

FIRST EVIDENCE FOR MIDDLE MIOCENE PETRIFIED WOOD REMAINS FROM THE BULGARIAN BLACK SEA SHORE

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Abstract

Ten specimens of Middle Miocene petrified wood remains collected from the Bulgarian shore of Black Sea, close to Byala locality, were analysed through a microscopic study. The samples originate from the Galata Formation and are of Chokrakian age. Eight of these are taxonomically identified as *Populoxylon* sp. (cf. *Populus tremula* L.). This find represents the first record of the genus *Populoxylon* in the Bulgarian Miocene flora. Based on the great similarity of the xylotomical features of studied specimens to those of the recent species, a close connection with recent *Populus tremula* is observed. Genus *Populus* is widespread in the fossil record of Bulgarian Cenozoic flora as leaf imprints.

Key words: Black Sea shore, Bulgaria, Chokrakian, petrified wood, *Populoxylon*

Introduction and geological settings. We had in study some petrified wood remains collected by two of the coauthors from the Bulgarian shore of Black Sea, close to Karadere beach, Byala locality, south of Varna (Fig. 1). The studied area represents the southernmost part of Varna-Balchik Depression [1]. The analysed wood remains originate from Galata Formation [2]. The age of deposits is

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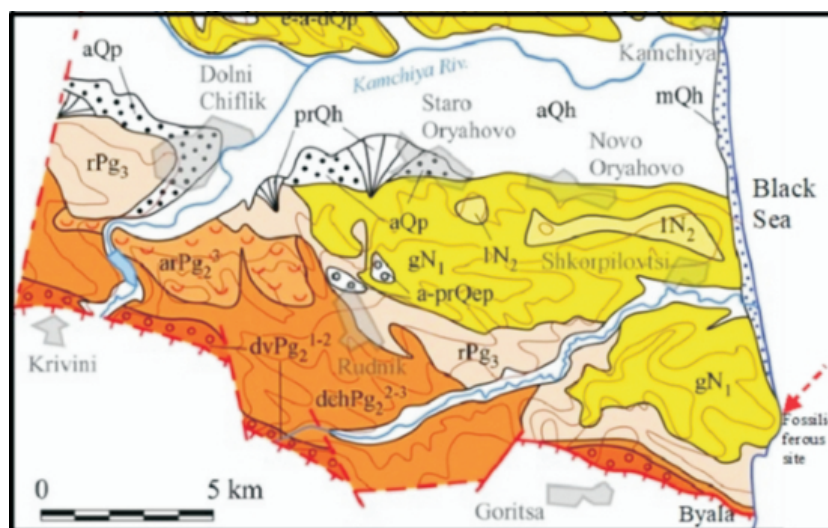


Fig. 1. Geological map of studied area with the position of fossil wood remains (after [2,3]); gN₁ = Chokrakian (Miocene), Galata Formation

considered Chokrakian (= Langhian in Mediterranean area and Early Badenian in Central Paratethys), based on fossil molluscs and foraminifers [1].

The Galata Formation is composed predominantly of mid- to coarse-grained sands, intercalated by frequent clay and rare limestone and clayey sandstone beds. It was deposited in shallow marine environment of Varna-Balchik Depression, with predominant beach sands, tidal deposits and deltaic channels. According to POPOV and KOJUMDJIEVA [1], the southern part of the depression became dry land at the end of the Chokrakian, shifting the depocentre of maximum sedimentation northwards.

The collected material appears as fragments of big trunks in some sedimentary rocks from the beach outcrop to the north of Black Cape (Karadere), where sands, gravels and conglomerates with volcanic clasts are exposed. Also fragmentary samples were found, sometimes reworked (see Fig. 2a, b, c). All collected samples are hosted now in the Paleobotanical collection of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria, under Sh-1 to Sh-10 inventory numbers.

Material and methods. Ten samples collected from Byala area, Bulgarian shore of Black Sea, coming from Galata Formation (Middle Miocene) have been studied. For the xylotomical study, from each sample, oriented thin-sections of petrographic type were prepared, according to the recommended three standard directions – transversal, tangential and radial. These sections have been studied by transmitted light microscope. Eight specimens showed wood structure and were submitted to the microscopical study.

