

EARLY CRETACEOUS PROTOPINACEOUS FOSSIL WOOD FROM SOUTH DOBROGEA, ROMANIA

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Abstract: The paper presents the identification of some form-species of protopinaceous conifers originating within the probable Early Cretaceous Forests covering the ancient Dobrogea region, as the abundance of the vegetal material preserved by the Aptian fluvio-lacustrine and Albian proximal littoral formations tells. So, found within a coarse detrital level of the Gherghina Fm., some fragments of petrified wood were identified as an already described species *Protocupressinoxylon dragastanii* IAMANDEI & IAMANDEI, 1999. Also from the Early Albian, in Medgidia Valley, at Remus Opreanu, within Cochirleni Fm., the *Mammillatum* zone, several phosphatized wood remains have been collected and were identified as *Brachyoxylon avramii* n.sp. and *B. dobrogiacum* n.sp., which are new to Romanian paleoecology.

Key words: South Dobrogea, Aptian, Albian, *Brachyoxylon*, *Protocupressinoxylon*, Protopinaceae.

INTRODUCTION

Geographically, the studied material originates in South Dobrogea, around Medgidia locality (Textfig. 1), hosted by Early Cretaceous deposits.



Medgidia

Textfig. 1. Location of the fossiliferous sites on the Romania's Map.

The Mesozoic Flora of Dobrogea is rather poorly known, with few published papers. From the Jurassic deposits, well biostratigraphied based on ammonites fauna and on microfauna (Dragastan *et al.*, 1998), some vegetal remains found within Late Bathonian Tichileşti Formation, in Central Dobrogea, have been described and identified as form-species of *Williamsonia*, *Ptilophyllum*, *Androstrobus*, *Nilssonia*, *Brachyphyllum*, *Pterophyllum*, *Pseudecten* and *Cycadeorachys* (Dragastan & Bărbulescu, 1980). A single piece of petrified wood has been found, wrongly described at that time, by the same authors, as *Sahnioxylon sp.*, later revised as *Protocupressinoxylon sp.* (see Philippe *et al.*, 1999).

The Early Cretaceous deposits are known within South Dobrogea in some drillings and in some occurrences on the banks of the right tributary valleys or lakes from the right side of Danube

River, in Carasu Valley, and in the right bank of the Danube. There, geological formations mostly of calcareous character have been described: Cernavodă Fm., Dumbrăveni Fm. and Ostrov Fm. (Dragastan *et al.*, 1998). After a hiatus in the sedimentation, a change of facies appeared after the Neocomian, starting with a lacustrine series with Characeae (=Dăulari Fm.), or a continental-fluvial one (=Gherghina Fm.) comprising Bedoulian-Gargasian detrital beds with pebbles and sands, followed by kaolinitic-polychromatic clays, followed then by marine deposits with *Acanthoplites uhligi*, Clansaysian in age (Avram *et al.*, 1988; Dragastan *et al.*, 1998).

From the coarse detrital bed frequently preserving vegetal remains, previously we have identified some samples of coniferous wood as *Protocupressinoxylon dragastanii* IAMANDEI & IAMANDEI, 1999 and *Chamaecyparixylon privegillii* IAMANDEI & IAMANDEI, 1999, found close to Cernavodă, on the right bank of Danube, respectively on the southern bank of Ţibrinu Lake. From the same formation, at Cuza Vodă, close to Medgidia, within a conglomeratic level, we found some badly preserved petrified wood remains and now we have identified them as belonging also to *Protocupressinoxylon dragastanii* IAMANDEI & IAMANDEI.

Cores from some drillings located on Seimeni, Cuza Vodă, Medgidia, Peştera, Şipote, Lipniţa and Oltina alignment showed the transgressive deposits of Cochirleni Fm. starting with glauconitic sands, followed by glauconitic marls of the Latest Aptian and Early + Mid-Albian age (Avram & al., 1988). Within the basal part the age is given by the ammonitic association with *Acanthoplites*, *Hypacanthoplites* (Avram *et al.*, 1988) showing Latest Clansaysian, followed by glauconitic rocks with *Leymeriella* and *Douvilleiceras*, a typical association for Early Albian and by *Hoplites* and *Anahoplites* association, indicating Mid-Albian (Chiriac, 1981). In these circumstances, on Medgidia valley, within the *Mammillatum* zone, besides phosphatized ammonites, belemnites and crocodilian teeth, many wood remains, also phosphatized, have been found. By paleoecological study we have identi-

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fied from here two new taxa: *Brachyoxydon avramii* n.sp. and *B. dobrogiacum* n. sp. All these taxa belong to the Mesozoic Conifers that, beside the modern conifers, belong to the Phylum **Pinophyta** CRONQUIST (Takht. & Zimmerm. ex Reveal). Those conifers presented many xylotomical features very similar to some extant equivalents and were partially included by Kräusel (1919, 1949) within the parataxonomic group named Protopinaceae. According Grambast (1952) this group corresponds to "a stage of evolution where disappeared forms without descendants and the tribe of the extant Coniferales appear together". The Kräusel list contains 25 genera attributed by that author to the Protopinaceae. Some of them cannot resist now to a critical review (see Table 1)

Within an elaborated revision of Triassic and Jurassic Protopinaceae, Vogellehner (1967, 1968)

have selected and attributed to this group, more conscientiously revised valid genera (Table 1). Also, a lot of revised and renamed species have been attributed to these main protopinaceous genera. Most of those taxa, with similar features, can be found within Cretaceous also. He clearly established that the structure of the secondary wood of Protopinaceae is of coniferous type, but the radial pitting on tracheids is combined (araucarian and abietinean), giving a "mixed type", also named "protopinoid type", a primitive xylotomical feature.

According to Vogellehner (1968), in the cross-fields ocellipores or oopores can be present, often within araucarioid arrangement. The horizontal or tangential ray-cell walls are usually unpitted (Philippe, 1983). Sometimes, short persistent axial resin ducts, probably traumatic, may be present (i.e. in *Brachyoxydon*, *Telephragmoxydon*).

Table 1. Comparative table of the main admitted Protopinaceous genera.

From Kräusel system (1919,1949)	From Vogellehner system (1967, 1968)	A proposed list of main protopinaceous genera
<i>Protopodocarpoxylon</i> ECKHOLD - - <i>Protophyllocladoxylon</i> KRÄUSEL - <i>Circoporoxylon</i> KRÄUSEL - <i>Xenoxylon</i> GOTHAN	<i>Protopodocarpoxylon</i> ECKHOLD <i>Protopolyporoxylon</i> VOGELLEHNER <i>Polyporoxylon</i> VOGELLEHNER <i>Protophyllocladoxylon</i> KRÄUSEL <i>Protocircoporoxylon</i> VOGELLEHNER <i>Circoporoxylon</i> KRÄUSEL - <i>Xenoxylon</i> GOTHAN	<i>Protopodocarpoxylon</i> ECKHOLD 1922 <i>Protopolyporoxylon</i> VOGELLEHNER 1968 <i>Polyporoxylon</i> VOGELLEHNER 1968 <i>Protophyllocladoxylon</i> KRÄUSEL 1939 <i>Protocircoporoxylon</i> VOGELLEHNER 1967 <i>Circoporoxylon</i> KRÄUSEL 1949 <i>Simplicioxylon</i> ANDREANSZKY 1949 <i>Xenoxylon</i> GOTHAN 1905
<i>Brachyoxydon</i> HOLLICK&JEFFREY -	- -	<i>Brachyoxydon</i> HOLLICK & JEFFREY 1909 <i>Telephragmoxydon</i> TORREY 1921
<i>Protocupressinoxylon</i> ECKHOLD <i>Protojuniperoxylon</i> ECKHOLD - - - -	<i>Protocupressinoxylon</i> ECKHOLD <i>Protojuniperoxylon</i> ECKHOLD - - - -	<i>Protocupressinoxylon</i> ECKHOLD 1922 <i>Protojuniperoxylon</i> ECKHOLD 1922 <i>Protochamaecyparixylon</i> GIRAUD 1977 <i>Platyspiroxylon</i> GREGUSS 1961 <i>Protocalitrixylon</i> VOZENIN & SALARD 1992 <i>Protosciadopityoxylon</i> NADJAFI 1982
- -	- <i>Prototaxodioxydon</i> VOGELLEHNER	<i>Protoglyptostroboxylon</i> CONWENTZ 1884 <i>Prototaxodioxydon</i> VOGELLEHNER 1968
<i>Planoxylon</i> STOPES <i>Palaeopiceoxylon</i> KRÄUSEL <i>Protopinuxylon</i> ECKHOLD	<i>Protocedroxylon</i> GOTHAN <i>Protopiceoxylon</i> GOTHAN <i>Protopinuxylon</i> ECKHOLD	<i>Protocedroxylon</i> GOTHAN 1910 <i>Protopiceoxylon</i> GOTHAN 1907 <i>Protopinuxylon</i> ECKHOLD 1922
- - - - -	<i>Prototaxoxylon</i> KRÄUSEL&DOLIANITI - - -	<i>Prototaxoxylon</i> KRÄUSEL & DOLIANITI 1958 <i>Protelicoxylon</i> PHILIPPE 1995 <i>Protospiroxylon</i> LINGELSHEIM 1929 <i>Spiroxylon</i> HARTIG 1848 <i>Taxaceoxylon</i> KRÄUSEL & JAIN 1964
Modern Conifers with mesozoic species		
<i>Phyllocladoxylon</i> GOTHAN <i>Podocarpoxylon</i> GOTHAN	<i>Phyllocladoxylon</i> GOTHAN <i>Podocarpoxylon</i> GOTHAN	<i>Phyllocladoxylon</i> GOTHAN 1905 <i>Podocarpoxylon</i> GOTHAN 1905
<i>Cupressinoxylon</i> GOPPERT <i>Juniperoxylon</i> HOULBERT - -	<i>Cupressinoxylon</i> GOPPERT <i>Juniperoxylon</i> HOULBERT - -	<i>Cupressinoxylon</i> GOEPPERT 1850 <i>Juniperoxylon</i> HOULBERT 1910 <i>Chamaecyparixylon</i> CHUDAJBERD. 1968 <i>Tetraclinoxylon</i> GRAMBAST 1951
<i>Sciadopityoxylon</i> SCHMALHAUSEN	-	<i>Sciadopityoxylon</i> SCHMALHAUSEN 1877
<i>Taxodioxydon</i> HARTIG <i>Glyptostroboxylon</i> CONWENTZ	- -	<i>Taxodioxydon</i> HARTIG 1848 <i>Glyptostroboxylon</i> CONWENTZ 1884
<i>Cedroxylon</i> KRAUS - <i>Piceoxylon</i> GOTHAN <i>Pinuxylon</i> GOTHAN	<i>Cedroxylon</i> KRAUS - - <i>Pinuxylon</i> GOTHAN	<i>Cedroxylon</i> KRAUS 1872 <i>Keteleerioxylon</i> SHILKINA 1960 <i>Piceoxylon</i> GOTHAN 1905 <i>Pinuxylon</i> GOTHAN 1905
<i>Taxoxylon</i> UNGER	-	<i>Taxoxylon</i> UNGER 1847

