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NEW CONIFERS IN LATE CRETACEOUS LIGNOFLORA FROM THE SOUTH APUSENI

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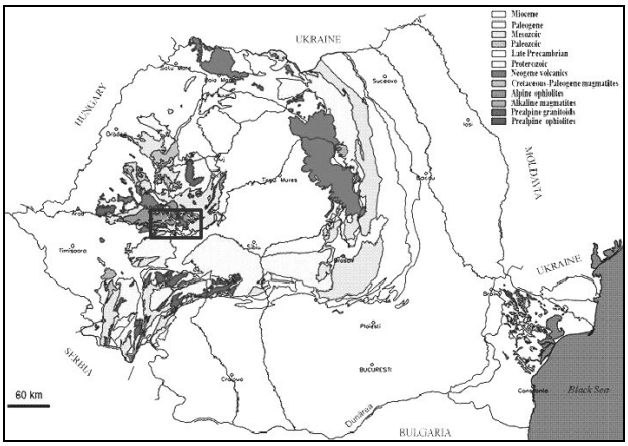
Abstract. This paper presents some new species of Late Cretaceous tracheidoxyles from South Apuseni, as *Dammaroxylon formosum* n.sp., *Agathoxylon ultimus* n.sp., *Prototaxodioxylon marisii* n.sp., in addition to a Lauraceae-Mastixiaceae Flora, priorly identified.

Keywords: Late Cretaceous, Araucariaceae, tracheidoxyles, Randzellen.

INTRODUCTION

The sedimentary deposits of the Late Cretaceous are well represented within the medial basin of Mureş river, between Alba Iulia-Geoagiu-Deva-Zam (E-W, in Textfig. 1), mainly by the marine facies of the Bozeş Formation (Campanian-Early Maastrichtian) followed by a continental fluvial-lacustrine facies (see Codrea et al. 2001; Bâlc & Chira, 2002) in a red Late Maastrichtian (+Early Palaeocene?) formation (illegitimately named Pâclişa or Vurpăr or Râpa Roşie or Gurasada Formation).



Text-fig. 1. Geological Sketch of Romania, localization of the studied Area in South Apuseni.

These last formations are equivalent to other red Transylvanian deposits similar in age, often volcano-sedimentary, known as Fața Băii Formation (Borcoş et al., 1986), or Sânpetru and Densuş-Ciula Formations (Grigorescu, 1992), some of them bearing reptilian remains, but all of them bearing vegetal remains.

The study of many fossil wood remains found in this region, mainly in South Apuseni, showed a flora with **Lauraceae** and **Mastixiaceae**, suggesting at least for this time interval a tropical paleoclimate. Within this paper we present some new identified arboreal Conifers of tracheidoxylic type. These new elements are coming from Câmpuri-Surduc,Gurasada-Țiganului valley and Geoagiu areas.

From this region of South Apuseni (Metalliferous Mts.), many Angiosperm taxa belonging to **Cornaceae, Euphorbiaceae, Icacinaceae, Lauraceae, Mastixiaceae, Platanaceae** and **Palmae** families were already identified (Felix, 1887; Petrescu et Nuțu, 1970, 1971; Iamandei & Iamandei, 1998-2000). Maybe it is good to mention that formerly, some of this deposits (from Gurasada area) were missinterpreted as Mid-Miocene in age, Rather recently their age was established, by radiogenic studies of absolute age (Borcoş et al., 1986), as Late Maastrichtian+Early Palaeocene(?). This is the till now outlined arboreal association, in South Apuseni Mts.: *Araucarioxylon* sp. (Petrescu & Nuțu, 1970); *Pinuxylon* sp. (Petrescu & Nuțu, 1970); *Laurinoxylon* sp. 1,2,3 (Petrescu & Nuțu, 1971); *Perseoxylon antiquum* FELIX 1887; *Laurinoxylon neagui* IAMANDEI & IAMANDEI 1998; *Icacinoxylon tyleradiatum* IAMANDEI & IAMANDEI 1998; *P. bacense* IAMANDEI & IAMANDEI 2000; *Securinegoxylon bacense* IAMANDEI & IAMANDEI 2000; *Plataninium porosum* FELIX 1887; *Platanoxylon porosum* (FELIX 1887) PETRESCU & NUȚU 1970; *P. catenatum SÜSS & MÜLLER-STOLL 1977,* (in Iamandei & Iamandei, 2000); *Cornoxylon romanicum* PETRESCU & NUȚU 1971; *Mastixioxylon microporosum* GOTTWALD, (in Iamandei & Iamandei, 1999); *Palmoxylon techerense* IAMANDEI & IAMANDEI (in press).

PALEOXYLOTOMY

Genus ***Dammaroxylon*** SCHULTZE-MOTEL 1966

Dammaroxylon formosum n.sp.

Plate II, Figs. 1–9.

Holotype: figured in Plate I, Figs. 1–9., deposited in G.I.R. Collection, inv.no. 26477.

Diagnosis: Tracheidoxyl with araucarian pitting and araucarioid cross fields. Less distinct growth rings, of 40-60 cells wide, devoid of any resin ducts. Tracheids rounded in cross section, thick walled (16-22 µm double wall), circular lumina. Radial araucarian pitting, in 1-2(3) vertical rows, with round to tilted elliptic apertures, smaller pits tangentially fewer. Wood parenchyma few, small simple pitted, with smooth horizontal walls. Exclusive uniseriate medullary rays, of 1-16(32) cells high, smooth thick-walled cells (3-5 µm double wall), 13-16 µm diameter, 20-37 µm high, frequency 9-16 rays on tg.

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mm., arcuate tangential walls without indentures, rays homocellular - ray cells all procumbent, the marginals higher, with hypermarginal unpitted spaces of "Randzellen" type, araucarioid cross-fields with alternate pits, more numerous within taller marginal fields, having vertical to oblique apertures.