All the anatomical details were studied and described for each specimen,

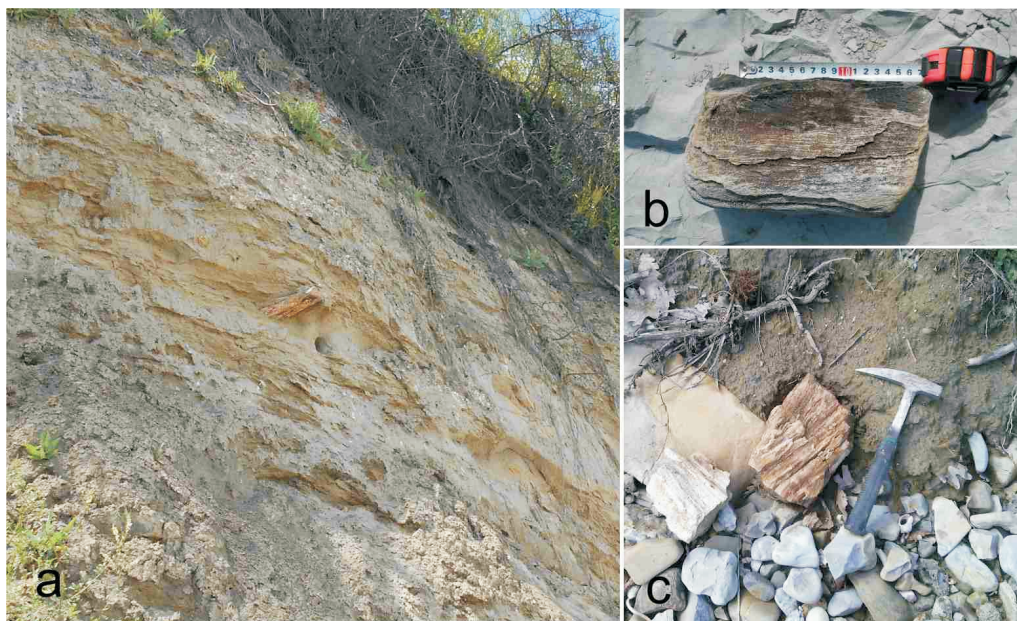


Fig. 2. Photos of petrified wood in the fossiliferous site

using the scientific terms as defined by the IAWA lists of microscopic features for softwood and hardwood identification published by IAWA Committee [4].

The photos of the xylotomical details were captured with an “EverFocus” video-camera adapted to microscope, using the software “AVerMedia”, and the images were processed with specialized computer programs.

The identification of the unknown original tree was subsequently performed by comparison with previously described similar aspects of fossil or recent wood structures, from published scientific papers (all included in the References section).

The systematics followed APG IV [5], and the ICN-Shenzhen Code [6].

Results.

Family **SALICACEAE** MIRBEL

Genus ***Populoxylon*** MÄDEL-ANGELIEWA, 1968

Populoxylon sp. (cf. *Populus tremula* L.)

(Fig. 3a-i)

Material code: Sh-1, Sh-2, Sh-4, Sh-6, Sh-7, Sh-8, Sh-9, Sh-10.

Locality: the samples were collected from the Bulgarian shore of Black Sea, close to Karadere beach, Byala locality, South of Varna.

Age: Middle Miocene, Chokrakian.

Formation: sedimentary deposits of Galata Formation [2] outcropping at the shore of the sea [1].

Repository: The samples are hosted in the Paleobotanical collection of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria, under the inventory numbers: Sh-1, Sh-2, Sh-4, Sh-6, Sh-7, Sh-8, Sh-9, Sh-10.

Microscopic description. Growth rings, in cross-section seen, are wide, with a diffuse-porous to semi-ring porous wood-structure and quite indistinct ring-boundaries, guessed between the late-wood with small vessels and the early-wood, suddenly starting with large pores.