Even if we were lacking the last published papers on this subject, we tried to compare within a table (Table 1) the main protopinaceous genera admitted in most important taxonomic systems already expressed by Kräusel (1919, 1949) and Vogelgehner (1967, 1968).

The Araucariaceae like: *Araucarioxylon* KRAUS, *Planoxylon* STOPES, *Agathoxylon* HARTIG, *Simplicioxylon* ANDREANSZKY, *Pseudagthoxylon* GREGUSS, *Dammaroxylon* SCHULTZE-MOTEL were excluded. Also, the accepted forms described as “wood of genus ..., with pith”, like *Woodworthia* JEFFREY, *Scotoxylon* VOGELLEHNER, *Yorkoxylon* VOGELLEHNER, *Svalbardoxylon* VOGELLEHNER, or others often synonymized with other taxa, like *Arctoxylon* KRÄUSEL, *Peuce* WITHAM, *Araucariopitys* JEFFREY, *Pinoxylon* KNOWLTON, *Pinites* GOEPPERT, *Mesembrioxylon* McLEAN, *Voltzioxylon* TORREY are missing from these lists. A proposed list of confirmed already described protopinaceous genera, partially in accord with the last papers of Philippe (1993-2004) is proposed (Table 1).

According to all the considered authors, a list of the modern coniferous genera with Mesozoic already described species is added in the second part of the Table 1.

Many Mesozoic Conifers were described based on leaves, shoots or other vegetative structures, rarely found in connection with woody stems. They allowed defining some strictly mesozoic Conifer families.

From them, the Cheirolepidiaceae HIRMER & HÖRHHAMMER, 1934, represent a large mesozoic family with only fossil members having the xylotomical structure of Protopinaceous type. For example, foliage of *Brachyphyllum* type was found in connection with wood of *Brachyoxylon* type (see Machhour & Pons, 1992, quoting papers of Jeffrey, Alvin *et al.*, Laujervat & Pons, Zhou Zhian, Shilkina & Doludenko, Stopes & Fujii). It is very possible

that *Telephragmoxylon* too, had had the same type of foliage (Iamandei *et al.*, 2005). Also, wood of *Protocupressinoxylon* ECKHOLD was found in connection with cupressoid foliage of *Cupressinocladus valdensis* (Francis, 1983).

This facts support the assumption that *Brachyoxylon* and *Protocupressinoxylon* could belong to Cheirolepidiaceae, a diverse and dominant Mesozoic group that probably had *Classopollis* as unifying character, but difficult to correlate with the extant conifers (Taylor & Taylor, 1993).

PALEOXYLOTOMY

Group **Protopinaceae** KRÄUSEL, 1917, 1949

Family **Cheirolepidiaceae** HIRM. & HÖRHHAM.
Genus *Brachyoxylon* HOLLICK & JEFFREY, 1909
Brachyoxylon avramii n. sp.
Plate 1, figs. 1–9; Plate 2, figs. 1–9; Textfig. 2, 3.

Origin of the studied material

Six small pieces of phosphatized wood found in Remus Opreanu locality area, in a little quarry on Medgidia valley, have been studied. From them, 14 standard oriented slides have been realized and deposited together with the remained material, into G.I.R. Collection under the inventory nos. 26,529; 26,530; 26,532; 26,533; 26,536; 26,537 at the National Geological Museum (Table 2). These wood remains were preserved within a phosphatic level besides an interesting association of ammonites, belemnites and crocodilian teeth also phosphatized. This level is known as “biozone with *Mammillatum*”, representing the mid and late part of the sedimentary deposits of the Early Albian (Avram *et al.*, 1988).

Table 2 (studied material)

Inv. No.	Slides	Size of remained material	Specimens
26,529	3	-one piece: 0.8/1.0/0.5 cm;	Holotype
26,530	3	-one piece: 2.8/0.5/0.4 cm;	Material
26,532	3	-one piece: 2.4/0.7/0.3 cm;	Material
26,533	3	-four pieces: 2.2/0.6/0.3; 0.8/0.9/0.5; 1.0/0.7/0.2; 0.7/0.5/0.2 cm;	Paratype
26,536	1	-smaller, nothing remained after the slide was made;	Material
26,537	1	-smaller, nothing remained after the slide was made.	Material

Macroscopic description

All the studied samples represent slender-branch fragments, having small sizes (see Table 2), gray-brown or light-beige color and slightly satiny texture. By magnifying glass or even by naked eye, regular fibrous structure without vessels is visible suggesting a conifer wood. Some samples still keep the axial medullary zone.

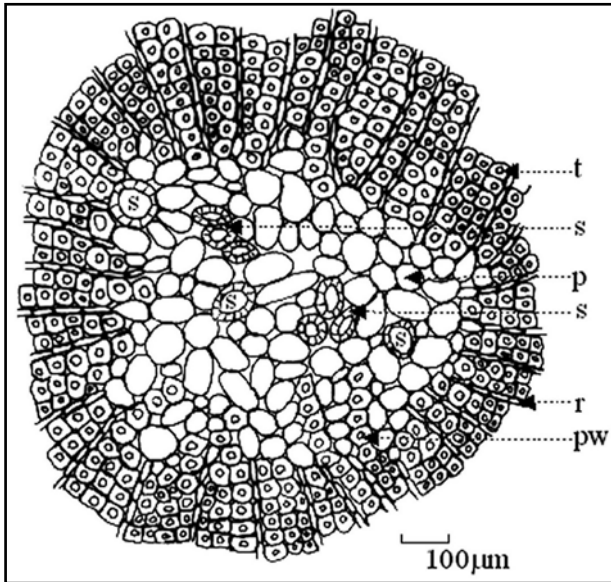
Microscopic description

The studied slides comprised secondary wood and sometimes, in some samples, in the axial zone, with primary wood and pith, like in the specimen designed as holotype (inv.no. 26,529).

The pith is constituted by large polygonal or rounded to elliptic thick-walled cells with variably mixed sizes, having 40-100 µm in diameter, filled by white to brownish clear deposit matter and determining evident intercellular spaces (*méats*).

Dispersed or in small isles, stone-cells (scleritic cells) appear.

Sometimes, marginally, the medullary cells appear to organize themselves in a radial parenchyma, since they obtain an elongate shape, cross the primary wood and then continue as typical ray-cells radially elongated, crossing the secondary wood to the outer part of the structure (Plate I, fig. 2 and Textfig. 2).



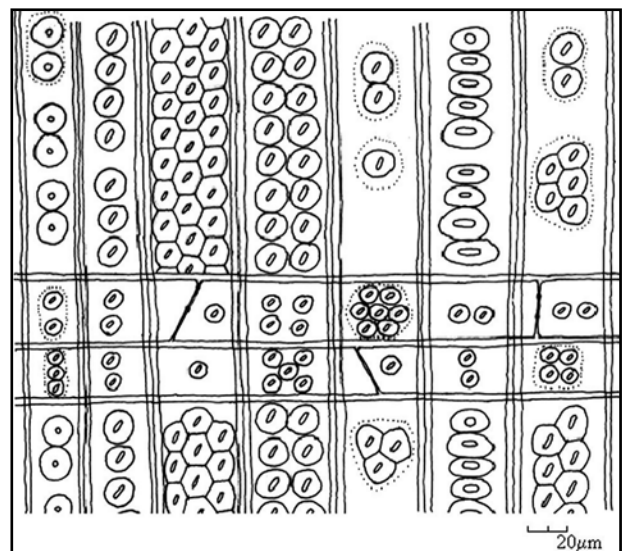
Textfig. 2. Primary structure: medullary parenchymatic cells (p), stone cells (s), primary wood (pw). Secondary structure: rays (r), tracheids (t).

