Family *Araliaceae* in the Bulgarian macrofossil flora

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Abstract. This study is aimed at rendering in a more precise form the so far collected data about representatives of the family *Araliaceae* in the Bulgarian fossil macroflora, and to compare them with the latest findings in Europe and SW Asia. Fossil finds in Bulgaria identified so far as *Dewalquea fraxinifolia* are revised. They were referred to the species *Platanus fraxinifolia* in line with the contemporary researches into the fossil representatives of genus *Platanus*. Attention is paid to a new find of a fossil species from genus *Brassaiopsis* in Armenia and revision is suggested of this species status. On the basis of published data and fossil material from IBER paleobotanical collection, a new combination *Brassaiopsis digitata* comb. n. is presented, as well as a new fossil taxon *Brassaiopsis* aff. *hispida*.

Key words: *Araliaceae*, Bulgaria, macrofossil floras, Neogene, Paleogene

Introduction

The family *Araliaceae* comprises about 50 genera and 1350 species, widespread in the tropical and subtropical regions of both hemispheres, and much less diverse in the temperate areas (Qibai & Lowry 2007). Genus *Schefflera* J.R. Forst. & G. Forst. was regarded as largest in the family. It comprises over 700 species distributed mainly in tropical Asia. Another large genus is *Oreopanax* Decne. & Planch., with more than 120 species distributed in tropical and subtropical America. In the temperate areas in Asia some 10 species of this family are encountered. One of which is the widely known Ginseng (*Panax ginseng* C.A.Mey) whose roots have been used for medicinal purposes for ages. *Hedera helix* L. is the only species of the family distributed in Europe.

In the Bulgarian paleoflora, six genera of the family *Araliaceae* were registered from macroremains: *Aralia* L., *Brassaiopsis* Decne & Planch., *Hedera* L., *Oreopanax* Decne. & Planch., *Panax* L., and *Schefflera* J.R. Frost. & G. Frost. (Palamarev & all. 2005).

The genus *Dewalquea* Sap. & Mar. was registered too, but its systematic position is unclear.

Various authors refer it to *Ranunculaceae* (Saporta 1868), *Araliaceae* (Saporta & Marion 1878), *Theaceae* (Makulbekov 1977), or *Platanaceae* (Mai & Walther 1985). The species *Dewalquea fraxinifolia* T. Johnson & Gilmore, widely distributed in the Paleogene flora of Bulgaria, has been referred so far to the family *Araliaceae* (Černjavska & al. 1988; Palamarev & Staneva 1995; Palamarev & al. 1999). This paper accepts the revision of Mai & Walther (1985) based on the morphology of a preserved leaf epidermis of *Dewalquea fraxinifolia*. The authors regard this species as belonging to genus *Platanus* L. and describe a new combination *P. fraxinifolia* (T. Johnson & Gilmore) Walther. That revision was confirmed subsequently by Kvaček & al. (2001).

Palynological studies show that pollen belonging to members of the family *Araliaceae* is mainly reported in Miocene sediments in Bulgaria, but it occurs in Oligocene and Pliocene too (Ivanov 2010; Ivanov & al. 2002, 2007ab, 2010, 2011, 2012; Jiménez-Moreno & al. 2007).

Material and methods

The investigated material is part of the paleobotanical collection of the Institute of Biodiversity and Ecosystem Research (IBER), Bulgarian Academy of Sciences. Morphological characters of the leaf lamina follow the scheme of Dilcher (1974). The photographs are made by PENTAX Optio E70L camera.

Systematics

Division Magnoliophyta
Class Magnoliopsida
Family *Araliaceae* Juss.
Genus *Brassaiopsis* Decne & Planch.

Brassaiopsis digitata (Ung.) Bozukov comb. n. (Pl. I, Figs 1, 3-4)

1847. *Platanus digitata* Unger, p. 137, Pl. 45, Fig. 6.

