Ung.) Bužek & Kotl.** (Plate I, Fig. 4).

1963. Bužek & Kotlaba in Kotlaba, p. 59, Pl. 3, Figs 7-8; 1998. Palamarev, Ivanov & Kitanov, pp. 14-15; pars 1843. *Ulmus zelkovifolia* Ung., p. 405, Pl. 24, Figs 9-12 (non Pl. 24, Figs 8, 13 = *Zelkova* sp. fruct.);

1929. *Z. crenata* auct. Stojanoff & Stefanoff, p. 66, Pl. 10, Figs 7-10; text-Fig. 19: 1-3, 5, non Spach.

Material: 2 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Hamamelidaceae

***Parrotia pristina* (Ett.) Stur** (Plate IV, Fig. 1).

1867. Stur, p. 192, Pl. 5, Figs 2-3; 1932. *P. fagifolia* Goepp.; Konjaroff, p. 54, Pl. 23, Figs 2-3; p. 98, Pl. 24, Figs 6-7; 1998. Palamarev, Ivanov & Kitanov, pp. 14-15; 1851. *Styrax pristinum* Ett., p. 19, Pl. 3, Fig. 9.

Material: 1 leaf imprint.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Salicaceae

***Populus populina* (Brongn.) Knobl.** (Plate V, Fig. 2).

1964. Knobloch, p. 601; 1999. Bozukov, p. 51; 1932. *P. latior* A. Braun; Konjaroff, p. 54, Pl. 16, text-Fig. 3; Pl. 17, Fig. 2; 1822. *Phyllites populina* Brongn., p. 237, Pl. 14, Fig. 4.

Material: 2 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

***Salix* cf. *haidingeri* Ett.** (Plate VI, Fig. 7).

1866. *S. haidingeri* Ett., p. 88, Pl. 29, Figs 9-16 (non Fig. 8); 1954. *S. angusta* A. Braun; Hantke, p. 58, Pl. 6, Figs 1-4; 1971. Bůžek, p. 66, Pl. 27, Figs 1-10; Pl. 28, Figs 1-12; text-Fig. 9.

Material: 3 leaf imprints.

Description: Shape lorate; base acute normal; top part acute; leaf margin entire. Nervation brohidodromous; median vein straight or slightly arched; secondary veins numerous, contiguous, at an angle of 40° towards the median vein, arched; intercalary veins have not been observed; tertiary veins not preserved. Size: length of the preserved fragments of the leaf blade 3.0–4.0 cm, width 0.9–1.2 cm.

Comparison: The fossil species *S. haidingeri* has no recent analogue. Nevertheless, Bůžek (1971) mentioned *S. purpurea* L. and *S. caspica* Pall., now distributed in the Caucasus and Iran, as closest in the structure of leaves. Fragmentation of the fossil material makes it impossible any precise determination and that is why we have used the combination *S.* cf. *haidingeri.*

Geographical and stratigraphic distribution: This fossil species is known from the Lower Miocene in Czech Republic (Bůžek op.c.) and Upper Miocene in Germany (Hantke 1954).

***Salix lavateri* A. Braun** emend. Heer (Plate III, Fig. 6).

1851. A. Braun in Stizenberger, p. 78; 1856. Heer, p. 30, Pl. 68, Figs 1-4; 1987. Palamarev & Petkova, p. 95, Pl. 25, Fig. 8.

Material: 6 leaf imprints

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Rhamnaceae

***Paliurus spina-cristii* Mill. foss.** (Plate I, Fig. 6; Plate VI, Fig. 4).

1972. Kitanov, p. 178, pl. 2, fig. 3.; 1984. Kitanov, p. 65, pl. 12, fig. 3.

Material: 2 leaf and 1 carpoid imprints.

Note: Detailed description was published by Kitanov (1972) and the latest find has no morphological deviations.

***Rhamnus rectinervis* Heer** (Plate IV, Fig. 4).

1859. Heer, p. 80, Pl. 125, Figs 2-6; 1987. Palamarev & Petkova, p. 134, Pl. 34, Fig. 6; 2000. Bozukov, p. 25, Pl. 3, Fig. 2.