The primary wood appears between the pith and the secondary wood (endarchally disposed). It is formed by 2-5 rows of large tracheids with polygonal section, narrow lumina and with thickened walls, indistinctly pitted. Just at the boundary with the pith, some smaller thick-walled tracheids are alternating with pith-cells (Plate I, fig. 2; Textfig. 2).

The secondary wood presents a tracheidoxyle structure in all the studied samples, with variably sized growth-rings, between 29-90 cells wide (sometimes wider, up to 150 cells). The ring boundaries are distinct, even the late wood is not too developed it can have 4-6 tangential rows of radially compressed cells, slightly smaller than in the early wood. Sometimes, some boundaries are marked by tangential series of traumatic axial ducts, variably sized, of 32-128/36-63 μm in radial/tangential diameters, very similar to some extant conifers (see Plate I, figs. 1, 3). The tracheids are polygonal in cross section, slightly rounded to oval, variably sized, with thick to very thick walls, of 10-11(-18) μm the double wall, and rounded to oval small-sized lumina, of 22-30/22-25(28) μm radial/tangential diameters in early wood (smaller in the late wood, of 16-22/15-20 μm). The interradian woody bundles have 1-7 regular radial rows of normal tracheids, sometimes with short radial rows of smaller cells with point-like lumina intermingled. The density is of 1840-2016 cells on sq. mm., but the wood seems to be in a juvenile stage. Tangen-

tially the tracheidal walls are usually unpitted. Rarely uniseriate or biseriate alternate protopinoid pits have been observed. Radial pitting, rather bad preserved, is definitely protopinoid, with circular borders of 12.4-18.6 μm in diameter and circular or elliptic apertures of 3.4-6.2 μm in diameter, more or less spaced or even contiguous, in uniseriate rows arranged. Sometimes the pitting is missing from the row, leaving an empty space on the wall. When uniseriate, the borders can be contiguous, frequently slightly vertically compressed, the compression coefficient is 0.6-0.7. On other tracheids biseriate or triseriate pitting appear, opposite, round or alternate, hexagonal with slightly smaller borders (10-12 μm in diameter), and with small circular to elliptic apertures of 2-3 μm . Sometimes the pitting is more numerous, loosely alternately arranged or slightly irregular, coming again to uniseriate disposition, or in small groups of 1-5(9), outlined by a visible boundary (see Textfig. 3). Coarse *striae* on the tracheidal walls appear and brown to dark-red granular content, sometimes agglutinated to compact has been observed inside the tracheids.

Wood parenchyma is absent or is extremely rare.



Textfig. 3. Radial pitting on tracheids and pitted cross fields (in holotype).

The medullary fine rays, in cross section seen, have short linear trajectory and are constituted by rectangular cells, radially elongated, with slightly rounded endings, with smooth unpitted horizontal walls and showing moderately thick radial or tangential walls. Tangentially the rays are almost exclusive uniseriate and not too high, having 1-11(21) cells in height rarely more, i.e. 20-230(320) μm . The ray cells are circular to square, slightly rounded or vertical oval, with 10-20 μm in diameter, and 2-3.2 μm the simple wall. Sometimes biseriate stories are present and the terminal cells are slightly taller. This arrangement does not determine intercellular lateral spaces. The ray-density is of 5-9 rays on tangential horizontal mm. In radial section the rays are homocellular, constituted by cells all procumbent, with moderately thick horizontal walls, of 2.5-4 μm the double wall. The tangen-

tial walls are slightly oblique or arcuate and smooth, rarely feebly knotted. The indentures are absent. The body ray-cells have 15-30(50) μm in length and 12.4-18.6 μm in height, the marginals are slightly taller, of 20-24.8 μm . Almost all the ray-cells are resiniferous, having a granular content, sometimes agglutinated to compact, brown to dark-red in color that makes difficult to observe the pitting. However within the cross-fields one solitary, or a pair horizontally, diagonally or vertically disposed, or 3 triangularly arranged or 4 as superposed pairs have been observed. More numerous pitting appears within the larger cross-fields, up to 8 oval smaller pits, alternately arranged, in 2-3 horizontal rows, in a typical araucarioid disposition. In the marginal taller cross-fields 2-3 pits in vertical row appear or more numerous (5-9 pits) alternately arranged, sometimes outlined by a boundary. All of them are round pits of cupressoid type, with round border of 9.5-12.4 μm , and elliptic oblique included apertures of 4-6 μm (Textfig. 3).

Affinities and discussions

All these studied samples of fossil wood present a tracheidoxylic structure with uniseriate rays, mixed pitting (or protopinoid) on the radial walls of the tracheids, araucarioid cross-fields and, sometimes, traumatic axial ducts. Such a structure is typical for the Mesozoic coniferous gymnosperms.

This description perfectly agrees with the diagnosis of the genus *Brachyoxyton* HOLLICK & JEFFREY, a disappeared Conifer of protopinaceous type (*sensu* Kräusel, 1949), even if the original diagnosis of *Brachyoxyton* genus (the designated generotype was *B. notabile* HOLLICK & JEFFREY), is very elliptic, defining a tracheidoxylic devoid of normal secretory ducts, with mixed radial pitting, araucarioid cross fields, other ray walls integer (see Philippe, 1993). Hollick & Jeffrey, 1909). In a recent synthesis, Taylor & Taylor (1993, p. 689) noted that none cheirolepidiaceus wood have normal resin ducts but traumatic ducts can be present sometimes in this genus, as a result of injury or freezing (Phillipe, 1995).

A xylotomical comparison of our material with species of *Brachyoxyton* already described can be useful (see Table 3). Some already described species like *B. notabile* HOLLICK & JEFFREY, *B. woodworthianum* TORREY, *B. libermanii* PHILIPPE, *B. brachyphylloides* (TORREY) KRÄUSEL preserve primary structure and pith, very similarly to our studied material, having an axial parenchymatous tissue with isles of scleritic cells, isolated or vertically connected. Such structures were described as *Telephragmoxylon* TORREY, or *Brachyoxyton* sp. (Holden 1914), or *Brachyoxyton* sp. (Shimakura 1937), having mostly uniseriate radial pitting and low rays (according to Machhour & Pons, 1992).

Some other species are no more considered as *Brachyoxyton* species. For example:

- *B. urkutense* GREGUSS according Philippe & Barbacka (1997) it is synonymous with *Simplioxyton hungaricum* ANDREANSZKY;
- *B. brachyphylloides* (TORREY) KRÄUSEL according Philippe (1993) is known as *Telephragmoxylon brachyphylloides* TORREY;
- *B. nipponicum* NISHIDA that according Vozenin-Serra & Pons (1990) is synonymous with *Protopodocarpoxylon orientale* SERRA, 1969 (see also Machhour & Pons, 1992);
- *B. desnoyersii* LEMOIGNE was renamed as *Agathoxyton desnoyersii* PHILIPPE, 1995.

After this comparative study of the xylotomical features of our material we decided that it can be attributed to *Brachyoxyton* genus, and we described for it a new species named *Brachyoxyton avramii* n.sp.

The species name was given in honor of the distinguished paleontologist Dr. Emil Avram that kindly offered us, for study, these samples of fossil wood, perfectly localized within *Mammillatum* zone of the Early Albian from south Dobrogea.

From the six fragments of phosphatized wood we have designated as holotype the sample with inv.nr. 26,529 and as paratype the sample with inv.nr. 26,533 that allowed us to make good oriented slides. All the studied material including the types is deposited in G.I.R. Coll., at Geological Museum from Bucharest.

Diagnosis of *Brachioxyton avramii* n.sp.:

Branch wood preserving the axial zone showing parenchymatous pith with solitary and grouped scleritic cells and endarchal primary wood with thick-walled tracheids.

Secondary wood tracheidoxylic, with rather distinct wide growth rings, marked by smaller tracheids and occasionally by tangential series of traumatic axial ducts. Thick-walled polygonal-rounded tracheids with lumina of 20-30/22-25(28) μm the r/tg diameters. Tangential walls usually unpitted, rarely with small pits. Radial pitting typical protopinoid, spaced or contiguous, rounded borders of 12.4-18.6 μm , or vertically compressed when uniseriate (coefficient of compression=0.6-0.7). When biseriate or triseriate round and opposite can appear, but usually hexagonally when alternately arranged. Sometimes in small irregular groups appear. Parenchyma is usually absent. Uniseriate rays, of 1-11(21) cells high, density of 5-9 rays on horizontal mm. Rays homocellular, with all procumbent cells, marginally taller, resiniferous, moderately thick walled, with oblique or arcuate tangential walls, smooth or feebly nodular, indentures absent. Araucarioid cross-fields with 1-8 cupressoid oculipores of 9.5-12 μm in diameter and oblique elliptic apertures of 4-6 μm , alternately arranged on 2-3 rows especially within taller fields.