P.p. 1987. *Brassaiopsis jatrophaefolia* (Unger) Palamarev & Petkova, p. 128, Pl. 33, Figs 4a,b.

Material: leaf imprints from the Ruzhintsi Middle Miocene flora (P-3788a,b).

Comparison: The species *Brassaiopsis jatrophaefolia* was described in detail by Palamarev & Petkova (1987). The authors unite two Unger's (1847) species in it. These are *Platanus digitata* Ung. and *P. jatrophaefolia* Ung. Unger in turn separates them due to the difference in their leaf margin. The leaf lobe margin is entire in *P. digitata* (Pl. I, Fig. 1) (= *Brassaiopsis digitata in hoc. loco*), while it is toothed in *P. jatrophaefolia* (Pl. 2, Fig. 3) (= *Brassaiopsis jatrophaefolia* (Ung.) Palam. & Petkova).

We support the view of Palamarev & Petkova (1987) that the aforementioned fossil material described by Unger (1847) has the morphological characteristics rather representatives of the family *Araliaceae*, than on the family *Platanaceae*. So we accept the opinion of Palamarev & Petkova (1987), that most likely it comes to species of genus *Brassaiopsis*. But we assume that the character of the leaf margin is sufficient for the species described by Unger (1847) to remain two, and they are to be referred to the genus *Brassaiopsis* separately.

That is why we are creating the new combination for which the lack of teeth on the leaf lobe margin is characteristic.

Among the recent species of genus *Brassaiopsis,* the closest morphological characters to those of *B. digitata* comb. n. has the species *B. grushvitzkyi* J. Wen & al., widely distributed in Indochina. The leaf lamina dentation is unclear or missing altogether in it. Moreover, the leaf lobes shape and width of this recent species are closer to those of the new fossil taxon, than to those of *B. jatrophaefolia*, which are narrower and more elongated.

Brassaiopsis aff. *hispida* Seem. (Pl. II, Figs 1-2)

P.p. 2000. *Brassaiopsis jatrophaefolia* (Ung.) Palam. & Petkova; Bozukov, p. 15.

Material: leaf imprints from the Satovcha Middle Miocene flora (Sat.-1193a,b).

Description: The leaf lamina is symmetrical, probably orbiculate in form. The leaf margin is eleven-lobed. Only one small obtuse tooth is preserved, where the secondary vein reaches the leaf margin. In the other analogous areas, a curve of the leaf margin is observed. The lobe apexes are not preserved. Sinuses between the lobes are rounded. Venation is a basal actinodromous type. Angle between the primary veins is 25–30 degrees. Angle between the primary and secondary veins is approximately 55–65 degrees. There are intersecondary veins. The tertiary veins are hardly visible which is insufficient for their exact description.

Dimensions: The preserved part of the leaf is 19.0 cm wide and 16.0 cm long. The probable size of the entire leaf is about 25.0 cm.

Comparison: Owing to the fact that the leaf is only partially preserved, we can only approximately claim any resemblance with some recent species. Judging by the number of lobes, the type of sinuses and the angles between their central veins, we could presume that the Indochinese species *Brassaiopsis hispida* Seem. is closest to it. This recent species has a dentate leaf lamina, but some of its forms have spaced out small teeth, similar to our preserved fossil material.

Brassaiopsis jatrophaefolia (Ung.) Palam. & Petkova (Pl. I, Fig. 2; Pl. II, Figs 3-4)

1847. *Platanus jatrophaefolia* Unger, p. 137, Pl. 45, Fig. 7.

1957. *Aralia mirabilis* Kolakovsky, p. 249, Pl. 3, Fig. 3; Pl. 4, Fig. 1; Pl. 5, Fig. 1.

1964. *Brassaiopsis mirabilis* (Kolak.) Kolakovsky, p. 53, Pl. 11, Figs 2-3; Pl. 12, Fig. 5; Pl. 13, Figs 1-2; Pl. 14, Fig. 6.