Material: 5 leaf imprints.

Note: Detailed description was published by Palamarev & Petkova (1987) and the latest find has no morphological deviations.

Anacardiaceae

***Pistacia* cf. *miocenica* Saporta** (Plate I, Fig. 1).

1868. *P. miocenica* Saporta, p. 52, Pl. 6, Figs 4-6; 1965. *P.* cf. *miocenica* Saporta; Kryshtofovich & Baikovskaya, p. 92, Pl. 23, Fig. 1.

Material: 1 leaf imprint.

Description: Shape narrow elliptical; base acute normal; top part not preserved (probably acute); leaf margin entire. Nervation cladodromous; median vein slightly arched, thick at the base of the leaf blade and strongly thinning out towards the top: secondary veins in 11-12 pairs, very thin, contiguous, at an angle of 70º towards the median, straight; intercalary veins have not been observed; tertiary veins not preserved. Size: length of the preserved fragment of the leaf blade 4.0 cm, width 1.5 cm.

Comparison: Saporta (1868) described the fossil species *P. miocenica* with *P. terebinthus* L. as its analogue, distributed in the Mediterranean. Kryshtofovich & Baikovskaya (1965) assumed as similar to that fossil species a leaf imprint determined by them, and classified it as *P.* cf. *miocenica,* owing to some differences in the shape of the leaf blade. For the same reason we have used the same combination.

Geographical and stratigraphic distribution: This fossil species has been known from the Middle Oligocene sediments close to Marceilles (Southeast France) (Saporta 1868) and sediments dated to the Middle Miocene, at the frontier between the East Ukraine and Russia (the mouth of Don River) (Kryshtofovich & Baikovskaya 1965).

Discussion

The so far identified fossil flora comprises 33 taxa from 16 families. Widest represented are the families *Juglandaceae*, *Fagaceae*, *Salicaceae*, *Betulaceae*, *Lauraceae*. The species with greatest occurrence are: *P. paradisiaca, S. lavateri, Q. pliovariabilis, Q. kubinyi, A. gaudinii,* and *L. ovata*.

The composition of the paleofrlora testifies to the development of riverine communites formed of representatives of the genera *Salix, Pterocarya, Liquidambar, Alnus,* and *Rhamnus*, as well as mesophytic and xeromesophytic forest and shrub paleocoenoses with the participation of *Lindera, Ocotea, Quercus, Robinia, Wisteria, Paliurus, Arbutus,* and *Styrax*.

A detailed palaeoecological and phytogeographical analysis of the flora will be the subject of the next article.

