

***PTEROPHYLLA* (CUNONIACEAE) – A NEW GENUS  
FOR THE FOSSIL FLORA OF BULGARIA**

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**Abstract**

New macrofossil material from Palaeogene sediments of the Hvoyna Basin (Central Rhodopes, Bulgaria) has been investigated. The material originates from sandstone–siltstone deposits of Late Eocene–Early Oligocene age exposed near the village of Pavelsko. It represents the imprint of a leaflet assigned to the species *Weinmannia paradisiaca*.

Based on a revised interpretation of the generic affiliation of the nearest living relative of this fossil species – *Weinmannia sylvicola* (= *Pterophylla sylvicola*) – a new combination, *Pterophylla paradisiaca* (comb. nov.), is proposed. The genus *Pterophylla* is reported for the first time from the fossil flora of Bulgaria.

In addition, fossil material from the Early Oligocene flora of Brezhani (NW Pirin Mountains, Bulgaria), previously identified as *Celastrus aeoli*, is reinterpreted here as belonging to *Pterophylla paradisiaca*.

**Key words:** Cunoniaceae, Early Oligocene, fossil macroflora, *Pterophylla*, Rhodopes, *Weinmannia*

**Introduction.** The Hvoyna Basin is situated in the northern part of the Central Rhodopes. Its Palaeogene section comprises sedimentary and volcanic rocks (Fig. 1A). According to recent geological investigations [1], the sandstone–siltstone formation bearing fossil flora is dated to the Late Eocene–Early Oligocene. This formation crops out in the eastern part of the basin, in the vicinity of the villages of Pavelsko (Fig. 1B, C) and Hvoyna (Smolyan Region).

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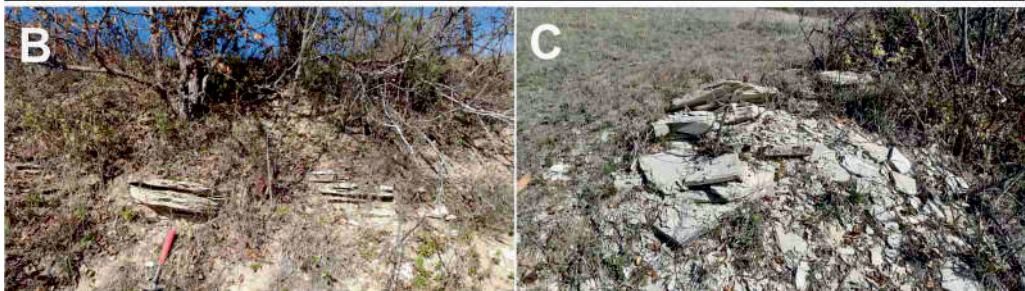
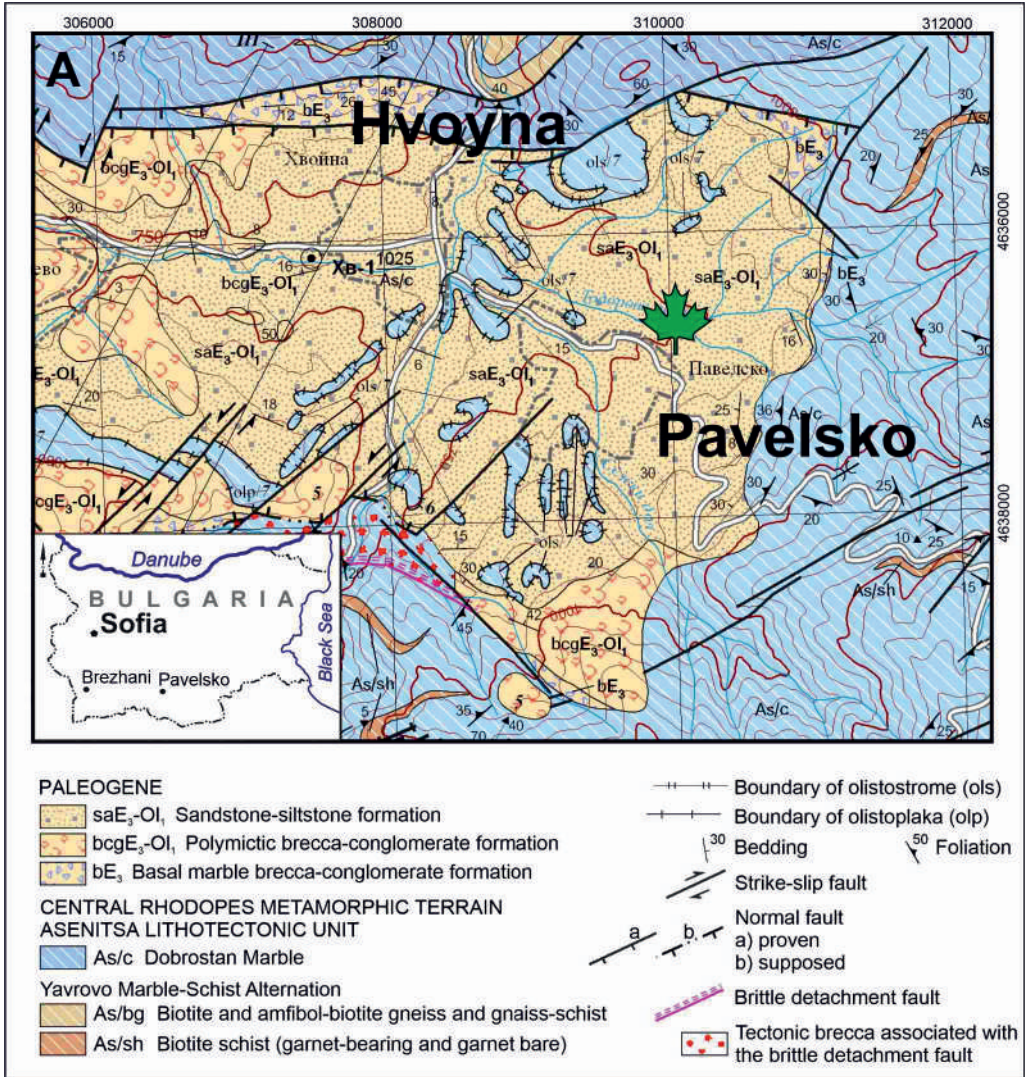