Table 3. A comparative table of the xylotomical features (secondary wood) of different species of *Brachyoxylon*.

Species of <i>Brachyoxylon</i>	Authors	Structure	Resin ducts	Tg. pitting	Radial pitting	Index of compression	Cras-sulae	Paren- chyma	Rays	Cross fields	Pits in cross fields
<i>B. notabile-generotyp</i>	HOLLICK et JEFFREY	trachei- doxylic	trau- matic	+/-	mixed, 1-2seriate	-	+	-	uniseriate, low, of 1-8 cells	pairs	round to cu- pressoid
<i>B. woodwor- thianum</i>	TORREY	idem + tyloses	-	-	mixed	-	-	-	uniser.-high 2-4-ser.- low	-	cupressoid
<i>B. aff. wood- worthianum</i>	TORREY	idem + tyloses	-	-	mixed	-	-	-	uniser.- high 2-4-ser.- low	-	cupressoid
<i>B. japonicum</i>	SHIMAKURA	trachei- doxylic	-	-	mixed, 2-3seriate	-	-	-	uniser.- high of 50-60 cells	-	cupressoid
<i>B. eboracense</i>	HOLDEN	idem	-	-	mixed, 1-2seriate	<<1	+	-	uniseriate, low	-	cupressoid
<i>B. rotnaensis</i>	MATHIESEN - (et in Serra)	idem	trau- matic	+(late wood)	mixed, 1(2)seriate	+/-<1	-	-	uniseriate, low, 1-15(30) cells	2-4 rows	4-12 oculi- pores / 2-4 rows
<i>B. saurinii</i>	BOUREAU et SERRA	idem	trau- matic	-	mixed, 1(2)seriate	+/-<1	-	-	uniseriate, low, 1-13(31) cells	2-3 rows	2-12 small oculipores
<i>B. boureaui</i>	SERRA	idem	-	-	mixed, 1-2seriate	-	-	-	uniseriate, low	2-4 rows	4-36 small oculipores
<i>B. nonakai</i>	YAMAZAKI & TSUNADA	idem	-	-	2(4)seriate opposite	-	-	-	uniseriate,	-	cupressoid
<i>B. trautii</i>	(BARALE) PHILIPPE	idem + false rings	-	+	mixed, 1(2)seriate	-	-	-	uniseriate, low	arau- carioid	4-9 oculi- pores
<i>B. liebermanii</i>	PHILIPPE	idem + false rings	-	+(late wood)	mixed, uniseriate	-	-	-	uniseriate, low	arau- carioid	5-12 cupres- soid to podocarpoid
<i>B. lagonense</i>	(LAUDOUÉNEIX) DUPÉRON – LAUDOUÉNEIX	idem	trau- matic	-	mixed, 2-3seriate	-	-	-	uniseriate, low, dense	-	cupressoid
<i>B. avramii n.sp.</i>	here described	idem	trau- matic	rare	mixed, 1-2seriate	0.6-0.7	-	-	uniseriate, low, 1-11(21) cells	arauca- rioid	1-8 cupres- soid
<i>B. dobrogiacum n.sp.</i>	next taxon in this paper	idem	absent	1-2- seriate	mixed, 1-3-seriate	0.5-0.7	+	+	uniseriate, low, 1-10 cells high	arauca- rioid	1-3(4-6) cu- pressoid

Brachyoxylon dobrogiacum n.sp.

Plate 3, figs. 1–9; Plate 4, figs. 1–9. Textfig. 4, 5, 6.

Origin of the studied material

From a little quarry on Medgidia valley, in the right bank, close to Remus Opreanu locality, seven small pieces of phosphatized wood collected by Dr. Emil Avram have been studied. They come from the same “biozone with *Mammillatum*” that

preserve also, as we showed, phosphatized remains of ammonites, belemnites and crocodilian teeth certifying the mid and late part of the Early Albian (Avram *et al.*, 1988). The sixteen standard slides made and the remained material have been deposited in GIR Collection under the inventory nos. 26,684; 26,685; 26,686; 26,687; 26,688; 26,689; 26,690 at the National Geological Museum in Bucharest (in Table 4).

Table 4 (studied material)

Inv. No.	Slides	Size of remained material	Specimens
26,684	2	-small piece, nothing remained after slide was made	Material
26,685	3	-two pieces: 2,5/0,5/0,5 cm; 1,5/0,7/0,5 cm;	Holotype
26,686	2	-one piece: 3,7/1,5/1,6 cm;	Material
26,687	2	-one piece: 1,7/0,6/0,5 cm;	Material
26,688	3	-one piece: 1,5/0,6/0,6 cm; 1,5/1,0/0,7 cm;	Paratype
26,689	2	-small piece, nothing remained after the slides were made;	Material
26,690	2	-small piece, nothing remained after the slides were made.	Material

Macroscopic description

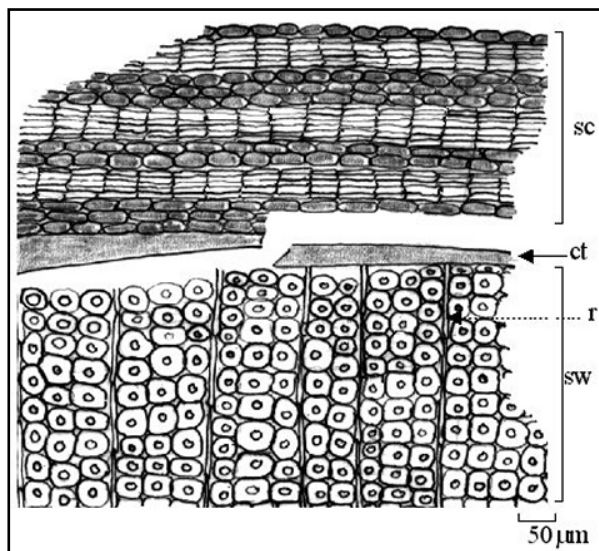
All the samples represent slender branch fragments or juvenile stages, having small sizes (see Table 4), of gray-brown or light-beige color and fibrous or slightly satiny texture. By magnifying glass or even by naked eye regular fibrous structure without vessels is visible suggesting a conifer wood. Four of the studied samples (nos. 26,685-26,688) still preserve the axial zone and one of them is preserving even the bark.

Microscopic description

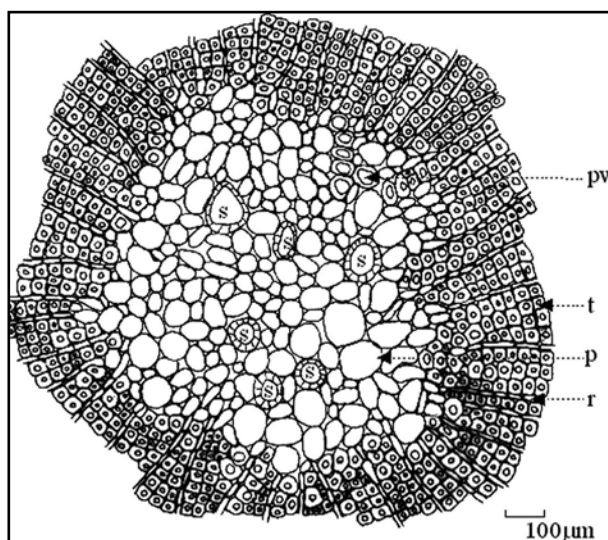
Coming from slender branches, in almost all the pieces of fossil wood preserved, not only the secondary wood but the primary wood also and the axial medullary zone are present and, exceptionally, even the bark zone described here. Within the external zone suberous cork and phloematic cells in a condensed tissue are present (Textfig. 4).

The periderm is obvious and includes the suberous zone, visible as tangentially elongate cells with suberized walls and more difficult to guess, the phellogen, the phelloderm and the parenchymatous bark, the primary and secondary phloem also, all of them appearing compressed and condensed by the suberous zone. The cambium appears within the same condensed zone as tangentially elongate cells with dark content and without other anatomical details. Below this, the secondary wood is present, constituted by tracheids in growth rings organized, crossed by medullary rays (see Textfig. 4).

The axial zone of the structure preserves the pith and the primary wood. The pith is constituted by big parenchyma-cells, of 50-95 μm in diameter, polygonal or rounded, thick-walled, quasi-isometric, unequal in size, mixed arranged, filled by white or brown deposits and determining obvious intercellular spaces (*méats*). Scattered sclerotic cells appear between. Marginally, elongate parenchyma cells seems to organize themselves as primary rays, radially penetrating the primary and then the secondary wood to the external part of the structure (Plate III, fig. 1 and Textfig. 5).



Textfig. 4. The external zone: suberous cork (sc), condensed tissue (phloem + cambium) (ct), rays (r), secondary wood (sw).



Textfig. 5. The axial zone: parenchymatic pith cells (p), stone cells (s), primary wood (pw), secondary wood (t), rays (r).

otic cells appear between. Marginally, elongate parenchyma cells seems to organize themselves as primary rays, radially penetrating the primary and then the secondary wood to the external part of the structure (Plate III, fig. 1 and Textfig. 5).