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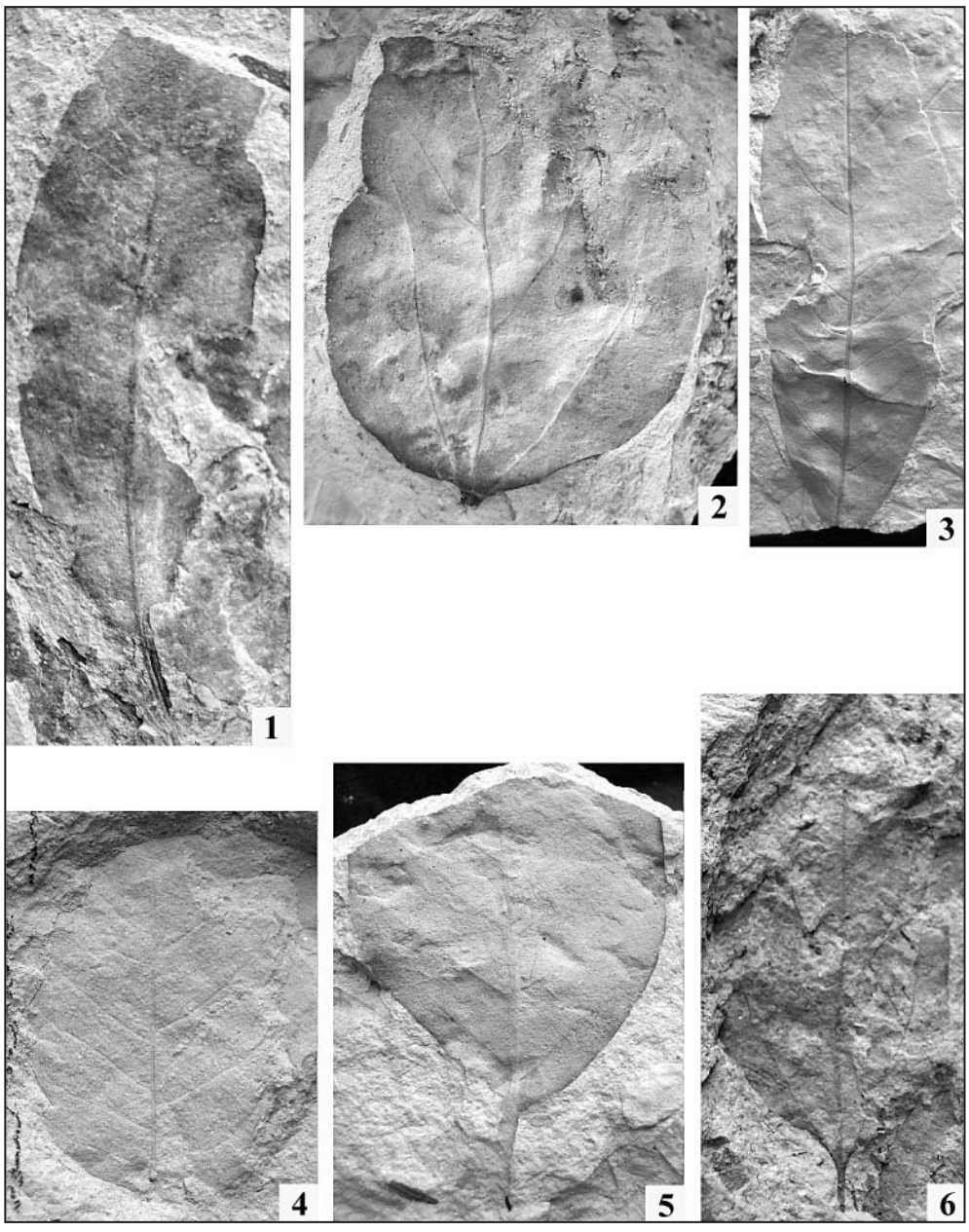
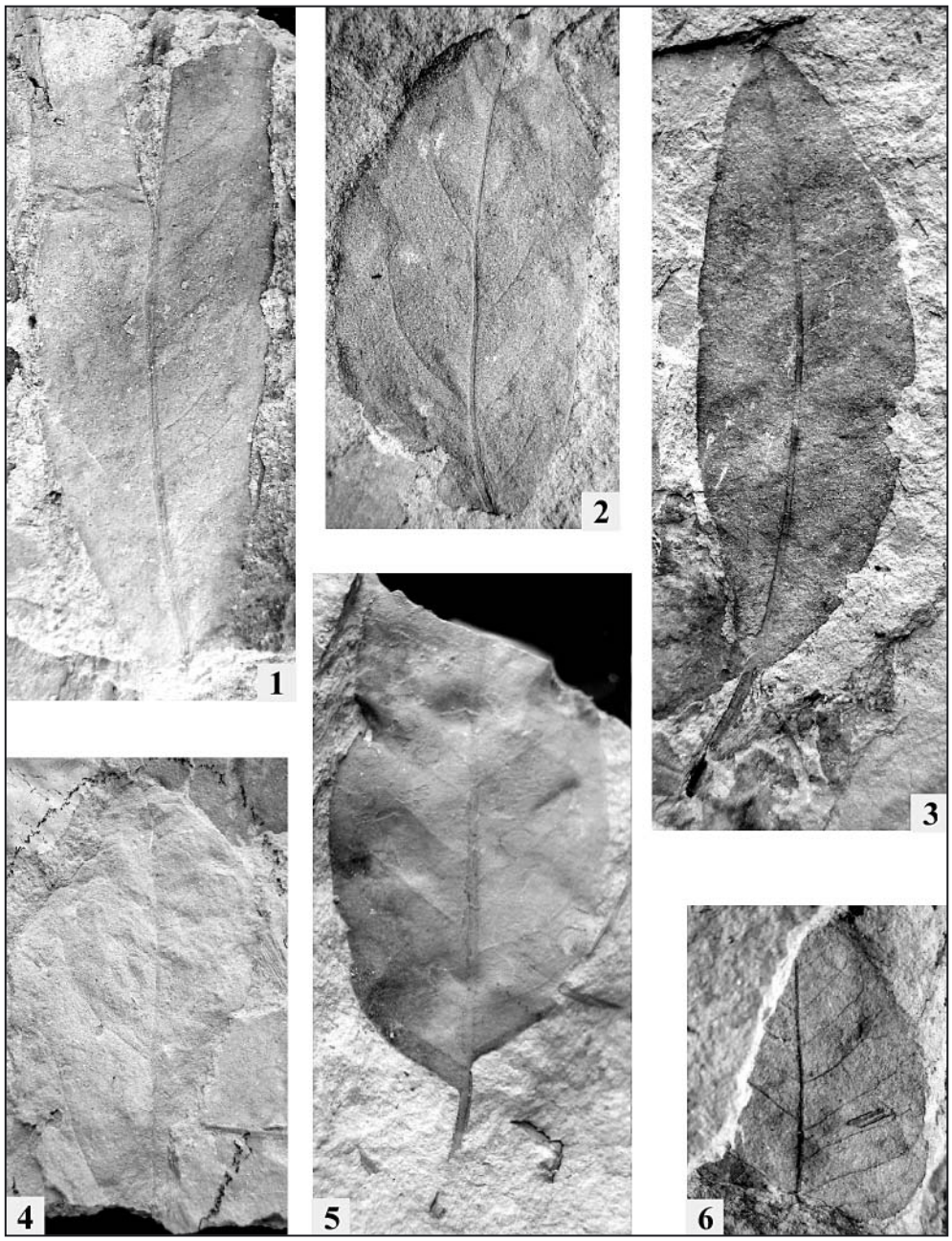
Plate I