MACROSCOPIC DESCRIPTION

A piece of fossil wood was collected from Geoagiu Valley, South Apuseni coming from Bozeş Formation., a flishoid one that sometimes preserves vegetal remains, also observed by prospectors (E. Roşu, 1999, personal communication). The real age of this formation was recently identified by microfauna and nannoplancton studies, as Campanian-Lower Maastrichtian (Codrea et al., 2001; Bâlc & Chira, 2002). The sample is a piece of silicified wood, dark in colour and of centimetric size (16/7/6 cm). At magnifying glass or even by nacked eye annual rings can be seen, and fibrous structure without vessels suggestig a tracheidoxylic wood. The studied silicified wood sample and three slides are deposited in G.I.R. Collection (at National Geological Museum) under the inventory number. 26477.

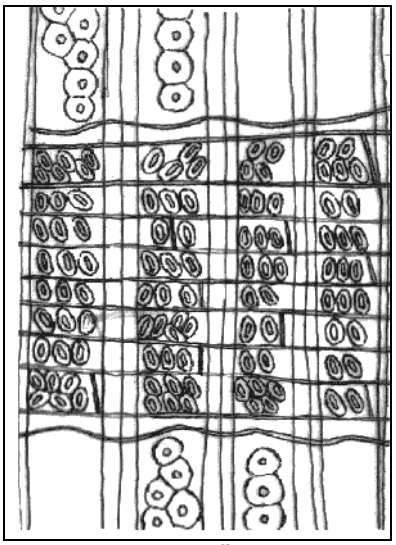
MICROSCOPIC DESCRIPTION

Secondary wood with tracheidoxylic structure, with relatively distinct **growth rings** in cross section, of 24-60 cells wide and devoid of normal or traumatic resin ducts.

Tracheids rounded in cross section, variably sized, thick walled (16-22 μm the double wall), circular lumina to elliptic or slightly irregular, locally narrower (compression wood). Lumina diameters (radial/tangential) are of 24-45/30-50 μm, smaller within the late wood that is marked by 4-6 tangential rows of small sized and flattened cells. Their density is 400-650 cells on mm^2. The tangential walls are usually unpitted but, sometimes small araucarian bordered pits can be seen, of 12-14 μm in diameter, with tilted oval apertures of 5-6 μm, contiguous in uni- or biseriate short rows. Radial pits are bigger, of 15-20 μm in diameter, araucarian, uni-, biseriate or even triseriate, with circular or tilted elliptic apertures of 6-8 μm. The uniseriate rows have flattened pits with a right line-contact, and sometimes with bi- or triseriate storeys. The bi- or triseriate rows are constituted by alternate rounded to polygonal pits, rarely subopposite, in typical araucarian disposition. The tracheidal walls are obviously striated, as differentiate alteration of the microfibrils of the secondary wall, that may characterize a reaction to compression, as the cross section suggests.

Wood parenchyma is few or even absent. Longitudinally, rarely appears as vertical rectangular cells, sometimes with many simple small pits, of 1.2-1.8 μm, and with smooth and thin horizontal walls.

Medulary rays appear uniseriate in cross section, with rectiligne trajectory, and are built from thin-walled rectangular elongate cells. Tangentially, the exclusively uniseriate rays have 1-16(-32) cells in height, i.e. till 572 μm. The ray cells have round to oval vertical section, of 13-16 μm in diameter and 20-37 μm in height and are moderately thick-walled (3-5 μm double wall). The density is of 9-16 rays on a horizontal tangential millimeter.



Text-fig. 2

Radially seen, the ray-cells have right to arcuate tangential thin and smooth walls, without indentures. The rays are homocellular, with all procumbent ray cells, the marginals higher, but almost always having less developed marginal unpitted spaces with slightly irregular waved outline (Text-fig. 2), of "Randzellen" type (*sensu* Schultze-Motel, 1966). They appear even in tangential section, as small triangular or circular outlined spaces, missing in the low rays, of 1-2 cells high. The ordinary cross-fields present 1-5 araucarioid pits (Textfig. 2), with oblique to vertical elliptic apertures. The marginal cross fields are more populated: 3-6-9 alternately disposed or slightly irregular on 1-2(3), so typical araucarioid. The pits have elliptic borders of 12-15 μm in diameter, and vertical to oblique apertures 4-6 μm, all of them similarly tilted.

AFFINITIES AND DISCUSSIONS

The here studied wood structure comes from a Late Cretaceous formation and, taking into account the typical araucarian xylotomical characters: araucarian radial pitting, araucarioid cross fields with araucarian pits (*sensu* Greguss, 1955, 1968), we assign it to **Araucariaceae f**amily, since it is very similar to the extant species *Agathis philippinensis* WARB. (see Greguss, 1972). Today this family has only three genera (*Araucaria, Agathis* and *Wollemia*), with almost 40 species. Xylotomically however, we talk about only two types of wood, very similar one another,

their features being presented comparatively in the following synthetic table, simplified from Greguss (1955):

Features	*Araucaria Type*	*Agathis Type*
Growth rings	Indistinct	Relatively distinct
Tracheids	Without gradual transition to late wood	With gradual transition to late wood
Radial pitting	Araucarian, 1-5-seriate	Araucarian, 1-3-seriate
Rezinous content	Sometimes compact, plates, trabeculae	Sometimes present
Parenchyma	Absent or very rare	Occasionally present
Ray height	1-15(25) cells	1-15(40) cells
Cross-field	Araucarioid, contiguous,	Araucarioid, hexagonal, contiguous
Pits	2-8(10) μm in 2-3 vertical rows	2-8(10-16) μm in 1-2-3 horizontal rows

The already described fossil forms with araucaroid characters are numerous and distributed to form-genera *Dadoxylon* ENDLICHER - *Araucarioxylon* KRAUS, and generally to the **Protopinaceae**, a group well defined by Kräusel in 1949, and partially revised by Vogellehner (1967, 1968), but contested by some new authors (Philippe, 1993, 1995; Dupéron-Laudouéneix & Dupéron, 1995).

But since *Araucarioxylon* does't represents **Araucariaceae**-wood or *Araucaria*-wood, and there are discussions on its validity, the fossil wood of **Araucariaceae** is represented by 4 valid paleoxylotomic form-genera of tracheidoxylic type, correctly defined: *Agathoxylon* HARTIG, *Pseudagathoxylon* GREGUSS, *Dammaroxylon* SCHULTZE - MOTEL, *Simplicioxylon* ANDREÁNSZKY (see Philippe, 1993).