2017. Papikyan & Gabrielyan, p. 62, Pl. Text-Figs 1-2.

P.p. 1987. *B. jatrophaefolia* (Ung.) Palamarev & Petkova, p. 128, Pl. 33, Fig. 5.

P.p. 2000. Bozukov, p. 15, Pl. 1, Fig. 1.

Material: leaf imprints from the Middle Miocene floras of Ruzhintsi (P-3755a,b, P-3650) and Satovcha (Sat.-2427a,b).

Comparison: When Palamarev & Petkova (1987) supported with arguments their new tasxonomic combination *B. jatrophaefolia,* they reported an ungrounded description by Kolakovsky (1964) of a new species under the name of *B. mirabilis*. This author had not taken into consideration that a species with identical morphology already existed. According to Palamarev & Petkova (1987), it is about the same species, namely *B. jatrophaefolia*. On these grounds, we assume that Papikyan & Gabrielyan's (2017) find of *B. mirabilis* in the Early Pliocene flora Hartun-1 (Armenia), in fact is *B. jatrophaefolia.*

Discussion

From the above-stated it could be concluded that the family *Araliaceae* is comparatively well represented in the Bulgarian Neogene macroflora by five genera and eight species, while in the Bulgarian Paleogene macroflora only one species is registered – *Panax longisimum* (Table 1). The palynological data from Bulgaria, which were cited above, support the predominance of family during the Miocene. This ratio is analogous to the fossil family members on the territory of Europe too. Six species of four genera are registered in Paleogene by macrofossils, while they are thirty species of nine genera in Neogene (Table 1).

An interesting fact presents *Aralia* species originating from Oligocene sediments in Western Siberia (Dorofeev 1963), but registered on Bulgarian territory in the Neogene deposits (Palamarev 1971, 1994). Probably that was one of the directions of this species migration triggered out by the climatic changes in W Asia during these periods.

Of the species analyzed here, only *Hedera helix* is an autochtonous species, the rest have nearest living relatives (NLR) mainly in areas with tropical and subtropical climate in Asia, Neotropics and New Zealand (Table 1). Analyzing the data presented in Table 1, it could be said that the greatest species variety of the family coincides with the Middle Miocene climatic optimum, which probably had contributed to the migration of species from Asia and America. At the boundary between Miocene and Pliocene, the number of species marks a sharp decrease and during the Pliocene only *H. helix* was registered on the territory of Bulgaria by leaf impressions (Stojanoff & Stefanoff 1929; Stefanov & Jordanov 1934) and *Aralia rugosa* by endocarps (Palamarev 1994). A decrease in the number of genera and species of this family is also observed across Europe during the Pliocene. Data on this epoch leaf remains are scanty again. Carporemains are predominant and only *Hedera helix* was reported by leaf imprints (Table 1).

The find of Middle Miocene Balkan originated species *Brassaiopsis jatrophaefolia* in Armenian Lower Pliocene sediments (Papikyan & Gabrielyan 2017) probably registers the last refuge of that species, which was situated on the border between Europe and Asia.

The nearest living relatives shown at Table 1 are mainly shrubs. *Brassaiopsis grushvitzkyi* and *Schefflera hypoleuca* are small trees. Only *Hedera helix* is a root-climber plant. This suggests that the role of the family in the Neogene vegetation composition on the territory of Bulgaria was mainly in shaping out of the shrub floor.

Climatic requirements of the NLR are a reliable indicator of the climatic parameters, under which the fossil species had existed. With the exception of some *Aralia* species and *Hedera*, all other NLR are distributed in regions with Cfa type climate. According to Köppen's classification (1931), that means a temperate climate with hot summer and without a dry season. This climate type has enabled the representatives of family *Araliaceae* to achieve their most important distribution on the territory of Bulgaria, especially in the Middle Miocene – six species of four genera (Table 1). The family had gradually lost its species diversity after that peak in its development mainly due to the climate change. Thus, only one representative of the family – *Hedera helix* is present in Bulgaria and Europe now. Particularly for genus *Hedera*, the driving force for its evolution was the geographic isolation (Valcárcel & al. 2017).