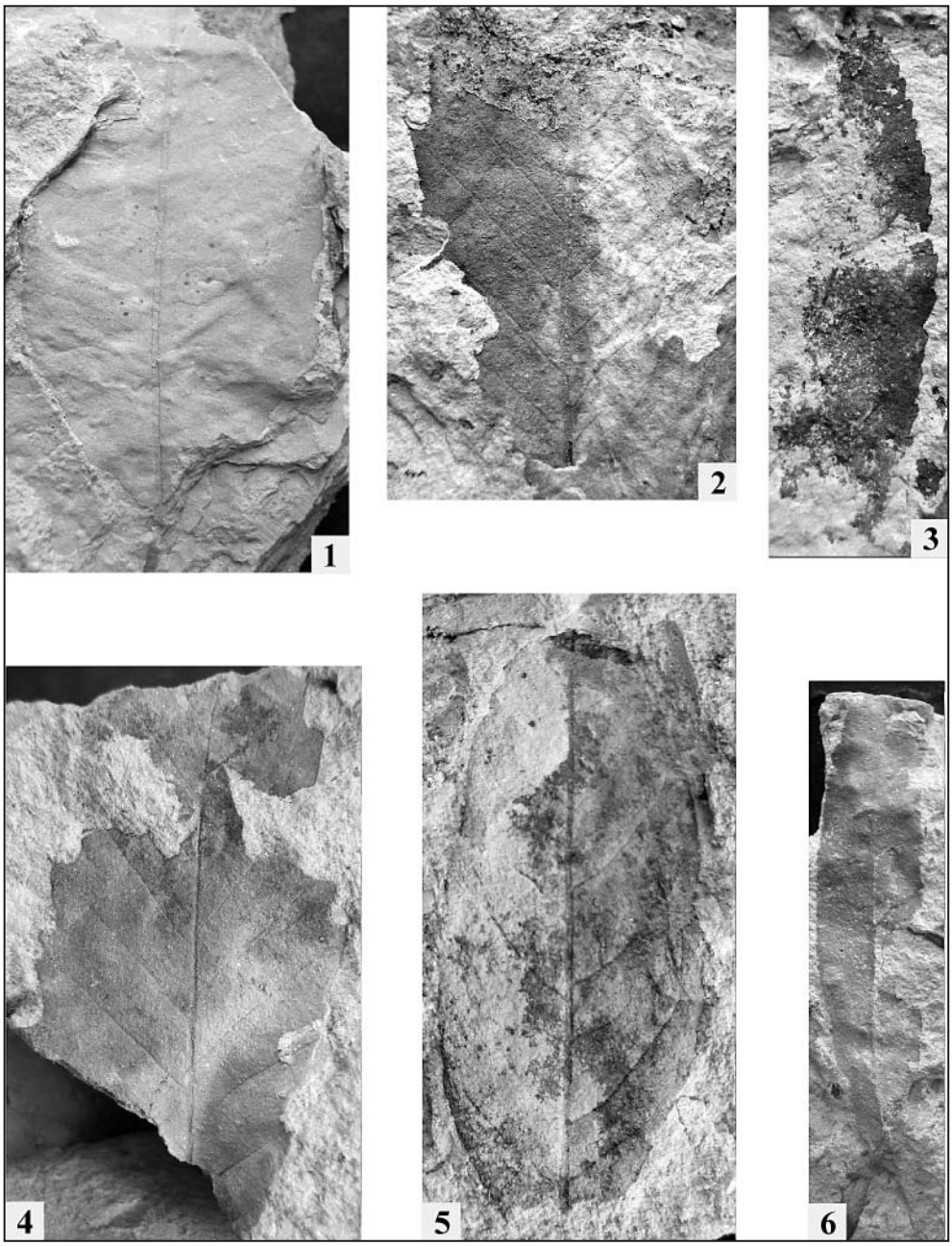
Figs 1-6. Pictures of the investigated fossil species: **1,** *Pistacia miocenica* (×2); **2,** *Lindera ovata* (×2); **3,** *Actinodaphne* cf. *dolichophylla* (×2); **4,** *Zelkova zelkovifolia* (×2); **5,** *Magnolia dianae* (1:1); **6,** *Paliurus spina-cristii* foss. (×2).