The real problem is that in Northern Hemisphere, it appears that few araucariaceae are confirmed to live within Upper Cretaceous. This is a synthesis of them (after Marc Philippe, 2000, written communication):

- Greguss (1967 p.13) lists erroneously *Dadoxylon graminovillae ZIMMERM* and *D. implexum ZIMMERM*, from Germany, as Cretaceous, even initially they were described as Triasic (Zimmermann, 1953), now they are considered having *Gingko*-features, and of Permian age (Greguss, 1967, p.18). Also from Germany (near Quedlinburg) was described a *Dadoxylon subhercynicum* SCHULTZE-MOTEL 1962, Upper Cretaceous in age, not contested.
- In a recent revision of the Cretaceous woods from Hungary (Philippe & Barbacka, 1995) it is shown that there are not concrete informations about araucarian woods in Upper Cretaceous, but they are frequent until Aptian-Albian. Within the Senonian lignite from Ajka they seem to be unknown, and Greguss informations about Tata woods (Kalvaria hill), sometimes attributed to the Upper Cretaceous (see Schultze-Motel, 1962, p. 470), were demonstrated to be associated with Upper Aptian ammonites (*Cheloniceras*).
- In France, Philippe shows that this type of wood is frequent until Aptian-Albian, and the lignoflora studied by Fliche (of Albian-Cenomanian age), is devoid of *Araucarioxylon*. But there is an *A. breveradiatum* described by Lignier, and an *A. gardoniense* CRIÉ, from the French Cenomanian, recently is confirmed as generic identification (Philippe, 2000, written communication).
- It is also known that in Austria, Krasser identified an *Araucarioxylon* sp. from the Cretaceous Flisch from Klosterneuburg, Jacobsohn have found another *Araucarioxylon*, and in Italy, Biondi determined some species of *Araucarioxylon*, from Aptian-Albian deposits and in Japan were described from Upper Cretaceous (Senonian from Southern Sachalin): *A. tankoense* STOPES & FUJII, *A. kiiense* OGURA and *Dadoxylon tankoense* (STOPES & FUJII) SHIMAKURA (Philippe, 2000, written communication, see also Schultze-Motel, 1962).
- In Romania, Petrescu & Nuțu (1971) have described an *Araucarioxylon sp*. from Boiu de Jos, Gurasada area. That time, the vulcano-sedimentary host deposits were missinterpreted as Mid-Miocene, now they are correctly attributed to Latest Cretaceous (Upper Maastrichtian), equivalent to other red Transylvanian formations (sometimes with Dinosaurs remains, like those from Hateg or Vurpăr-Vinț-Oarda (Mureş Valley) (Codrea et al., 2001). The authors suggested that the wood had to be reworked from Lower Cretaceous. Other *Araucarioxylon* sp.(?) is only quoted for Late Cretaceous in Săsciori and Hațeg-Pui (Petrescu, 1973; Petrescu & Duşa, 1970; Petrescu & Huică, 1972). A correct but odd identification is *A. moldaviense* BOUREAU, STAROSTIN & TRELEA 1961, a wood found within Sarmatian sedimentary deposits, most probably reworked from older deposits. In this paper we also describe some other araucariaceae from Romania.

Evaluating the xylotomical characters of our specimen innitially we found that they fit with *Agathoxylon* HARTIG. Thoroughgoing study and the comparisons with fossil forms already described we found many similarities with the genus *Dammaroxylon* SCHULTZE-MOTEL 1966, a valid araucariaceous genus after Philippe (1993), characterized by the presence of the "Randzellen" structures.

Having some doubts, Philippe (2000, written

communication) was wondering if the simple presence of the marginal spaces of "Randzellen" type, *sensu* Schultze-Motel (1966), (=cellules bordieres), really allows to distinguish a generic rank of a taxon, even paleogeographically it seems to have coherence. It is good to note that even the name is "Randzellen", they don't seem to be cells but extracellular spaces, as they have been figured by Schultze-Motel (1966, p.282-287) and Greguss (1955, pl. 5-7; 1972, p.40-51)., that mentioned: “the broader rays tend to have some parenchymal lining” (ibidem, p.39). Also, being unpitted (we haven't seen any pit in our slides) they can be neither radial tracheids nor other type of ray-cell.

Greguss figured this character at many modern species of *Agathis*, even to some species of *Araucaria* (Greguss, 1955, 1972), and it is possible that even they are not radial tracheids but inter- or extracellular spaces, or artefacts due to fossilization, they however seem to have an important taxonomic character. And if "Randzellen" are artefacts they wouldn't exist in the modern species. Reading this paper, Philippe (2004, written communication) point out that "scanning electronic microscopy of fossil and recent woods demonstrate that these "Randzellen" occur by most wood types".

The comparison with the species of *Damaroxylon* already described show that very close to our structure are the forms *D. africanum* SCHULZE-MOTEL 1966, *D. uzambense* SCHULTZE-MOTEL 1966. However our specimen shows growth rings, 1-2(3)-seriate radial pitting, different than both African species that have, also, different cross fields with 1-4 araucaroid pits (*sensu* Greguss, 1955, 1968), in vertical pairs, with narrow elliptical apertures. *Dammaroxylon* sp., described in the same paper, are devoid of the details from cross fields. Other species described from some deposits from the limit Tertiary-Quaternary in Sumatra (*D. kaurioides* KRÄMER 1974), without growth-rings, the tracheids have regular cross section, small araucarian radial pitting 1-3-seriate with crossed apertures and similar tangential pitting but smaller. The rays are 1-2-seriate, the uniseriates of 1-60 cells high and cross fields with 1-2-4(8) alternate oculipores, more numerous in the marginal taller fields.

We found many similarities with *Dadoxylon subhercinicum* SCHULTZE-MOTEL 1962 regarding the wood structure, the radial pitting, the parenchyma and the cross fields, but having no "Randzellen" and the rays being taller (1-32 cells). So, after such a comparison and analysis on the xylotomical characters of our specimen, we decided that it is a new species we named *Dammaroxylon formosum* n.sp., after its really beautiful structure preserving many microscopic details.