The vessels, in the cross-section seen appear in radial pattern between two successive rays, usually grouped as radial multiples of 2–5 pores or more and grouped as 6–9 pores. Also, solitary pores appear, whose contour is polygonal, or rounded to oval. As grouped, larger and smaller vessels are present and are deformed by compression. The mean tangential diameter of the solitary vessels lumen is of 50–120 μm , and thick-walled 3–5 μm simple wall. The density is 50–100 vessels per square millimeter, sometimes more. In longitudinal view, the vessels show simple perforation plates, inclined, usually poorly preserved. Mean vessel element length, 500–700 μm , but usually difficult to measure. The intervessel pits, of bordered type, are polygonal, mean-sized – of 7–10 μm in diameter and have horizontal-elliptic apertures of 3–4 μm . They are numerous, alternately arranged, but very poorly preserved. Vessel-ray pits are quite similar to the intervessel pits in size and shape throughout the ray cell, but poorly preserved, so usually difficult to observe (see the cross field pits described below). The vessel-element length is probably $\geq 800 \mu\text{m}$, but difficult to measure, due to poor preservation. Thin-walled globular tyloses and with dark gum remains or fungi, sometimes appear inside the vessels. Thin helical thickenings on vessels walls are usually present.

The ground tissue includes fibres and parenchyma, which appear usually mixed.

The libriform fibres have polygonal cross-section, of 12–16 μm in diameter, and relatively thick walls: 3–5 μm the double wall. They are non-septate and have a poorly preserved pitting on the longitudinal walls. Fibro-tracheids are present, linking the radial groups of vessels, as 1–5 cells, and are similar to the libriform fibres, or larger, of 15–20 μm , and are moderately thick-walled, of 3–6 μm the double wall. More microscopic details are difficult to observe, due to poor preservation.

The axial parenchyma appears in cross section few and scarce, diffuse or terminal, rather indiscernible, even if sometimes it appears, in vertical section, as chambered cells, probably crystalliferous.

The rays appear thin in cross-section, exclusively uniseriate, as radial fascicles of rectangular radially elongated cells, often full of gum content, so it is difficult to see details on their horizontal walls. The ray trajectory is usually linear, or slightly sinuous. Tangentially the rays clearly appear exclusively uniseriate, and have 5–15(–25) cells in height or even more. Sometimes biseriate stories appear.

The ray-cells have polygonal rounded to vertical elongate shape and, the marginals are slightly higher. The ray-frequency is ≥ 12 / mm, we counted even 18–22(–35) rays per tangential mm. Radially, the ray-body is constituted from thin-walled cells, homocellular and all procumbent, the marginals are slightly taller or even square, suggesting a tendency to heterocellularity. The cross-fields with vessels present 1–2(–4), weakly bordered pits per field, sometimes more numerous, in the marginal fields. The pits are polygonal rounded to oval, of 4–7 μm in diameter, in 1–4 horizontal rows arranged, in the marginal fields in 2–7 rows, but often are difficult to observe, due to the poor preservation.

Special details as sheath cells or tile cells are not present. Also storied structures, secretory elements, intercellular canals, cambial variants, included phloem are absent.

Crystal inclusions are sometimes present in axial chambered parenchyma, probably as secondary mineralization during petrification. Sometimes, partially rotted wood structures were preserved, difficult to appreciate.

Affinities and discussions. The studied specimens show, in cross section, some xylotomical features typical for the current members of Salicaceae family, such as the uniseriate rays, diffuse-porous distribution of vessels, usually as radial multiples of 2–5 pores, or more, mixed with few solitary pores, and homocellular rays with cross-fields specifically pitted, similar to the current genus *Populus* L. Very similar features also appear in the current *Salix* L., in which the cross-section shows diffuse-porous distribution of vessels which appear usually solitary and the rays are heterocellular [7–9].

As about *Populus*, we searched in the above cited sources, on the current species naturally growing in Europe and in Anatolian area today, and we found that there are five species of poplars, as follows: *Populus euphratica* Oliver, *P. nigra* L., *P. alba* L., *P. tremula* L. and *P. × canescens* (Aiton) Sm., which is considered a hybrid between the last two species (see *P. × canescens*).

Unfortunately, all these current species have very similar features, so it is very difficult to distinguish from each other on the basis of their wood anatomy. Some differences could be, since in the fossil species the rays seem to be higher and the marginal axial parenchyma could be more common [8,9].