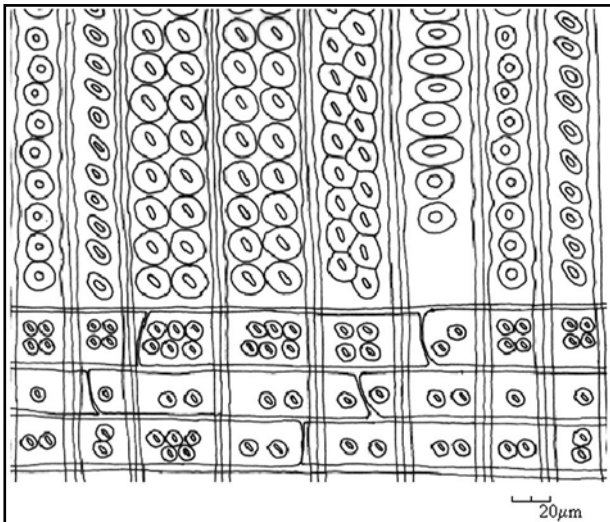
The primary wood appears at the boundary between pith and secondary wood, and is constituted by 2-6 rows of big thick-walled tracheids, polygonal in section, with narrow lumina, without pitting or helical thickenings, with endarch disposition within central cylinder, sometimes intermingled with pith cells (Plate III, fig. 1 and Textfig. 5).

The secondary wood presents a tracheidoxylic structure with variably sized growth rings, between (9)30-93 cells wide, with not very distinct boundaries, little late wood (1-4 rows of smaller radially compressed cells). The structure is devoid of any resin duct, normal or traumatic. The tracheids, appear polygonal in cross section, with slightly rounded corners and are variably sized, but generally small and thick-walled to very thick-walled, of 12-18(20) μm the double wall. Their lumina is polygonal to rounded or oval, rather uniformly sized, of 20-28/20-32(38) μm radial/tangential diameters, smaller in the late wood (15-18/15-20 μm). Between two rays 1-7 regular radial rows of normal tracheids appear and among them short radial rows of small round cells point-like lumened. The density is 1440-2070 tracheids on sq. mm, even this figure is not too significant, since the wood is in a juvenile stage. Often tangential mixed pitting is present, uniseriate, contiguous or spaced, with remains of *crassulae*, or biseriate, alternate and contiguous. The round borders of the pits have 9-12 μm in diameter, with circular to elliptic, inclined and small apertures, of 3-6(8) μm . Radial pitting typical protopinoid, with circular borders of 12-16(-19) μm in diameter and circular to elliptic apertures of 4-6(-8) μm in size, uniseriately arranged, more or less spaced or contiguous, larger in early wood. Often groups of pits are missing, leaving empty

spaces within the row. When contiguous the borders are frequently vertically compressed and separated by a horizontal line (the coefficient of compression is 0.5-0.7). Some tracheids show biseriate, rarely triseriate pitting, alternate, hexagonal shaped and smaller, of 9.3-12.6 μm in diameter, with circular to elliptic oblique apertures and small, of 3-5 μm . Often the uniseriate arrangement is reached. On larger tracheids, opposite, spaced, round pits appear. Coarse striations on walls appear and lumina content is granular, sometimes agglutinated to compact, brown to dark-red in color.

The wood parenchyma is usually absent, rarely appears, scarce, as radially compressed or crushed cells, similarly sized as adjacent tracheids and filled by dark content. Longitudinally it appears as rectangular high cells separated by thin and smooth horizontal walls.

The medullary rays, in cross section, are short, linear, mostly uniseriate, rarely biseriate, constituted by horizontal rectangular cells with smooth, unpitted horizontal walls. Tangentially the rays are obviously low, of 1-10 cells high, i.e. 20-160 μm . The ray cells are round or square-rounded or slightly vertical-oval, with 9-10 μm in diameter and of 2-3.2 μm the simple wall. The terminal cells are taller, of 14-20 μm . Sometimes biseriate stories are present. Lateral intercellular spaces absent. The density is 5-9 rays on tangential horizontal millimeter. Radially the rays are homocellular, with all procumbent cells, moderately thick-walled, of 2.5-4 μm the double wall. The tangential walls are slightly oblique or arcuate. Indentures are absent.



Textfig. 6. Radial pitting and cross-fields pitting (in holotype).

The ray body cells have (15)20-50 μm in length, 10-18.6 μm in height, the marginals are slightly taller, of 20-24.8 μm high. All the ray cells are resinous, filled with granular content, sometimes agglutinated to compact, brown to dark-red. Usually in the cross-fields one solitary circular to oval pit is present or 2-3 horizontally, vertically or diagonally arranged. Within taller fields, 4-6 pits alternating in

2 rows are present. The pits have round to oval borders of 6-9.5(-12.4) μm in diameter and round or elliptic apertures obliquely disposed, usually included, with diameters of 2-4(-6) μm . The type of oculipores is usually cupressoid tending to podocarpoid and their disposition is araucarioid (Textfig. 6).

Affinities and discussions

All the studied samples present a tracheidoxyl gymnospermous structure with uniseriate rays, devoid of any normal or traumatic resin ducts, with mixed (protopinoid) radial pitting and low rays with araucarioid cross-fields (sensu Philippe, 1993) bearing cupressoid to podocarpoid pits.

This combination of features better agrees with a tracheidoxyl of the *Brachyoxylon* type (sensu Philippe, 1993) even it slightly agrees also with *Protopodocarpoxylo* ECKHOLD (sensu Kräusel, 1949). Since the *status quo* of the last genus was well defined by Philippe *et al.* (2003) that proposed to conserve this name but establishing another conserved type having typical podocarpoid cross-field pits, *P. bedfordense* (STOPES) KRÄUSEL, originally the choice being made by Vogellehner (1968). This proposal was admitted by the Committee for fossil Plants of ICBN (Skog, 2003).

In these circumstances, even if we initially supposed some affinities with *Protopodocarpoxylo*, the cross-fields aspect clearly define the *Brachyoxylon* type.

So, considering the comparative table of the secondary wood from upward (Table 3) and the discussions on the precedent newly identified species we have to observe a slightly different secondary structure devoid of any resin duct, with mixed radial pitting, few parenchyma and low rays with cupressoid to podocarpoid pits in an araucarioid disposition in cross-fields, defining a new species of *Brachyoxylon* HOLLICK & JEFFREY, named by us *Brachyoxylon dobrogiacum* n.sp., after the name of the region from where it was found.

From the studied material (Table 4) a holotype was designated (inv.no. 26,685), and a paratype (inv.no. 26,688), having identical xylotomical features, almost identical with all the studied material, now deposited in GIR Coll., in the National Geological Museum in Bucharest.

Diagnosis of *Brachyoxylon dobrogiacum* n.sp.:

Primary structure in the axial zone with pith as large isometric parenchyma cells with *méats* and dispersed scleritic cells amongst and with primary wood as thick-walled tracheids.

Exceptionally the cork zone is present, and a condensed tissue including phloematic cells and the cambium.

The secondary wood is a tracheidoxyl with variable sized growth rings, not too distinct boundaries and devoid of any resin duct. Thick-walled to very thick-walled tracheids with polygonal cross section, polygonal to rounded lumina of 20-28/20-32(38) μm r/tg diameters in 1-7 interradianly rows arranged,

density of 1440-2070 tracheids on sq.mm. Tangential mixed pitting is often present, uniseriate, contiguous or spaced and with *crassulae* or biseriate alternate and contiguous, borders of 9-12 μm and circular to elliptic inclined and small included apertures, of 3-6(8) μm . Radial pitting protopinoid, pits with circular borders of 12-16(19) μm in diameter and circular to elliptic apertures of 4-6(-8) μm , uniseriate arranged, more or less spaced or contiguous. When contiguous the borders are frequently vertically compressed (coefficient of compression=0.5-0.7). When biseriate or triseriate pitting usually alternate, hexagonal and smaller, pits of 9.3-12.6 μm in diameter, with circular to elliptic oblique apertures and small, of (3-5 μm). The wood parenchyma scarce, as deformed cells, similarly sized as tracheids. Longitudinally appear as strands of rectangular high cells separated by thin and smooth horizontal walls. Uniseriate low medullary rays, of 1-10 cells high, density of 5-9 rays on tangential mm., homocellular, all procumbent moderately thick-walled cells with oblique or arcuate tangential walls, indentures are missing, smooth unpitted horizontal walls, length of cells is (15)20-50 μm , height of 10-18.6 μm , marginals taller (20-24.8 μm). Araucarioid cross-fields with

cupressoid or podocarpoid oculipores of 6-9.5(-12.4) μm in diameter and inclined elliptic apertures of 2-4(-6) μm , solitary big, circular to oval or 2-3 horizontally, vertically or diagonally arranged, or 4-6 alternate, elliptic rarely polygonal, in 2 rows within taller fields.

Genus *Protocupressinoxylon* ECKHOLD, 1921
Protocupressinoxylon dragastani IAMANDEI &
 IAMANDEI, 1999
 Plate V, figs. 1-9; Textfig. 7.

Origin of the studied material

From a fluvial conglomerate preserving many vegetal remains, from Agicabul Hill (Cuza-Vodă area, North of Medgidia locality), within the Aptian Gherghina Formation, five poorly preserved pieces of petrified wood have been detached and fifteen standard slides for xylotomical study have been realized. The remained material and the slides have been deposited in GIR Collection under the inventory nos. 26,681; 26,700; 26,701; 26,702 and 26,703 within the National Geological Museum in Bucharest (see Table 5).