Plate II



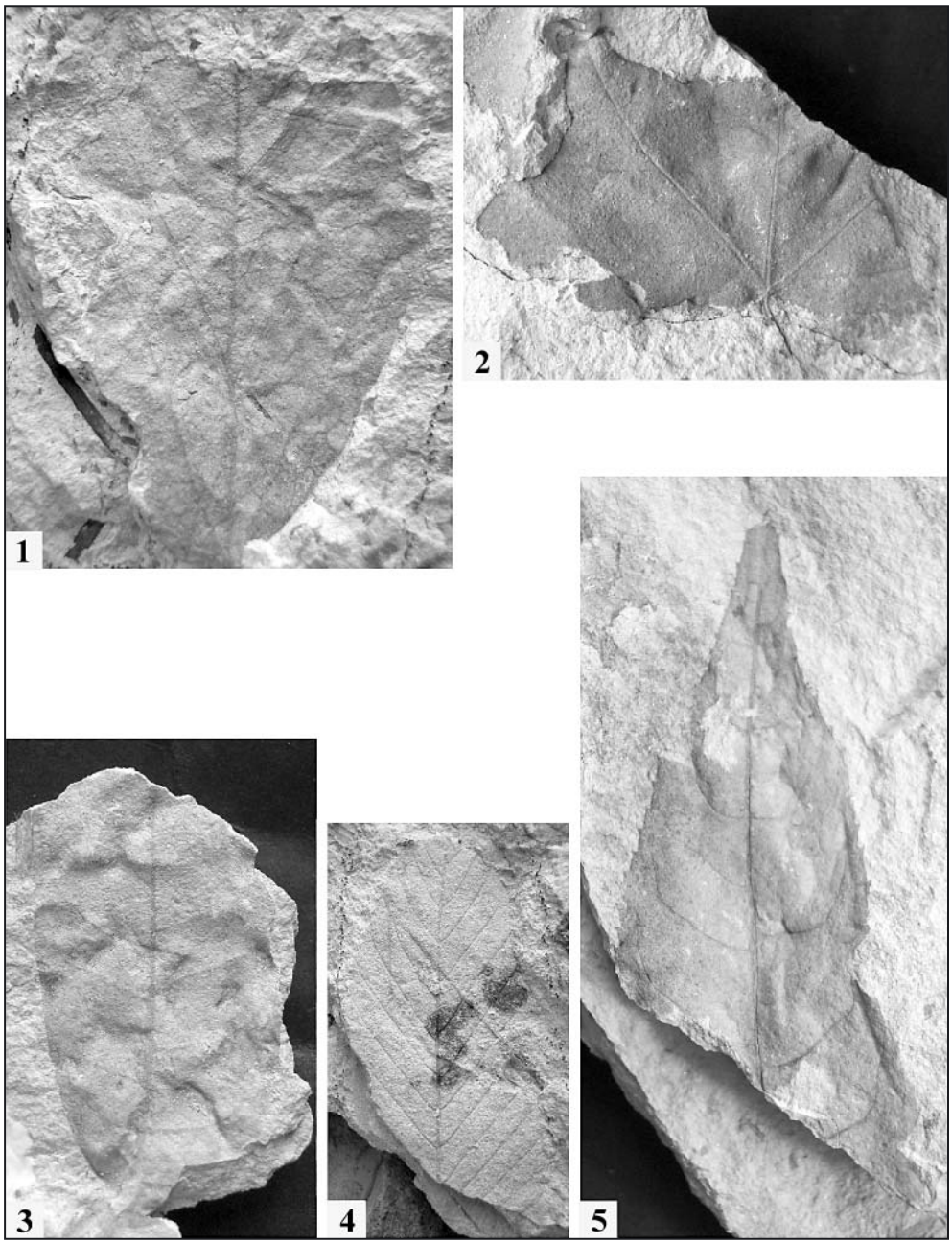
Figs 1-6. Pictures of the investigated fossil species**: 1,** *Litsea primigenia* (×2); **2,** *Styrax pseudooficinale* (×2); **3,** *Sapindus falcifolius* (×2); **4,** *Ocotea heeri* (×2); **5,** *O. euxina* (×2); **6,** *Wisteria* cf. *falax* (×2).