The correspondent fossil genus *Populoxylon* was erected by MÄDEL-ANGELIEWA [10], with *P. priscum* Mädel-Angeliowa, as type species. This is the original diagnosis: “Diffuse porous wood with usually grouped vessels, that has simple perforations and numerous alternate intervascular pitting. The uniseriate rays have all procumbent cells, the marginals higher, the cross-fields simple pitted, in 2–3 horizontal rows of slightly oval pits, and few parenchyma.” And our studied specimens have almost the same xylotomical features.

There are few described fossil forms and we consulted for comparison the paper of NASTSCHOKIN [11], who described from the Quaternary of Yenisei-river basin (Russia) a *Populus* sp. (*P. tremula* L.), which is slightly similar to our

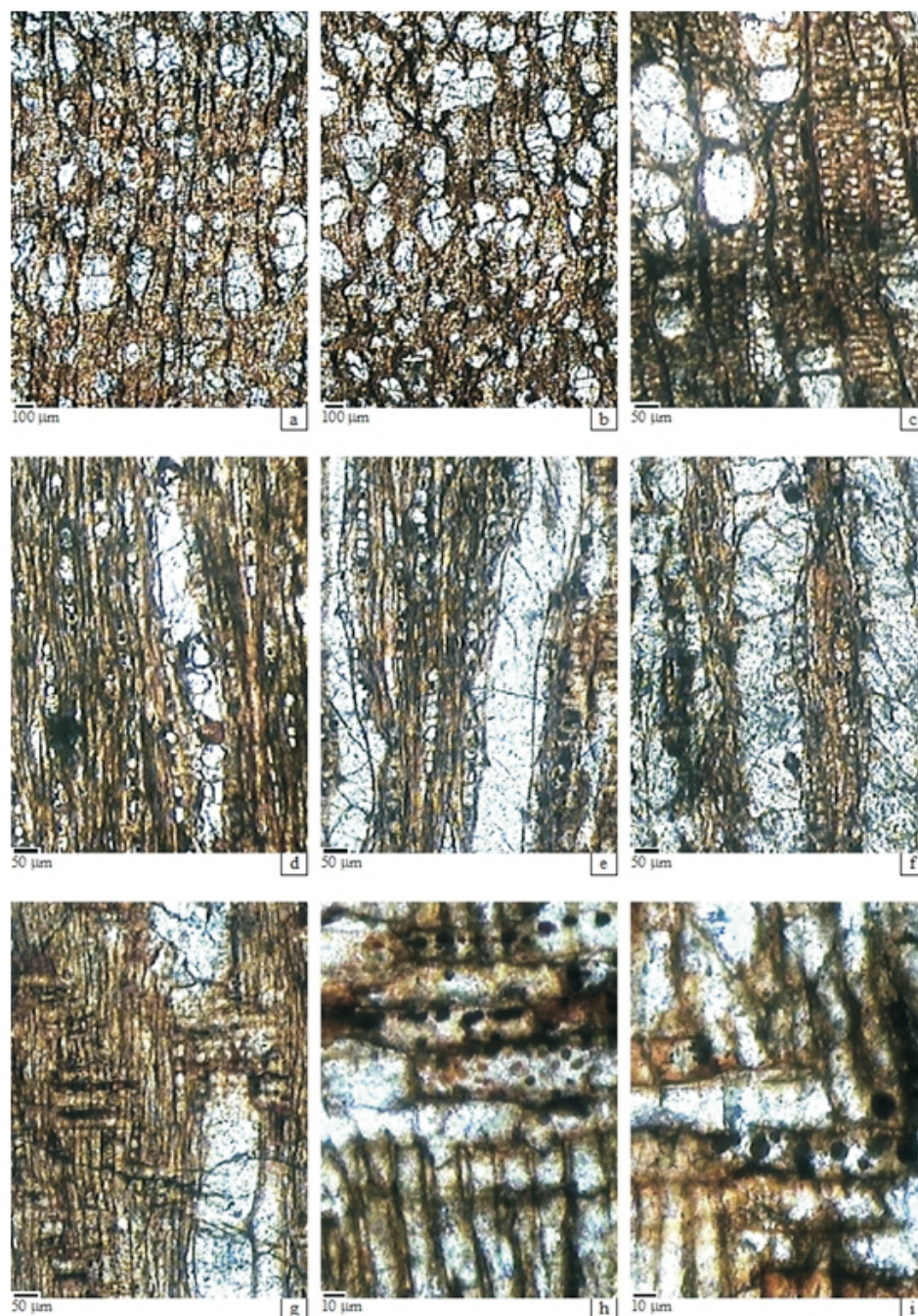


Fig. 3. *Populoxylon* sp. (cf. *Populus tremula* L.). Specimen Sh-2. a, b, c – cross-section: growth rings with diffuse porous distribution of vessels, fine rays, regular libriform fibres (c); d, e, f – tangential section: vessels with tyloses (d), thin spiral thickenings (e, f), poorly preserved alternate intervascular pitting (d, f) and uniseriate rays; g, h, i – radial section: vessels with simple perforated plates, parenchyma with crystals (g), homocellular rays, poorly preserved cross-fields with vessels (h, i)

studied specimens. Also, a similar form was described by GREGUSS [12], as *Populoxylon* sp. (cf. *Populus tremula* L.), from the Sarmatian of Mikfalva (Hungary), which has a semi-ring porous wood with radially grouped vessels with simple perforation plates and alternate polygonal intervessel pits and, only uniseriate rays.

Both these structures are similar to the current species *Populus tremula* L., see [7] and [8], and are very similar to our studied specimens. But it must be reminded that SAKALA [9,13] observed that, because the lack of the radial section at the identification of Greguss, it cannot confirm whether the rays are homocellular, similar to *Populus* L., or heterocellular, similar to *Salix* L.

Another form was described by DOUTRELEPONT et al. [14] as *Populoxylon* sp., as having the vessel distribution in cross-section similar to the extant *Populus euphratica* Olivier, so, it is slightly different of our specimens.