About the evolution of **Araucariaceae** in Europe during Upper-Cretaceous, Philippe said (2000, written communication): "Parmi les bois fossiles il faut reconnaître que les bois fossiles a affinités araucariennes constituent un groupe pléthorique ou il est bien difficile de tracer des limites taxonomiques. Nous ne discuterons donc pas les affinités avec les especes proches, appartenant par exemple au genre *Agathoxylon* HARTIG, mentionnées dans le Crétacé d'Europe. Il est, par contre, intéressant de souligner le caractere assez tardif de cette donnée. Alors qu'elles dominaient probablement les forets (s.l.) du Crétacé inférieur tout autour de la Téthys, les Araucariacées ont lentement été supplantées au Crétacé supérieur, jusqu'a disparaître d'Europe et de tout l'hémisphere Nord a la fin du Crétacé. Les Araucariacées ont meme disparu a cette époque de la marge sud de la Téthys (Barale et al., sous presse) ou elles étaient cependant massivement représentées durant tout le Crétacé (Dupéron-Laudouéneix & Dupéron, 1995). La chronologie de cette disparition est assez mal connue, et c'est pourquoi la donnée roumaine est importante".

Genus ***Agathoxylon*** HARTIG
Agathoxylon ultimus n.sp.
Plate III, Figs. 1–9; Plate IV, Figs. 1–9.

Holotype: figured in Plate II, Figs. 1–9., deposited in GIR Collection, inv.no. 26518;

Paratype: figured in Plate III, Figs. 1–9., deposited in GIR Collection, inv.no. 26480.

Diagnosis: Tracheidoxyl without growth rings, without any resin ducts, having thick-walled tracheids with rounded lumina, rd/tgd=20-30/20-35 µm, density 1750-1850 on sq.mm, tangential walls unpitted, araucarian radial pitting partially covering the wall, uni- or biseriate, usually contiguous, with round to slightly flatened or polygonal borders of 17-18.6 µm in diameter, tilted elliptic apertured, striated walls without crassulae, with trabeculae. Wood parenchyma absent. Uniseriate rays of 1-23 cells high, with short biseriate storeys, density of 8-12 rays on tangential millimeter, homogeneous, homocellular, thick-walled ray-cells, araucarioid cross fields with 1-7 or more alternate contiguous araucarioid pits on 1-2-3 horizontal rows.

MACROSCOPIC DESCRIPTION

Two pieces of silicified wood, one found in Câmpuri-Surduc area, the right bank of Mureş Valley and the second in Tiganului Brook, right tributary of Gurasada Valley, coming from a volcano-sedimentary formation, very probably equivalent to the Fața Băii Formation, of Late Maastrichtian (+Early Palaeocene?) age. The samples designated types, slightly fragmented during preparation, are deposited in G.I.R. Collection (at National Geological Museum), under the inv.no. 26518 and 3 standard slides the holotype (P.841), and under the inv.no. 26480 and 3 standard slides the paratype (P.7). They represented branch fragments, brown to dark in color, centimetric in size: the holotype have two

pieces with 5.2/3.0/2.5 and 3.8/2.3/2.3 cm and the paratype, 6.3/4.7/3.4 and 2.8/1.9/1.8 cm. With naked eye or by magnifying glass annual rings may be seen, fibrous structure without vessels, suggesting a coniferous structure.

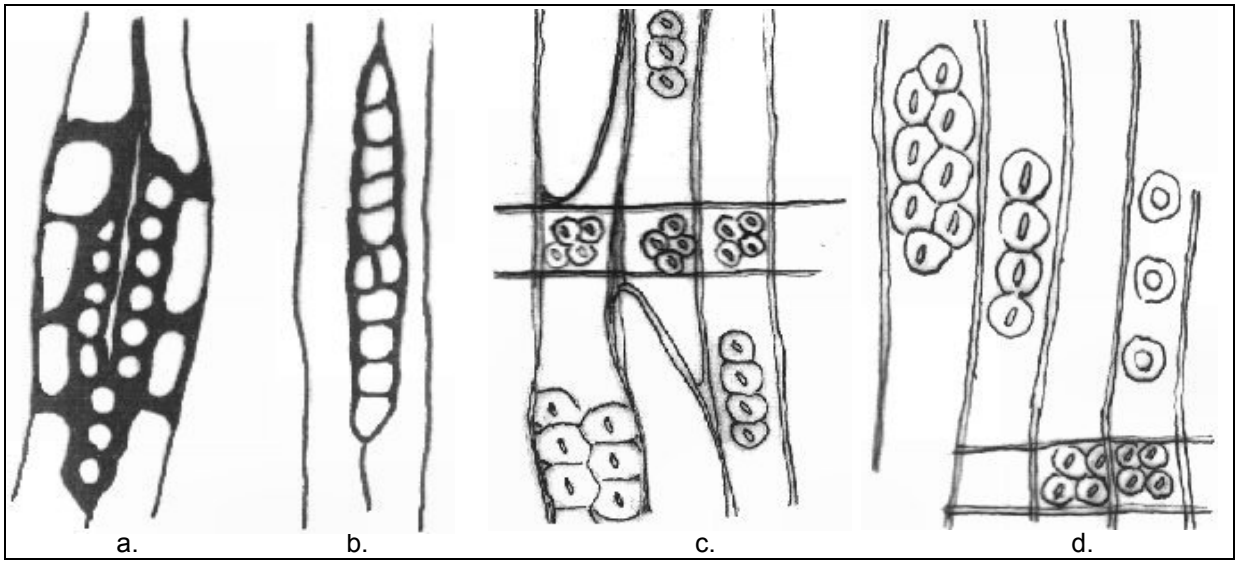
MICROSCOPIC DESCRIPTION

Secondary wood with homoxylic (tracheidoxylic) structure with indistinct or absent **growth rings** and devoid of any normal or traumatic resin ducts.

Tracheids polygonal, with slightly rounded corners in cross section, unequal in size, with quadrangular lumina to rounded or circular, with radial/tangential diameters of 20-30/20-35 µm, and thick walled (12-13 µm double wall, even thicker in the paratype specimen). The interradial bundles have 2-9 radial regular rows of tracheids and density is 1750-1850 tracheids on mm^2. (Sometimes, in the paratype specimen, areas with mixed variable sized tracheids intermingle with small sized tracheids areas and frequently show intercellular spaces due to rounded or crushed tracheids). Usually, tangentially seen the tracheids are unpitted**.** Radial pitting is araucarian, either circular spaced or contiguous and flattened (d/D=0.79), in a single vertical row, separated by a horizontal line, oblique elliptic apertured, or polygonal alternate contiguous on 2, rarely 3 vertical rows. Pits with borders of 17-18.6 µm, tilted elliptic apertures of 7.5/2.3 µm. The biseriate rows are sometimes continued by uniseriate portions, not occupying all the length of the wall and, generally, the pitted areas don't cover integrally the tracheidal wall. There are no crassulae or helical thickenings, but the walls are striated and the lumina show isolated globules or plugs of resin, and trabeculae.