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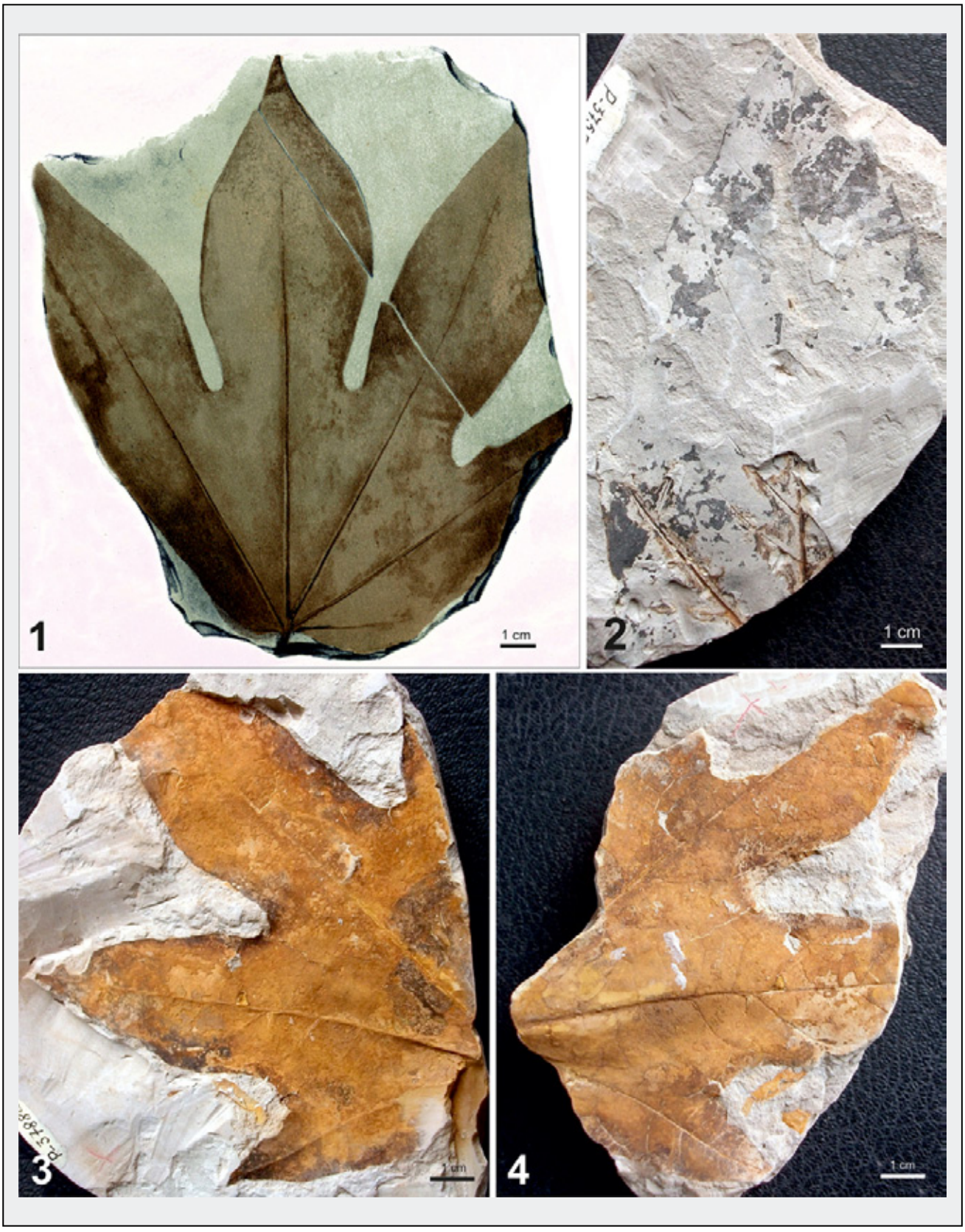
Plate I.