Fig. 1. A – Geological map of eastern part of the Hvoyna Basin (redrawn from [1] with additions); B, C – Flora-bearing layers near the village of Pavelsko

Fossil flora from the Hvoyna Basin has been recorded from four localities near the villages of Hvoyna, Malevo, Orehovo, and Pavelsko. A comprehensive macro- and microfossil study of these floras has yielded detailed floristic, palaeoecological, and biostratigraphic data [2]. The results confirm a Latest Eocene–Early Oligocene age for the flora-bearing sediments and establish the presence of a warm temperate (mesothermal), humid climate with hot summers – corresponding to a Cwa-type climate according to the Köppen climate classification (cited after [3]). Subsequent investigations have enriched the taxonomic composition of the palaeoflora and further supported these conclusions [4–7].

The study of Early Oligocene local floras in Bulgaria is of particular importance because, at that time, representatives of families that are exotic to the modern European flora – such as Proteaceae and Cunoniaceae – were still present. During the Late Oligocene, climatic changes led to their gradual replacement by Arctotertiary elements of Betulaceae, Fagaceae, Juglandaceae, and related families [8]. Thus, the Oligocene marks the transition from tropical and subtropical vegetation to the temperate-type flora that characterizes the region today.

**Material and methods.** The study is based on an imprint and counter-imprint of a leaflet preserved in sandstone–siltstone exposed near Pavelsko. The specimens are housed in the Palaeobotanical Collection of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (collection numbers CMII-350a and CMII-350b).

Leaf architecture was analyzed following the Angiosperm Leaf Morphology Scheme of DILCHER [9]. Higher-level taxonomy follows the Angiosperm Phylogeny Group (APG) classification system [10]. Photographs were taken using a Canon EOS 90D digital camera equipped with a SIGMA DG Macro HSM lens.

## Results and discussion.

### Systematics

Kingdom: Plantae

Clade: Angiosperms

Clade: Eudicots

Order: Oxalidales

Family: Cunoniaceae R.Br.

Genus: *Pterophylla* D.Don

*Pterophylla paradisiaca* (Ett.) comb. nov. (Fig. 2A, B)

1853. *Weinmannia paradisiaca* Ettingshausen, p. 14, Pl. 23, Fig. 1–7.

1963. *Celastrus aeoli* Ett.; Palamarev, p. 78, Pl. 2, Fig. 26.

**Description.** Leaflet lamina shape – symmetrical; form – narrow obovate; apex – acute; base – acute, decurrent. Leaflet margin – toothed, serrate; serration type – B1; sinuses between teeth – rounded; regular interval between teeth, with a relatively large distance separating them. Venation semicraspedodromous; secondary veins 6–7 pairs, markedly thinner than the midvein, diverging at 60° on the leaflet base to 40° on the upper part.