Wood parenchyma very rare or even absent. When it is present it has relatively thick vertical walls and the horizontal ones are thin and smooth.

Medullary rays uniseriate, rectilinear, sometimes shortly radially developed and constituted by quadrangular cells or "barrel like", with smooth horizontal cellular walls. Tangentially the rays have 1-13(-25) cells in height, i.e. 30-270(-450) µm high. Sometimes the taller rays have 1-2 short biseriations, or are compound with the neighbor rays (see text-fig. 3 a,b). The ray cells are circular to oval usually having a dark content and relatively thick walls. Ray density is 8-12 rays on horizontal tangential millimeter. Radially the rays are homocellular, cells all procumbent of 19-20 µm high and 80-120 µm long, moderately thick-walled: 5-6.2 µm the double wall. Within the marginal rows the cells are higher, of 28-30 µm and have 80-130 µm in length.The typical araucarioid cross fields have 1-7 oculipores, araucaroid pits (*sensu* Greguss), hexagonal or rounded of 9-13 µm in diameter, with circular or short elliptic tilted apertures of 3.5-5.5 µm. The disposition is alternate or slightly irregular on 1-2 rows, sometimes, in marginal fields are more numerous, alternate in 2-3 horizontal rows (text-fig. 3 c,d).



Text-fig. 3

AFFINITIES AND DISCUSSIONS

The studied fossil wood sample present a combination of xylotomic characters typical araucarian, and trying to compare it with the types of wood structure of Araucariaceae, as Greguss (1955) showed (see the upward comparative tabel).

Evaluating the character combination of our studied material, it seems to fit with *Agathis type*. Since the status of the genera *Araucarioxylon* and *Dadoxylon* may not be legitimate in all cases (see Philippe, 1993, 1995; Philippe & Barbacka, 1997), there were kept for fossil araucariaceous wood, or even of *Araucaria*, mainly tracheidoxyles, few valid

genera correctly described and published: *Agathoxylon* HARTIG, *Pseudagathoxylon* GREGUSS, *Dammaroxylon* SCHULTZE-MOTEL and *Simplicioxylon* ANDREÁNSZKY.

Using the identification key proposed by Philippe (1993) for tracheidoxyles with araucarioid cross fields, we found that the here studied specimens fit to *Agathoxylon* HARTIG. The generotype, *A. cordaianum* HARTIG, presents similar features having araucarian radial pitting, araucarioid cross fields and some axial parenchyma.

Taking into account that many Cretaceous species of *Araucarioxylon, Dadoxylon (Araucarioxylon)*, or *Dadoxylon* (see Schultze-Motel, 1960, 1962, 1966), some of them equivalent to *Agathoxylon*, it is very difficult to identify our material with them, when a serious revision about - is missing, and much more, some of them are not tracheidoxyles, or are coming from older deposits: in some recent partial revisions (Philippe, 1993, 1995; Philippe & Barbacka, 1997) of the Cretaceous woods from Hungary, Italy, France and Austria, it is shown that many of them are coming from Lower Cretaceous. From Upper Cretaceous few species are described and we quote: *A. tankoense* STOPES & FUJII, *A. kiiense* OGURA (in Schultze-Motel, 1966) from Japan, *Dadoxylon tankoense* (STOPES & FUJII) SHIMAKURA (in Philippe, 1993) from the Senonian of South Sachalin, *Dadoxylon subhercynicum* SCHULTZE-MOTEL 1962, from the German Senonian, an *Araucarioxylon sp*. (Petrescu & Nuțu, 1971) from Romanian Late Maastrichtian, and the *Dammaroxylon* described by us in this paper.

Comparatively judging the xylotomic features of our specimen designated as holotype, with other Cretaceous cited forms, we decided that our structure belongs to a new species that we named *Agathoxylon ultimus* n.sp., since it may represent the last araucariaceae from Europe, coming from the terminal Maastrichtian: post-mastrichtian one talk about the definitive disparition of these conifers from Europe.

Genus ***Prototaxodioxylon*** VOGELLEHNER 1968 emend. GIRAUD 1985

Prototaxodioxylon marisii n.sp.

Plate I, fig. 1-9; Textfig. 3.

Holotype: figured in Plate II, Figs. 1-9., deposited in G.I.R. Collection, inv.no. 26523

Diagnosis: Secondary wood with tracheidoxylic structure, without any resin ducts with distinct growth rings, of 20-26 cells wide, gradually diminishing, late wood marked by 3-7 rows of thick-walled tracheids. The tracheids are moderately thick-walled, lumina with radial/tangential diameters=40-60/25-40(50) μm, density=712-772 traheids on mm^2, tangentially usually unpitted, radially with abietineous 1-2-seriate pits, of 16-18 μm in diameter, with circular big apertures of 8-9 μm, opposite disposed, with crassulae, or subopposite to alternate, giving a mixed character to the pitting, usually striated walls. Wood parenchyma present, having smooth and not very thin unpitted horizontal walls, resin globules and plugs in lumina. Uniseriate rays of 1-24 cells high, sometimes with biseriate storeys, 8-10 rays on tangential mm. Radially heterocellular, even all procumbent, there are ordinary cells and ray tracheids, with not too thin walls, the tangentials without visible indentures, knotted at the insertion point, 12-22 μm high, wavy in maginals - ray tracheids higher: 30 μm. Ordinary cross fields with 1-6 taxodioid pits oblique elliptic apertured, smaller in latewood. In ray tracheids cross field - smaller circular pits with circular apertures, sometimes taxodioid, superposed in two rows.