1. *Brassaiopsis digitata,* after Unger (1847); **2.** *B. jatrophaefolia* (P-3755a); **3.** *B. digitata* (P-3788a); 4. *B. digitata* (P-3788b).

Plate I I.

1. *Brassaiopsis* aff. *hispida* (Sat-1193a); **2.** *Brassaiopsis* aff. *hispida* (Sat-1193b); **3.** *B. jatrophaefolia,* after Unger (1847); **4.** *B. jatrophaefolia* (Sat-2427a).

Table 1. An alphabetical list of *Araliaceae* Cenozoic macrofossil taxa from Europe, their nearest living relative (NLR) and other characteristics.

Fossil taxa / fossil type	NLR / life-form / geographic distribution	Geographic / Stratigraphic distribution of fossil taxa	References
Acanthopanax solutus Gregor / carpoid	*A. senticosus* (Rupr. & Maxim.) Seem. / shrub / E Asia	Germany / M Miocene	Gregor (1978)
Acanthopanax sp. 2 / carpoid	Not shown	Poland / Pliocene	Szafer (1954)
Aralia cf. *cachemirica* Dcne. / carpoid	*A. cachemirica* Dcne. / shrub / C Asia	Poland / Pliocene	Szafer (1954)
Aralia cordata Thunb. foss. / carpoid	*A. cordata* Thunb. / shrub / Japan	Poland / Pliocene England / Pliocene	Szafer (1954) Reid (1920)
Aralia crassa Dorof. / carpoid	*A. nudicaulis* L. / shrub / N and E Nord America; *A. spinosa* L. / shrub / Florida peninsula	Bulgaria / M Miocene	Palamarev (1971)
Aralia dorofeevii Mai / carpoid	*A. continentalis* Kitag. / shrub / E Asia	Germany / U Oligocene - L Miocene Germany / U Oligocene	Mai & Walther (1991) Mai (1997)
Aralia cf. *hispida* Mchx. / carpoid	*A. hispida* Mchx. / shrub / N America	Poland / Pliocene	Szafer (1954)
Aralia cf. *mandchuurica* Rupr. & Maxim. / carpoid	*A. mandchuurica* Rupr. & Maxim. / shrub / SE Asia	Poland / Pliocene	Szafer (1954)
Aralia longisperma Dorof. / carpoid	Not shown	Germany / M Miocene Germany / U Oligocene Germany / U Miocene	Gregor (1978) Mai & Walther (1991) Mai (2001)
Aralia lusatica Mai / carpoid	*A. spinosa* L. / shrub / E North America	Germany / U Oligocene - L Miocene Germany / U Oligocene	Mai & Walther (1991) Mai (1997)
Aralia cf. *mandchuurica* Rupr. & Maxim. / carpoid	*A. mandchuurica* Rupr. & Maxim. / shrub / SE Asia	Poland / Pliocene	Szafer (1954)
Aralia rugosa Dorof. / carpoid	*A. hispida* Went. / shrub /N and E North America; *A. spinosa* L. / shrub / pen. Florida	Poland / Miocene Bulgaria / U Miocene - L Pliocene	Łańcucka-Środoniowa (1979) Palamarev (1994)
Aralia szaferi Mai & Walth. / *carpoid*	*A. californica* Wats. / shrub / W Nord America	Germany / Pliocene	Mai & Walther (1988)
Aralia tertiaria Dorof. / carpoid	*A. continentalis* Kitag. / shrub / E Asia	Poland / Miocene Germany / M - U Miocene	Łańcucka-Środoniowa (1979) Mai (2001)
Aralia ucrainica Dorof. / carpoid	*A. thomsonii* Seem. / shrub / SE Asia	Ukraine / U Miocene Poland / Miocene	Dorofeev (1955) Łańcucka-Środoniowa (1979)
Aralia sp. / carpoid	*A. cordata* Thunb. / shrub / Japan; *A. racemosa* L. / shrub / N America	Poland / Miocene	Łańcucka-Środoniowa (1979)
Aralia sp. / carpoid	Not shown	Italy / L Pliocene	Martinetto & al. (1997)
Brassaiopsis digitata (Ung.) comb. nov. / leaf	*B. grushvitzkyi* J. Wen & al. / small tree / Indo-China	Croatia / M Miocene Bulgaria / M Miocene	Unger (1847) in hoc loco
Brassaiopsis aff. *hispida* Seem. / leaf	*B. hispida* Seem. / shrub / Indo-China	Bulgaria / M Miocene Bulgaria / M Miocene	Bozukov (2000) in hoc loco
B. jatrophaefolia (Ung.) Palam. & Petkova / leaf	*B. hainla* (Buch.-Ham.) Seem. / shrub / Indo-China	Croatia / M Miocene Bulgaria / M Miocene	Unger (1847) Palamarev & Petkova (1987); Bozukov (2000)
Eleuterococcus uralensis Dorof. / carpoid	*A. sessiliflorum* (Rupr. & Maxim.) Seem. / shrub / SE Asia	Poland / Pliocene Germany / Pliocene	Szafer (1954) (*Acanthopanax* sp. 1) Mai & Walther (1988)
Hedera helix L. / leaf	*H. helix* L. / liana / Europe, Asia	France / U Miocene Bulgaria / U Miocene - L Pliocene Germany / Pliocene	Grangeon (1958) Stojanoff & Stefanoff (1929); Stefanoff & Jordanoff (1934) Mai & Walther (1988)
Hedera cf. *helix* L. / leaf	*H. helix* L. / liana / Europe, Asia	Hungary / M Miocene Italy / U Miocene - L Pliocene	Andreanszky (1959) Kovar-Eder & all. (2006)
Hedera multinervis Kolak. / leaf	*H. colchica* (K. Koch) K. Koch / liana / Near, Middle East	Greece / U Miocene	Kvaček & al. (2002)