Table 5 (studied material)

Inv. No.	Slides	Size of remained material	Specimens
26681	3	-one piece: 7.5/6.0/3.5 cm;	Material
26700	3	-one piece: 5.0/2.5/1.8 cm;	Material
26701	3	-one piece: 6.0/5.5/4.5 cm;	Material
26702	3	-one piece: 7.0/6.0/3.0 cm;	Material
26703	3	-one piece: 6.5/5.5/4.00 cm.	Material

Macroscopic description

The studied material is constituted by five small fragments of calcitized wood still preserving traces of xylophagy, rotting and erosion that existed before fossilization and diagenesis. All the specimens are light-beige to reddish-beige in color and of small size (see Table 5). However with naked eye or by magnifying glass growth rings regular fibrous structure without vessels can be observed, suggesting a coniferous wood.

Microscopic description

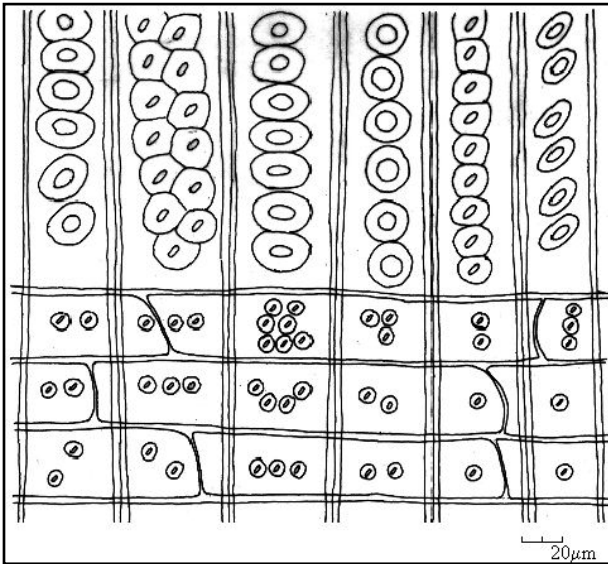
Secondary wood with tracheidoxylic structure, with distinct growth rings not too broad (11-15 cells in thickness), devoid of any normal or traumatic resin duct. Frequently galleries of xylophagous, patches of rotting, traces of erosion and fissures appear, all of them filled by detrital material.

The tracheids in cross section show polygonal shape with rounded corners and are slightly irregular disposed in early wood. They are thick-walled, of 10-12 μm the double wall, and polygonal-rounded to circular lumina, of 20-35-50/25-30-60 μm the radial/tangential diameters, the late wood marked by some tangential rows of smaller radially compressed cells. Between two rays, usually 1-9

radial rows of tracheids are present. The density is of up to 1848 cells on sq. mm. The tangential walls are unpitted. On the radial walls protopinoid pitting is present, with circular or slightly polygonal borders of 12-15.6 μm in diameter, and circular apertures of 6.2-7 μm in diameter, usually contiguous and slightly compressed in uniseriate rows or biseriate and opposite or alternately arranged (Textfig. 7). To the ray cells the pitting is similar but smaller. The tracheids present a compact content inside their lumina.

The wood parenchyma is absent or indiscernible.

The medullary rays in cross section are uniseriate, with linear trajectory and constituted by polygonal or radial elliptic thin walled unpitted cells. Tangentially the uniseriate rays have 1-9(21) cells in height, i.e. 20-185(320) μm , sometimes with biseriate stories. The ray cells are circular to square-rounded or oval, of 14-20 μm in diameter, moderately thick-walled (2 μm simple walls). Ray density is of 6-9 rays on tangential horizontal millimeter. In radial section the rays are certainly homocellular, all the cells are procumbent, with right or slightly arcuate tangential walls and without indentures. The cells have 20-25(50) μm in length and 12.4-15 μm in height, the marginals taller, of 18.6-35 μm high. The araucarioid cross-fields



Text-fig. 7. Radial pitting and cross fields.

(Textfig. 7) present 1-2(4) cupressoid pits, circular to oval, of 10-13(15) μm in diameter and with circular to elliptic obliquely disposed apertures of 5-6 μm . Within the taller marginal fields can be more numerous as 1-3 vertical pairs. Almost all the ray-cells have a dark compact content.

Affinities and discussions

The xylotomy of the five here studied specimens definitely is tracheidoxylic, having mixed radial pitting, no resin ducts or parenchyma, uniseriate rays with araucarioid cross-fields with cupressoid pits, details that can define a member of Protopinaceae and can be compared with the diagnoses of other genera with oculipores in the cross-fields admitted by Kräusel (1949) and Vogellehner (1967, 1968).

In a comparative table of the features (Table 6) it is obvious that, at generic level, the xylotomical

features of our material mostly agree with *Protocupressinoxylon* type. This genus was established by Eckhold in 1921, and have as generotype the species *P. cupressoides* (HOLDEN) ECKHOLD 1921 (bazionyme *Paracupressinoxylon cupressoides* HOLDEN).

For this genus many Jurassic and Cretaceous species have been described: *P. leonardianum* (CHARRIER) VOGELLEHNER, *P. catenatum* SCHULTZE-MOTEL, *P. liasinum* SCHULTZE-MOTEL, *P. rhaeticum* VOGELLEHNER, *P. dockumense* (TORREY) KRÄUSEL, *P. malayense* ROGGEVEEN, *P. coromandelinum* (SAHNI) KRÄUSEL, *P. eboracense* (HOLDEN) ECKHOLD, *Protocupressinoxylon purbeckensis* FRANCIS, *P. carentanensis* BARALE, *P. munense* SHILKINA & BLOKHINA and *P. angrenicum* JUNUSOV (in Philippe, 1995, p. 51). These species have many similar features with our material, regarding the tracheidal pitting or the cross fields, but they are not identical.

Some Cretaceous species already described can be excluded from the comparison because either they have traumatic resin ducts like *P. potomacense*, *P. solmsi*, *P. vectense*, *P. luccombense* (in Kräusel, 1949, p. 183-185), or they have multiseriate rays like *P. weidlingense* (ibid., p. 184).

Closer of the structure of our specimens is the species *P. mesozoicum* ECKHOLD (see Eckhold, 1922), having quite similar cross fields, but there is a species described from the same formation from Cernavodă (Iamandei & Iamandei, 1999) that have almost identical structure regarding the aspect of the radial pitting and of the cross fields, so we attributed the here studied material to the species *Protocupressinoxylon dragastani* IAMANDEI & IAMANDEI, 1999.

Table 6. A comparative table of the features between some Protopopinoid genera and our material.

Features	<i>Protopodocarpoxylon</i> ECKHOLD	<i>Brachyoxylon</i> HOLLICK & JEF- FREY	<i>Protocupressinoxylon</i> ECKHOLD	<i>Prototaxodioxylon</i> VOGELLEHNER	Our material
Radial pitting	araucarian or mixed	mixed	mixed	mixed	mixed
Cross-field pitting	podocarpoid	cupressoid	cupressoid	taxodioid	cupressoid
Horizontal ray-cell wall	unpitted	unpitted	unpitted	unpitted	unpitted
Parenchyma	absent	sometimes present	present	present	present
Resin ducts	absent	often, traumatic	usually absent	absent	absent

CONCLUSIONS

This paper presents the paleoxylotomical study of some fragments of fossil wood found within postenocomian deposits belonging to Aptian and Albian, and their identification as three "protopinaceae", two of them as new form-species of *Brachyoxylon*, the first forms of this type described within the Romanian paleoxylogy and a form of *Protocupressinoxylon* already described from similar deposits in South Dobrogea (Iamandei & Iamandei, 1999).

The presence of wood remains from an Early Cretaceous conifer flora within this region is in agreement with other paleogeographic reconstructions for that time, supposing an extended insular emerged area, belonging now to Central and North Dobrogea, but partially to South Dobrogea (see Dragastan *et al.*, 1998).

To reconstruct the paleogeography and the paleoclimate of that time it's very difficult. However, taking into account the type of sedimentation and the presence of vegetal remains sometimes mixed with marine fossils, we can imagine a mountainous

plateau covered by an arboreal vegetation and submitted to an intense erosion, proved by the coarse detrital fluvial deposits preserving vegetal remains of Gherghina Formation.

Also, according to Rees *et al.* (2000) and Philippe *et al.* (2004), taking into account the probable paleolatitude of 28-35° North, the regional extension of Tethys Ocean and the local insular landscape we can suppose for the Aptian Dobrogea a subtropical paleoclimate to warm temperate, often excessive and with violent manifestations.

The marine, transgressive Early Albian deposits, mainly sandy and glauconitic, with phosphatic levels, and phosphatized remains of ammonites (biozone with *Mammillatum*), belemnites, crocodilian teeth and small fragments of branch remains of conifers also suggest the proximity of the shore, and similar warm paleoclimate, where crocodiles could live.

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CAPTIONS OF PLATES

(graphic scale)

PLATE I

Figs. 1-9. *Brachyoxylon avramii* n. sp., holotype.