MACROSCOPIC DESCRIPTION

A piece of silicified wood was found in Câmpuri-Surduc area, Mureş valley, the right bank, in a volcano-sedimentary deposit Late Maastrichtian (+Early Palaeocene?) in age that preserves here many vegetal remains. This sample is designated holotype, and it is deposited in G.I.R. Collection (at National Geological Museum) under the inv. no. 26523, (specimen P.846 and 3 standard slides). The sample is a trunk fragment, brownish in color and centimetrical in size: 6.0/5.8/2.5 cm. With nacked eye or by magnifying glass, annual growth-rings can be seen, and regular fibrous structure without vessels, that suggests a homoxylic (tracheidoxylic) coniferous wood.

MICROSCOPIC DESCRIPTION

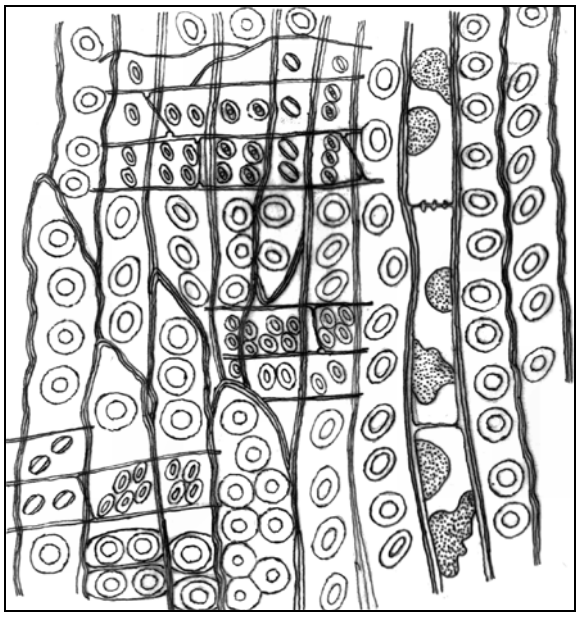
Secondary wood with homoxylic – tracheidoxylic structure, with distinct **growth rings** of unequal height, of 20-26 cells, 17-19 tangential rows from thinner-walled wide tracheids in early wood, gradually passing to a late wood marked by 3-7 tangential rows of thick-walled tracheids, slightly radially flattened. Normal or traumatic resin ducts are absent.

Tracheids in cross section, are polygonal (quadrangular) slightly rounded at the corners, and lumina with radial/tangential diameters of 40-60/(25)40-50 μm. The cell walls are thin to moderately thick: 5-6.2 μm the double wall. The density is 712-772 tracheids on mm^2. The interradial bundles have 1-4 radial regular rows of tracheids. The tangential wall is generally unpitted, rarely with smaller abietineous pits of 7-9 μm in diameter with small circular apertures, irregular disposed in a vertical row. On the radial walls usually abietineous pitting is present in a single vertical row, and with crassulae. On the wider early wood tracheids two rows, rarely three, with circular abietineous pits, opposite, with visible crassulae (Text-fig. 4), dwelling

in some rounded cases. On other tracheids the pitting appears subopposite or alternate, so giving a mixed (protopinoid) character to it. The pits have the border diameters of 16-18 µm, the apertures of 8-9 µm. Usually the tracheidal walls are striate.

Wood parenchyma is present, disperse, rather abundant, relatively thick walled, of 2-3 µm. The horizontal walls are also thick, of 1.5-2.5 µm, smooth to slightly rugose or even nodular, with 2-3 knots. Some parenchyma cells bear globules and plugs with round empty spaces in lumina.

Medullary rays uniseriate, rectilinear in cross section, constituted by polygonal elongate empty cells and with smooth unpitted horizontal walls. Tangentially they show 1-24(35) cells in height, i.e. 30-330(525) µm, sometimes with biseriate storeys, and circular to oval ray cells of 12 µm in diameter, usually having dark content, with extracellular lateral spaces. Ray frequency is 8-10 rays on tangential horizontal millimeter. Radially heterocellular even all procumbent, there are ordinary cells lower, of 12-22 µm high and 80-150 µm long, and only marginally ray-tracheids taller, till 30 µm high and 100-160 µm long, with not too thin walls (3-4 µm double wall). The tangential walls smooth, oblique or arcuate, without visible indentures but usually knotted at the insertion point with the horizontal wall, and wavy in maginals, giving them a special aspect of radial tracheids (Textfig. 4).



Textfig. 4

The ordinary cross-fields of araucarioid type show 1-3-6-7 usually cupressoid to taxodioid pits in early wood, in 1-2(3) horizontal rows disposed, sometimes filling all the cross-field. This pits have borders of 10-13 µm and oblique to horizontal wide elliptic apertures of 4-6/5-10 µm, till almost procumbent and touching the margin. In the latewood there are typical cupressoid ones with narrow oblique apertures, vertically disposed (Text-fig. 4). In the ray-tracheids cross-fields, usually appear 1-8 pits like those on the ordinar fields, or smaller cupressoid, of 9-10 µm with circular la elliptic apertures of 3-5 µm, superposed in two rows, or alternating, or as 2-3, vertically disposed in late-wood.

AFFINITIES AND DISCUSSIONS

Evaluating the xylotomic details of here studied specimen, it is obvious that it is characterized by 1-3-seriate opposite radial pitting with crassulae, sometimes subopposite or alternate, so of mixed (protopinoid) type, by the presence of relatively abundant parenchyma and by the araucarioid cross-fields with round, taxodioid and cupressoid oculipores, with tendency to a glyptostroboid arrangement. Even the tracheids are not very thick-walled, it is a tracheidoxyl with mixed radial pitting and araucarioid cross-fields.

Taking into account the numerous cupressoid pits from cross-fields, we tried firstly a comparison with some forms of ***Protocupressinoxylon*** ECKHOLD, using also the abreviated diagnosis of Kräusel (1949), Vogellehner (1967, 1968) for the Mesozoic species described from Triasic-Jurasic, even though some of them may have serious taxonomical problems: *P. leonardianum* (CHARRIER) VOGELLEHNER 1968, *P. catenatum* SCHULTZE-MOTEL 1960, *P. liasinum* SCHULTZE-MOTEL 1960, *Protocupressinoxylon sp.* (Vogellehner, 1968), *P. rhaeticum* VOGELLEHNER 1968, *P. dockumense* (TORREY) KRÄUSEL 1949, *P. coromandelinum* (SAHNI) KRÄUSEL 1949, *P. purbeckensis* FRANCIS 1983, and *P. malayense* ROGGEVEEN, *P. eboracense* (HOLDEN) ECKHOLD (Philippe, 1995), that cannot fit with our specimen, because they are devoid of parenchyma. *P. carentanensis* BARALE (in Philippe, 1995), is small spaced pitted in the cross field, while our specimen have slightly bigger cupressoid pits, more alike to araucaroid type, *sensu* Greguss (1955, 1968).