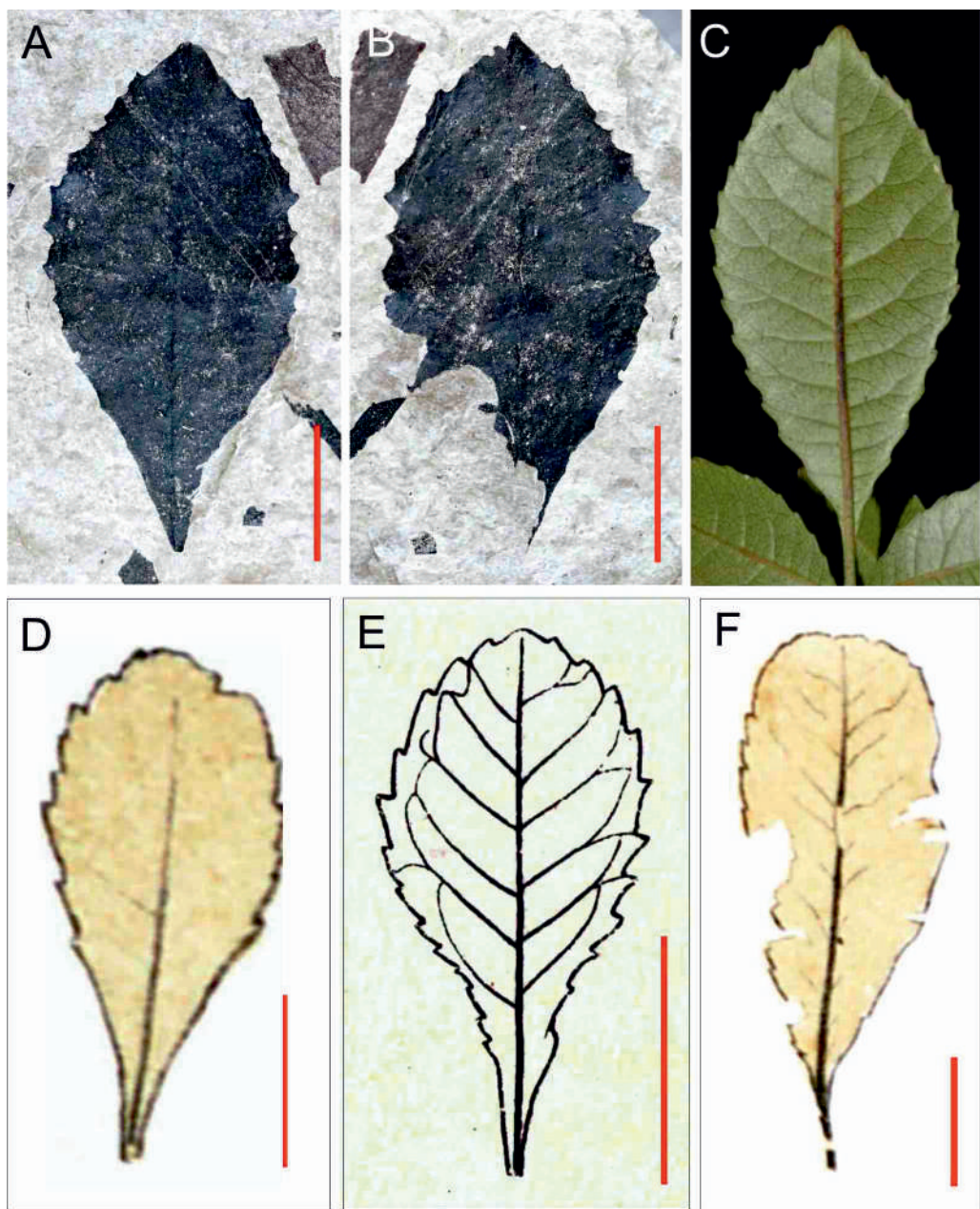


Fig. 2. A – Imprint of *Pretophylla paradisiaca*, CMII-350a; B – Its counter-imprint, CMII-350b; C – Leaflet of *P. sylvicola*, after [13]; D – *Weinmannia paradisiaca*, after [11]; E – *Celastrus aeoli*, after [14]; F – *C. aeoli*, after [11] (Measuring bar – 1 cm)

**Comparison.** The species *Weinmannia paradisiaca* was originally described from the Early Oligocene flora of Häring (Tyrol, Austria) [11] as leaflets of a

compound leaf. The illustrated material shows polymorphism typical of compound leaves, with apical and lateral leaflets differing in shape. The Pavelsko specimen closely corresponds to one of the forms illustrated in the original description [11] (Fig. 2D).