- Fig. 1. Cross-section. Growth-ring boundary, general view.
- Fig. 2. Cross section. Pith cells, primary and secondary wood.
- Fig. 3. Cross section, thick-walled tracheids, traumatic ducts, uniseriate rays.
- Figs. 4-5. Tangential section. Tracheids with less visible pitting, uniseriate rays with biseriate stories.
- Fig. 6. Tangential section. Tracheids with pitting, uniseriate rays with biseriate stories (detail).
- Fig. 7. Radial section, radial pitting on tracheids, cross-fields with rays.
- Figs. 8-9. Radial section, radial pitting on tracheids, pitted cross-fields.

PLATE II

Figs. 1-9. *Brachyoxylon avramii* n. sp., paratype.

- Fig. 1. Cross-section. Growth-ring boundary, general view.
- Figs. 2-3. Cross-section. Radial rows of thick-walled tracheids, linear fine rays.
- Figs. 4-5. Tangential section. Tracheids, uniseriate medullary rays.
- Fig. 6. Tangential section. Resiniferous tracheids, less visible pitting, uniseriate rays (detail).
- Figs. 7-9. Radial section. Radial pitting on tracheids, pitted cross-fields.

PLATE III

Figs. 1-9. *Brachyoxylon dobrogiacum* n.sp., holotype.

- Fig. 1. Cross-section. Medullary zone with parenchymatous pith-cells, primary and secondary wood.
- Figs. 2-3. Cross section. Radial rows of thick-walled tracheids, linear fine rays.
- Figs. 4-6. Tangential section. Bad preserved pitting on tracheids, low uniseriate rays.
- Figs. 7-9. Radial section. Resiniferous tracheids, bad preserved radial pitting, pitted cross-fields.

PLATE IV

Figs. 1-9. *Brachyoxylon dobrogiacum* n.sp., paratype.

- Figs. 1-3. Cross-section. Thick-walled tracheids, distinct boundary of growth ring, uniseriate rays.
- Figs. 4-6. Tangential section. Resiniferous tracheids, uniseriate rays.
- Figs. 7-9. Radial section. Pitted cross-fields, radial pitting on tracheids.

Plate V

Figs. 1-9. *Protocupresinoxylon dragastani* IAMANDEI & IAMANDEI 1999, material.

- Figs. 1-3. Cross section. Thick-walled tracheids, linear uniseriate rays.
- Figs. 4-6. Tangential section. Bad preserved structure with uniseriate rays.
- Figs. 7-9. Radial section. Bad preserved radial pitting on tracheids, cross fields with rays.

PLATE I

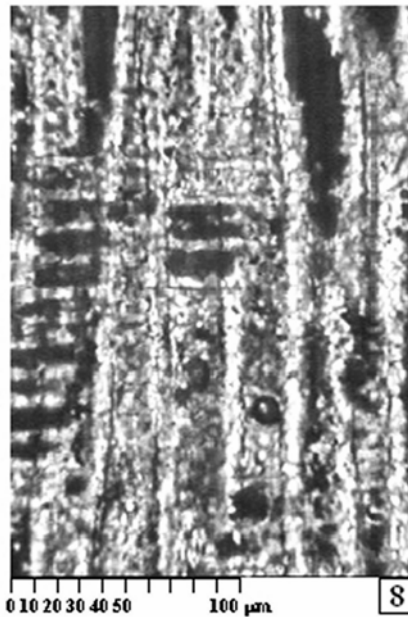
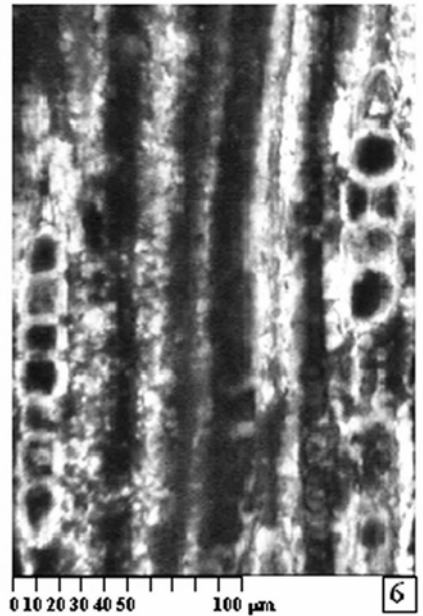
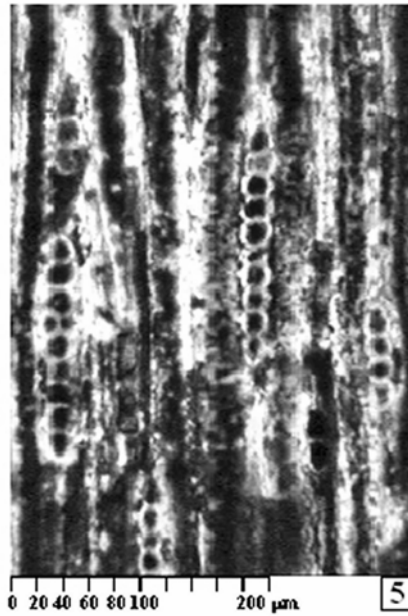
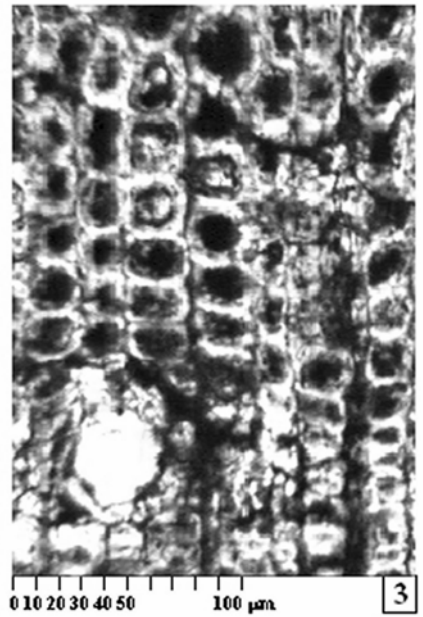
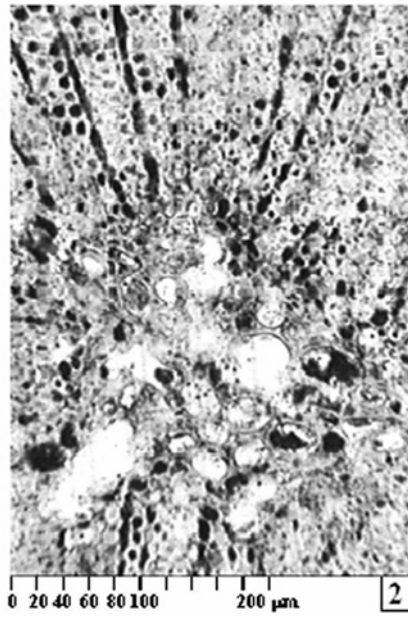
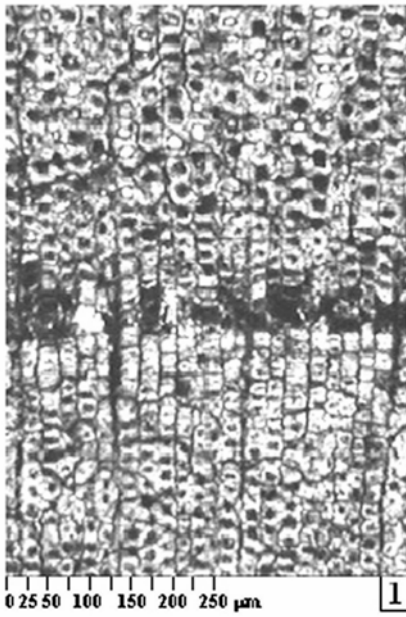