Some Cretaceous forms already described have traumatic resin ducts (similar to *Brachyoxylon*?) like *P. potomacense* ECKHOLD, *P. solmsi* (STOPES) KRÄUSEL 1949, *P. vectense* ECKHOLD, *P. luccombense* (STOPES) KRÄUSEL 1949, or have multiseriate rays like *P. weidlingense* (JACOBSOHN) KRÄUSEL 1949, so they are different.

However, seeing the taxodioid character of the cross-field pitting in early wood, and the obvious radial opposite pitting with crassulae on tracheids, we tried to compare our specimen with the form-genus ***Prototaxodioxylon*** VOGELLEHNER emend. GIRAUD, a taxon belonging maybe to **Cheirolepidiaceae,** a family generally representing "a divers and dominant Mesozoic group of conifers with yet equivocal descendents" (Taylor, 1981). Wood remains in connexion with taxodiaceous

foliage have been found in Cretaceous formations in Alberta (Canada), and it is possible to find foliage of taxodiaceae associated with Podocarpaceous or Cheirolepidiaceous wood remains, because "the wood and the foliar structures may evolve with different speeds or diverging directions" (Koeniguer, in Philippe, 1994).

In any case, our studied specimen has compatible characters with the original diagnosis of ***Prototaxodioxylon***, here presented: secondary wood without normal resin ducts, radial pitting araucarian or protopinoid (mixed), with taxodioid pitting in cross fields, tangential and horizontal ray-cell walls unpitted, parenchyma sometimes present.

Comparing the features of our specimen with other Jurassic and Cretaceous forms of ***Taxodioxylon*** and ***Prototaxodioxylon***, already described, we found many similar details, even if not all of them:

- *Prototaxodioxylon choubertii* (ATTIMS) VOGELLEHNER 1968, the generotype (basionym *Protocupressinoxylon chouberti*, firstly described by Attims from the Moroccan Dogger), has uniseriate round radial pitting and biseriate opposite to alternate, parenchyma absent and cross fields taxodioid to glyptostroboid.

- *P. romanensis* PHILIPPE, described from the French Lower Toarcian and the Upper Pliensbachian also, as a tracheidoxyl without resin ducts, but having parenchyma with smooth horizontal walls, round or flattened radial pitting, opposite or alternate, sometimes with crassulae and taxodioid cross fields (Philippe, 1994, 1995).

- *Prototaxodioxylon sp*. coming from Lower Liasic of Pecsbanyatelep, Hungary, initially described as *Taxodioxylon sp*. by Greguss & Kedves (1961), revised by Philippe & Barbacka (1997), as tracheidoxyle mixed pitted and with taxodioid cross fields. The last authors have found some other wood remains with similar structure coming from Vasas, Mecsek Mts., Hungary (unpub.).

- *Taxodioxylon lemoignei* PHILIPPE 1994, from the French Oxfordian, is a tracheidoxyl with abietineous radial pitting, frequently with crassulae, and cross fields with 1-4 taxodioid oculipores, cupressoid in the late wood.

- *T. cryptomerioides* SCHÖNFELD emend. RAMANUJAM 1972, described by Ramanujam from Oldman Fm., Campanian in age, from South Alberta (Canada), present abietineous radial pitting, uniseriate or biseriate opposite, sometimes with crassulae, with 1-4 taxodioid pitting in cross fields and abundant axial diffuse parenchyma, with smooth usually thin horizontal walls.

- *T. gypsaceum* (GOEPP.) KRÄUSEL, described by Ramanujam & Stewart (1969) from Edmonton Fm., of Maastrichtian age, in Drumheller area, Alberta (Canada), having similar structure with the extant species of *Sequoia*.

- *T. taxodii* GOTHAN, described by Ramanujam & Stewart (1969) from Edmonton Fm., of Maastrichtian age, in Drumheller area, Alberta (Canada), having similar structure with extant forms of *Taxodium*.

- *T. drumhellerense* RAMANUJAM & STEWART 1969 described from Edmonton Fm., of Maastrichtian age, from Drumheller area, Alberta (Canada), having similar structure with extant species of *Glyptostrobus*, with traheidal abietineous pitting, uni- or biseriate opposite, with crassulae, axial parenchyma with thick horizontal walls, weakly nodular, taxodioid to glyptostroboid cross fields with 1-4 pits in 1-2 rows.

- *T. antiquum* RAMANUJAM & STEWART 1969 described from Edmonton Fm. of Maastrichtian age, Drumheller area, Alberta (Canada), having big tracheids with trabeculae, 1-4-seriate radial pitted, abietineous, opposite, with crassulae, parenchyma few, usually in late wood, with smooth and thin horizontal walls, 1-4-seriate rays, high, taxodioid cross fields with 4-8 pits in 1-2 horizontal rows, 2-5 on a single row.

- *T. multiseriatum* RAMANUJAM & STEWART 1969, (and in Ramanujam, 1972), described in Oldman Fm., Campanian in age and Edmonton Fm., of Maastrichtian age, from South Alberta (Canada), characterized by the presence of multiseriate ray groups, usually of 2-4-seriate and higher than 25-30 cells, some of them extremely high.

The here studied structure that is a tracheidoxyl without normal resin ducts, with 1-2-3-seriate mixed (protopinoid) radial pitting alternate, and opposite with crassulae, having parenchyma with horizontal smooth and 1-3-knotted walls, uniseriate rays with taxodioid to cupressoid pitting (tending to a glyptostroboid pattern) (see Text-fig. 3), sometimes with ray-tracheids, seems to be similar to some of the cited forms, like *Prototaxodioxylon choubertii, Taxodioxylon lemoignei, T. cryptomerioides*, or *T. taxodii* and *T. drumhellerense*, but it is not identical. So, after this comparative discussion, it is obvious that our specimen preserves some particular original features, that define a new species, named by us *Prototaxodioxylon marisii* n.sp., after the latin name of Mureş river (*Maris*), in the right bank of which the fossil was found.