A *Populoxylon* sp. (cf. *Populus alba* L.) was described by IAMANDEI et al. [15,16], from some Mid-Miocene petrified woods collected from Prăvăleni-Ociu (Apuseni Mts.) and also, from Bala area (Mehedinți Mts.), as presenting a great xylotomical similarity to the current *Populus alba* L., but which is slightly different from our here studied specimens, at least by their porosity.

Also, AKKEMIK [17] described from Turkey (Hoçaş village, Seben city, Bolu), a new species of fossil poplar as *Populoxylon sebenense* Akkemik, which is slightly different from our specimens by the obvious presence of the marginal axial parenchyma.

Numerous Miocene wood remains, showing a xylotomy very similar to the current species *Populus tremula* L. were collected from Apuseni Mts. (Romania), and were described by us, as *Populoxylon tremuloides* (unpublished Ph.D. Thesis). Also, some other Miocene wood remains collected from the Moldovian platform, from Otovasca quarry, near Chișinău [18], and from Simila quarry, Bârlad area [19] showed a xylotomical structure very similar to the current species *Populus tremula* L., as well as to the here studied material.

Thus, taking into account the above discussion, and observing a great similarity of the xylotomical features of our here studied specimens to those of the above reminded current species, we attribute them to the species *Populoxylon* sp. (cf. *Populus tremula* L.).

The genus *Populus* is widespread in the Bulgarian Cenozoic flora. Thirteen species of this genus have been identified by leaf imprints. The species *P. tremula* is also recorded ranging from the Upper Miocene to Upper Pliocene [20]. At the same time, the genus *Populoxylon* has not been established yet in the territory of Bulgaria.

Conclusions. The petrified wood remains, as trunk fragments, coming from some Middle Miocene deposits of Galata Formation, and showing a poplar structure, were identified as *Populoxylon* sp. (cf. *Populus tremula* L.), a common poplar, still naturally growing in Europe and in the Anatolian area today. The occurrence of genus *Populoxylon* was established for the first time on the territory

of Bulgaria.

Advanced geological studies in the discovered site could give more information on the real age and the conditions of fossilization of the wood remains, and new prospections could furnish more numerous and diverse petrified wood remains.

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