PLATE II

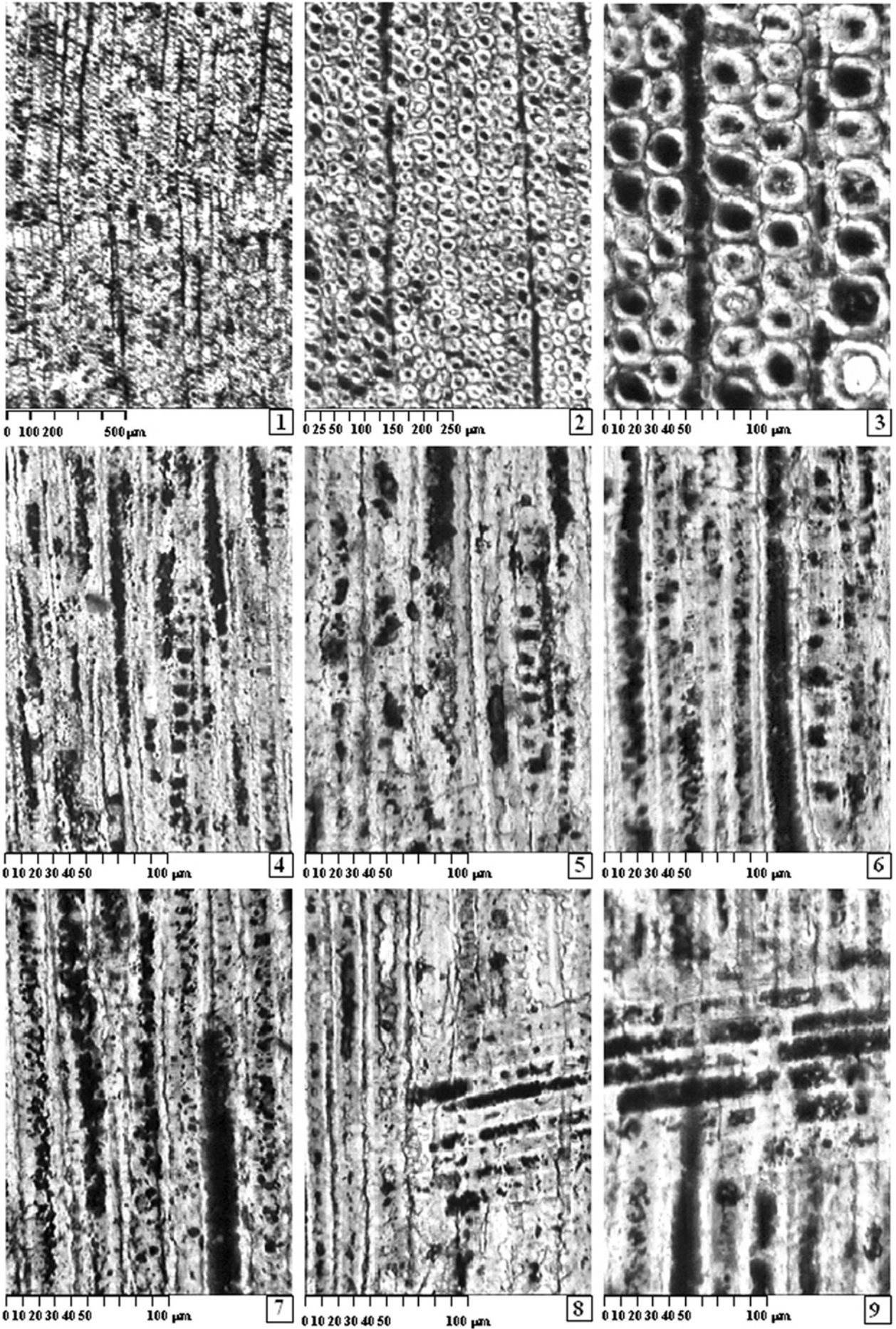


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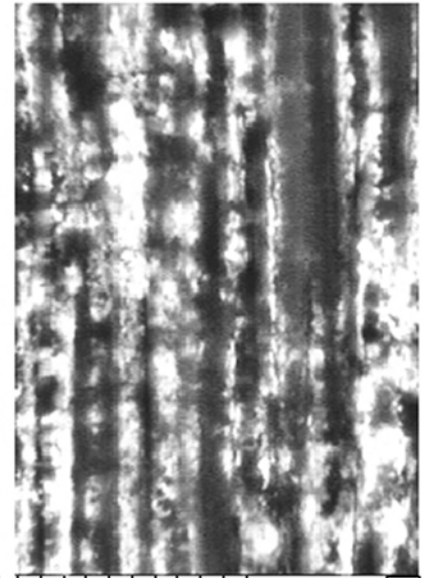
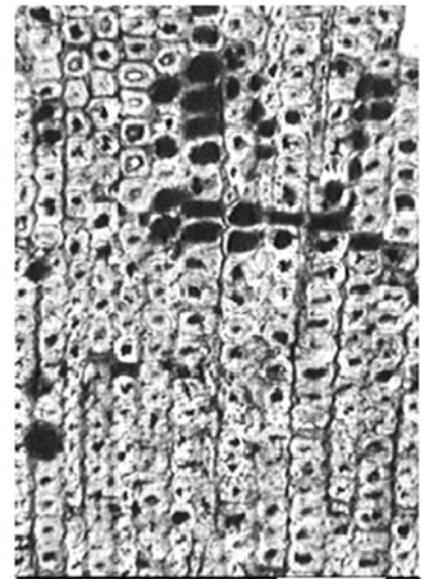
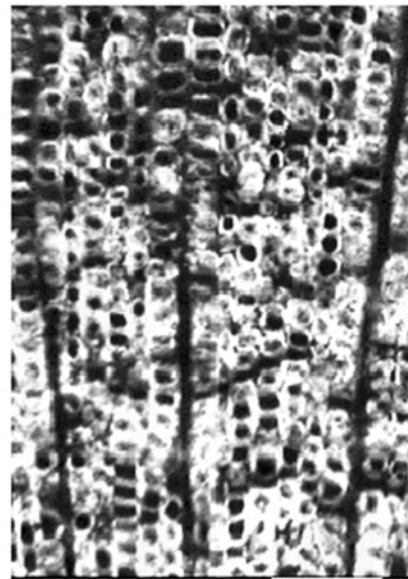
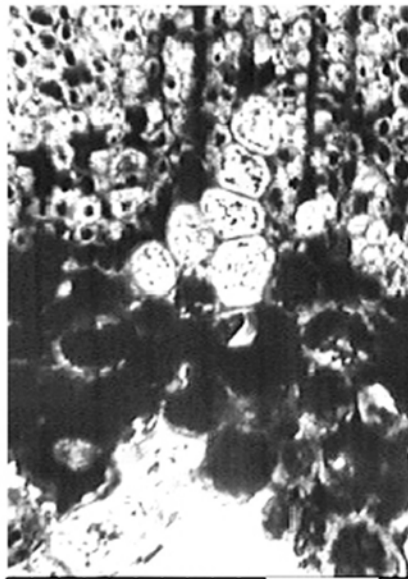


PLATE IV

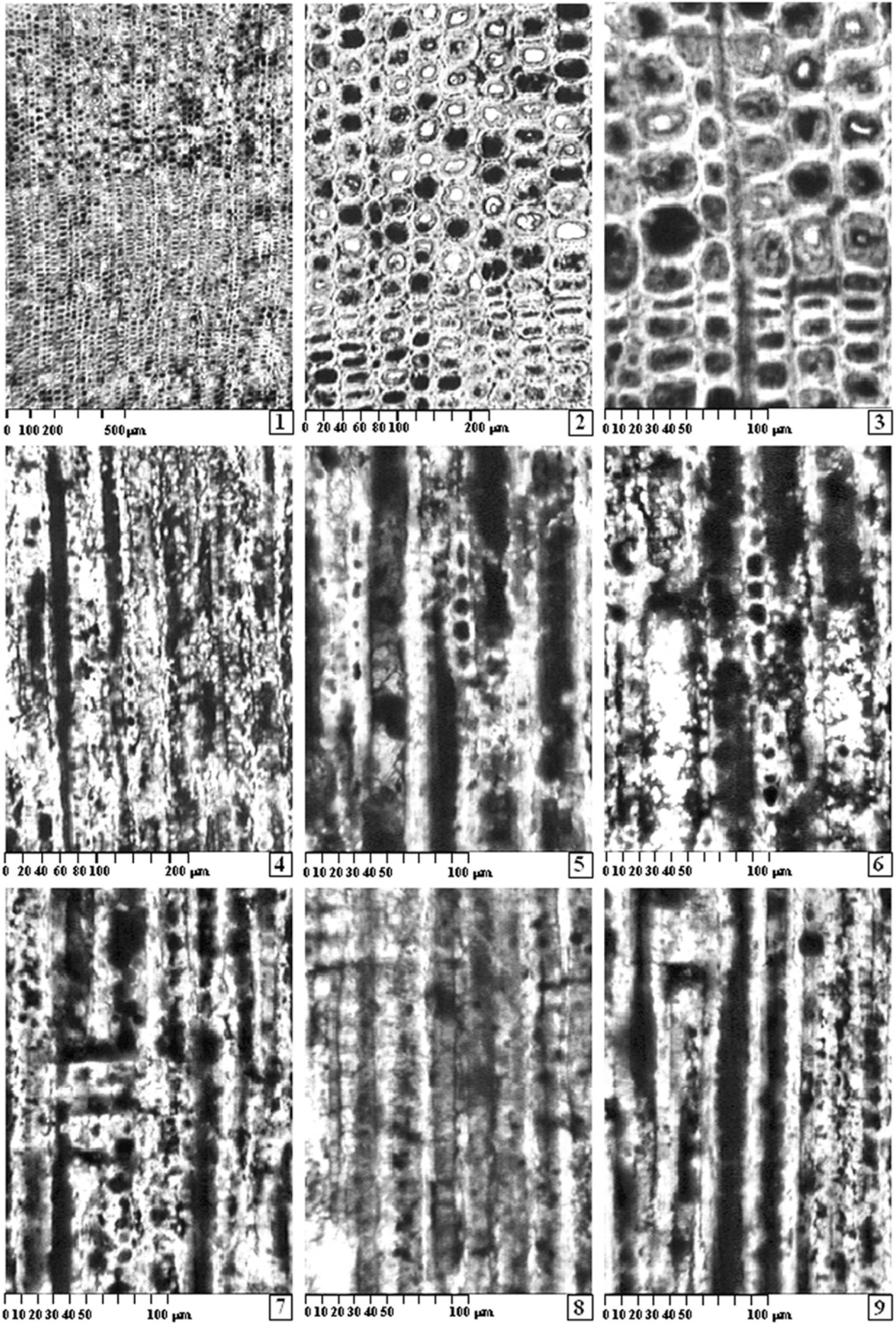


PLATE V