Table 1. Continuation.

Fossil taxa / fossil type	NLR / life-form / geographic distribution	Geographic / Stratigraphic distribution of fossil taxa	References
Hedera cf. *multinervis* Kolak. / leaf	*H. colchica* (K. Koch) K. Koch / liana / Near, Middle East	Spain / U Miocene	Barron & al. (2002)
Oreopanax protomulticaulis (Rasky) Hably / leaf	*O. crassinervium* Decne. & Planch. / shrub / Ecuador	Hungary / L Miocene Bulgaria / M Miocene	Hably (1983) Bozukov (2000)
Panax longissimum Ung. / leaf	*P. simplex* Forst / shrub /New Zeeland	Bulgaria / U Eocene - L Oligocene Slovenia / L Miocene	Černjavska & al. (1988) Unger (1850)
Pentapanax tertiarius Mai / carpoid	*P. yunnanensis* Franch. / shrub / China	Germany / Pliocene Germany / U Oligocene - L Miocene Germany / M - U Miocene	Mai & Walther (1988) Mai & Walther (1991) Mai (2001)
Schefflera chandlerae Palam. / carpoid	*S. digitata* Forst. & Forst. f. / shrub / New Zealand; *S. rigida* (Bl.) Harms / shrub / Indonesian; *S. hypoleuca* (Kurz.) Harms / small tree / Indo-China.	Bulgaria / M Miocene	Palamarev & Petkova (1987)
Schefflera dorofeevii Łańc.-Środ. / carpoid	*S. venulosa* (With. & Arm) Harms. / shrub / Indochina	Poland / Miocene Germany / U Oligocene Germany / Oligocene	Łańcucka-Środoniowa (1979) Mai & Walther (1991) Mai (1997)

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