The nearest living relative (NLR) of the fossil taxon was identified as *Weinmannia sylvicola* Sol. ex A.Cunn. [11], a species native to the North Island of New Zealand, where it grows as a tree in subtropical forest environments [12]. This species also exhibits variability in marginal tooth morphology (acute or obtuse apical angles). The Bulgarian fossil material corresponds to forms with acute teeth [13] (Fig. 2C).

Fossil material from the Early Oligocene flora of Brezhani (SW Bulgaria), previously assigned to *Celastrus aeoli* [14] (Fig. 2E), is morphologically identical to the Pavelsko material. However, some discrepancies argue against attribution to *Celastrus aeoli*:

1. The apex in the Brezhani material is acute or obtuse, whereas *C. aeoli* from Häring (Fig. 2F) shows rounded to emarginate apices.
2. The sinuses between teeth in *W. paradisiaca* are rounded, whereas those in *C. aeoli* are sharp.
3. In *W. paradisiaca*, the teeth are arranged at relatively large intervals, while in *C. aeoli* they are more densely spaced.
4. In *W. paradisiaca*, the secondary veins are 6–7 pairs, while in *C. aeoli* they are 9–10.

These differences justify reassignment of the Brezhani material to *W. paradisiaca*. Given the close geographical proximity and equivalent Early Oligocene age of the Brezhani and Pavelsko floras, the occurrence of the same species at both localities is plausible.

**Stratigraphic and geographic distribution.** The fossil species *W. paradisiaca* is currently known only from the Early Oligocene flora of Häring [11]. Its occurrence in the Bulgarian fossil flora is fully consistent with its established stratigraphic range, namely the Lower Oligocene. Geographically, the Central European locality and the newly discovered site in SE Europe are relatively close to one another, suggesting similarities in the composition of contemporaneous fossil floras.

Taxonomic research frequently results in revisions to the systematic placement of individual species and even entire genera. Such is the case with the genus *Weinmannia*, which comprises trees and shrubs belonging to the family Cunoniaceae. This family is predominantly distributed in tropical and humid temperate regions of the Southern Hemisphere. Until recently, it included species ranging from Mexico through Central and South America, including the Caribbean, as well

as the Mascarene Islands (Mauritius and Réunion) in the western Indian Ocean, Madagascar, Malesia, Papuasia, and the Pacific Islands. The genus is absent from mainland Africa and Australia, although some Australian fossil material has been attributed to *Weinmannia* [15].

Recent phylogenetic studies of Cunoniaceae [16] have resulted in the segregation of several species formerly placed in *Weinmannia* into the genus *Pterophylla* D. Don, including taxa distributed in Madagascar, the Comoros, Malesia, and the Pacific region. Since the NLR of the fossil species, formerly known as *Weinmannia sylvicola*, is now treated as *Pterophylla sylvicola*, the fossil species must likewise be transferred to *Pterophylla*. Accordingly, the new combination *Pterophylla paradisiaca* (Ett.) comb. nov. is proposed.

*P. sylvicola* grows primarily in forests and along forest margins, from North Cape southward to the Waitākere Ranges west of Auckland. It is most commonly found in the so-called “cloud forests,” defined as forest communities influenced by frequent and/or persistent ground-level cloud cover. These forests experience an average annual rainfall exceeding 2000 mm, a mean annual temperature of approximately 11–12 °C, and a high frequency of low-laying cloud cover [17].

These environmental parameters are consistent with the plant formations proposed by ČERNJAVSKA et al. [2] as representing part of the vegetation in the Rhodope region during the Late Eocene – Early Oligocene, whose modern analogue is the subtropical montane rain forest of Taiwan. High humidity and the absence of pronounced cold seasons are characteristic conditions both for the development of Late Eocene – Early Oligocene vegetation in the Rhodopes and for the present-day distribution of the NLR of the *P. paradisiaca*.

**Conclusions.** The macrofossil material from Pavelsko is assigned to the genus *Pterophylla* (Cunoniaceae). In light of recent taxonomic revisions within the family, the fossil species *Weinmannia paradisiaca* is here transferred to *Pterophylla* as *Pterophylla paradisiaca* (Ett.) comb. nov. This represents the first record of the genus *Pterophylla* in the fossil flora of Bulgaria.

The data further confirm that subtropical formations developed in the Rhodope region during the Late Eocene–Early Oligocene under warm and humid climatic conditions. The revision of the Brezhani material demonstrates that the species previously identified as *Celastrus aeoli* should be reassigned to *Pterophylla paradisiaca*.

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