Plate III



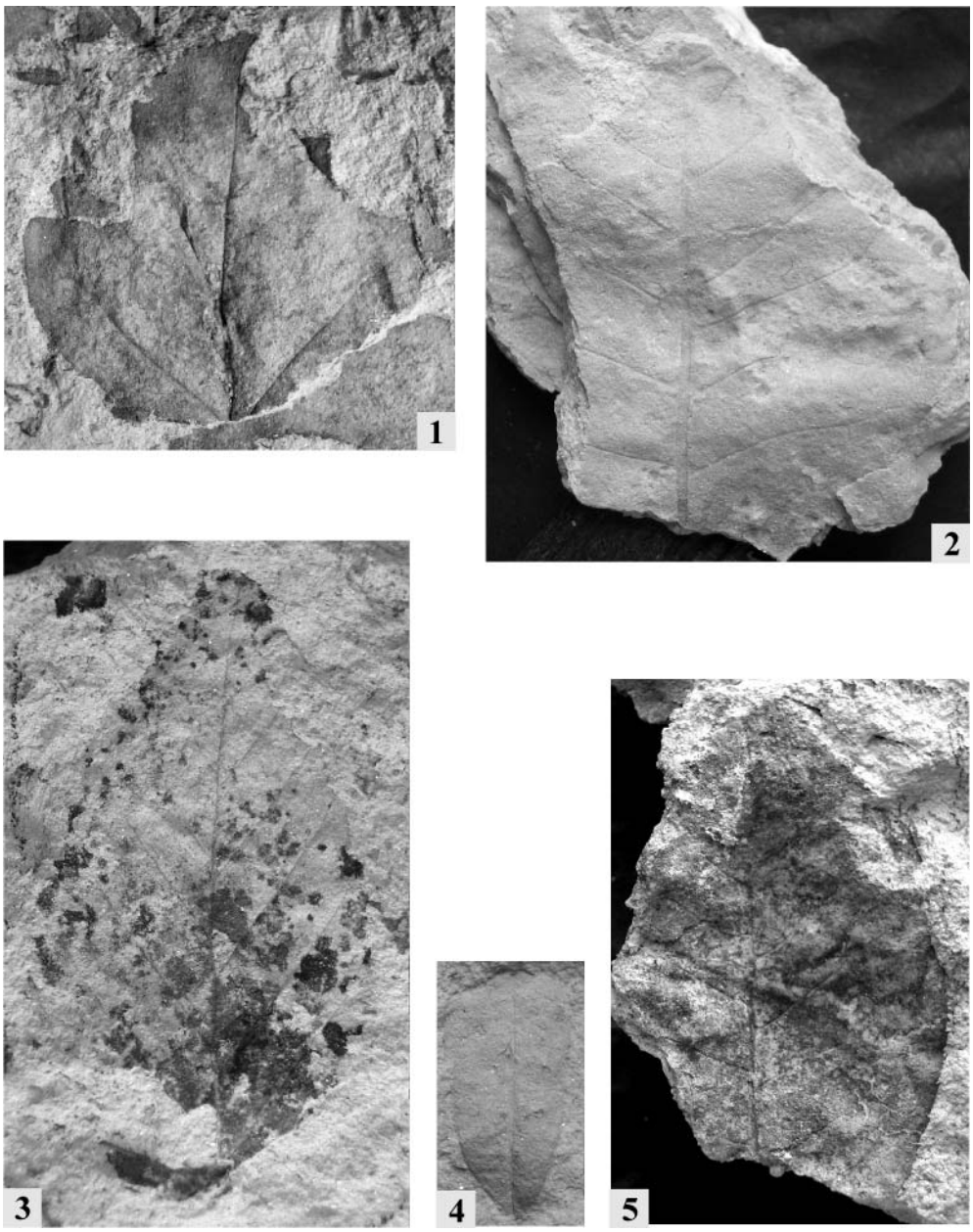
Figs 1-6. Pictures of the investigated fossil species: **1**, *Arbutus guriense* (1:1); **2**, *Quercus kubinyi* (×2); **3**, *Ulmus pyramidalis* (×2); **4**, *Q. pliovariabilis* (×2); **5**, *Persea pliocenica* (×2); **6**, *Salix lavateri* (×2).

Plate IV



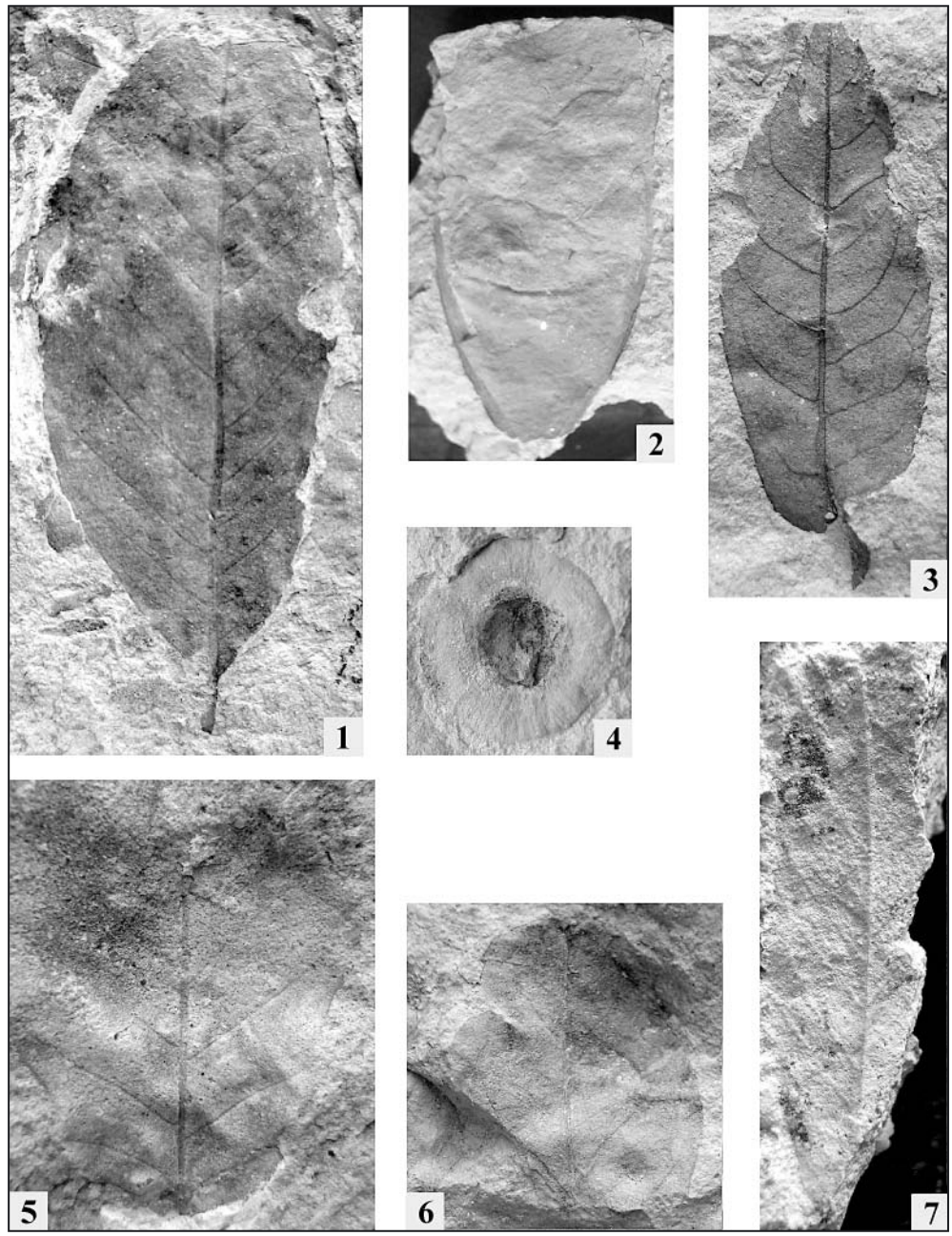
Figs 1-5. Pictures of the investigated fossil species: **1**, *Parrotia pristina* (×2); **2**, *Liquidambar europaeum* (×2); **3**, *Quercus neriifolia* (×2); **4**, *Rhamnus rectinervis* (1:1); **5,** *Carya denticulata*(×2).

Plate V



Figs 1-5. Pictures of the investigated fossil species: **1,** *Acer subcampestre* (×1.5); **2**, *Populus populina* (×1.5); **3**, *Carpinus grandis* (×2); **4**, *Gleditsia lyelliana* (×3); **5**, *Alnus rotundata* (1:1).

Plate VI



Figs 1-7. Pictures of the investigated fossil species: **1**, *Alnus gaudinii* (×2); **2**, *Robinia regeli* (×2); **3**, *Pterocarya paradisiaca* (×2); **4**, *Paliurus spina-cristii* foss. (×2); **5**, *Quercus kubinyi* (×2); **6**, *Sophora europaea* (×2); **7**, *Salix* cf. *haidingeri* (×2).

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