CONCLUSIONS

To the Late Cretaceous association quoted in the introduction of this paper, we add some new species of *Prototaxodioxylon, Dammaroxylon* and *Agathoxylon*, all of them firstly described in Romania. Wood remain of **Araucariaceae** firstly identified here, by Petrescu & Nuțu (1970) is also considered. The same deposits have provided a palynological association with *Classopollis* (yet unpub.) and many Angiosperm woods. It must be remarked that all the extant correspondents of the identified taxa live now within a wet tropical climate, that could be admitted

for such a paleoassociation. The reconstructed paleogeography of the Earth supports our conclusions about the paleoenvironment at the end of the Cretaceous, when all the Europe must have been more southward, and the insular territory of the South Apuseni probably had a tropical flora, as these fossil taxa are telling.

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PLATES

(grafic scale)

PLATE I

Figs 1-9 - Prototaxodioxylon marisii n.sp., holotype.
Figs. 1-3 – Tracheidoxyl in cross section;
Figs. 4-6 – Short rays in tangential section;
Figs. 7-9 - Radial pitting with crassulae and cross field pitting.

PLATE II

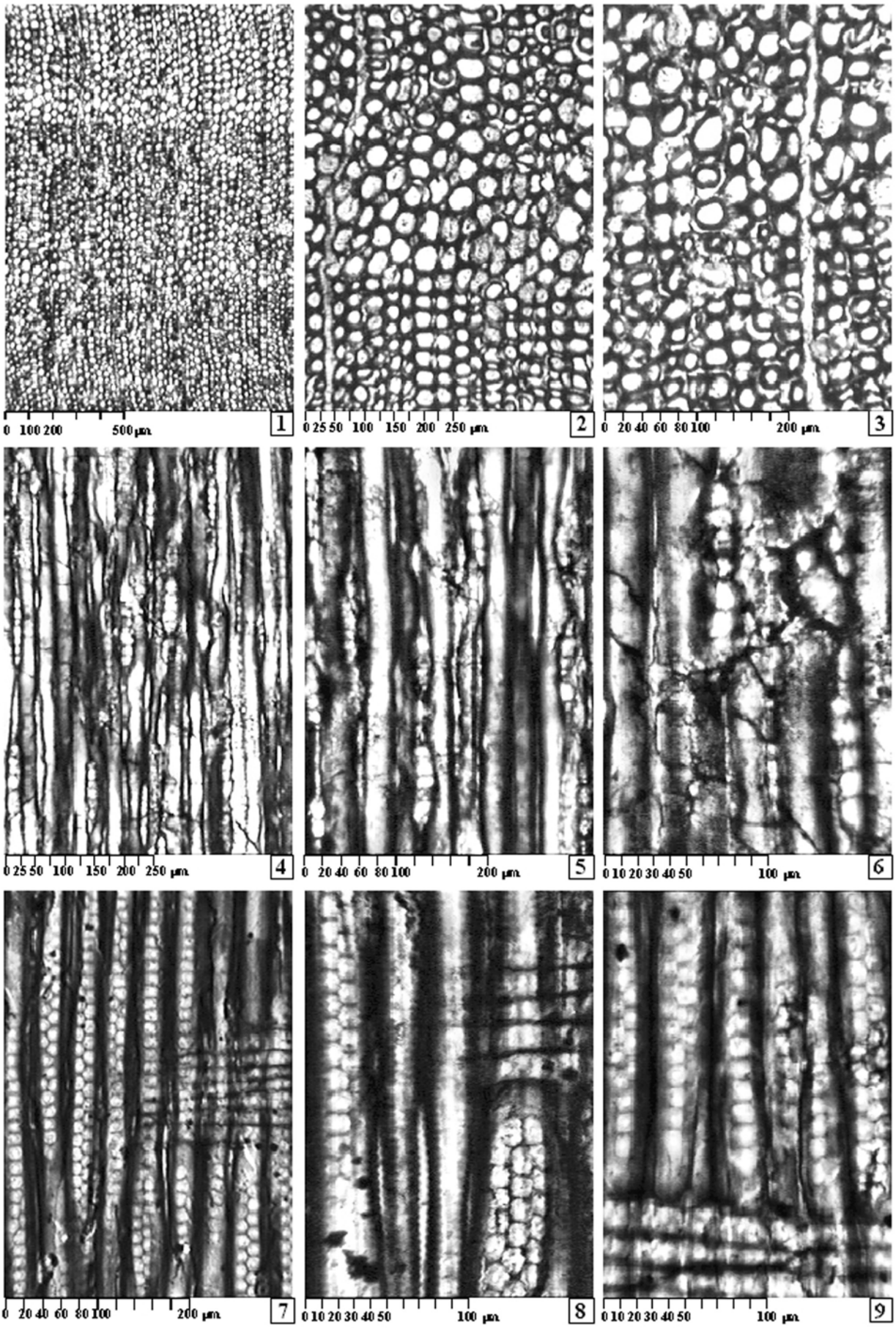
Figs. 1-9 - *Dammaroxylon formosum* n.sp., holotype.
Figs. 1-3 – Aspect and distribution of tracheids in cross section;
Figs. 4-6 – Short rays and tracheids in tangential section;
Figs. 7-9 - Araucarian radial pitted traheids and araucarioid cross fields.

PLATE III

Figs 1-9 - Agathoxylon ultimus n.sp., holotype.
Figs. 1-3 – Tracheids, rays in cross section;
Fig. 4 – Brachial bud disturbing the structure;
Figs. 5-6 – Rays in tangential section;
Figs. 7-9 - Radial araucarian pitting, cross fields.

PLATE IV

Figs 1-9 - Agathoxylon ultimus n.sp., paratype.
Figs. 1-3 – Tracheidoxyl with growth rings in cross section;
Figs. 4-6 – Tracheids, parenchyma and rays in tangential section;
Figs. 7-9 - Radial araucarian pitting, araucarioid cross fields.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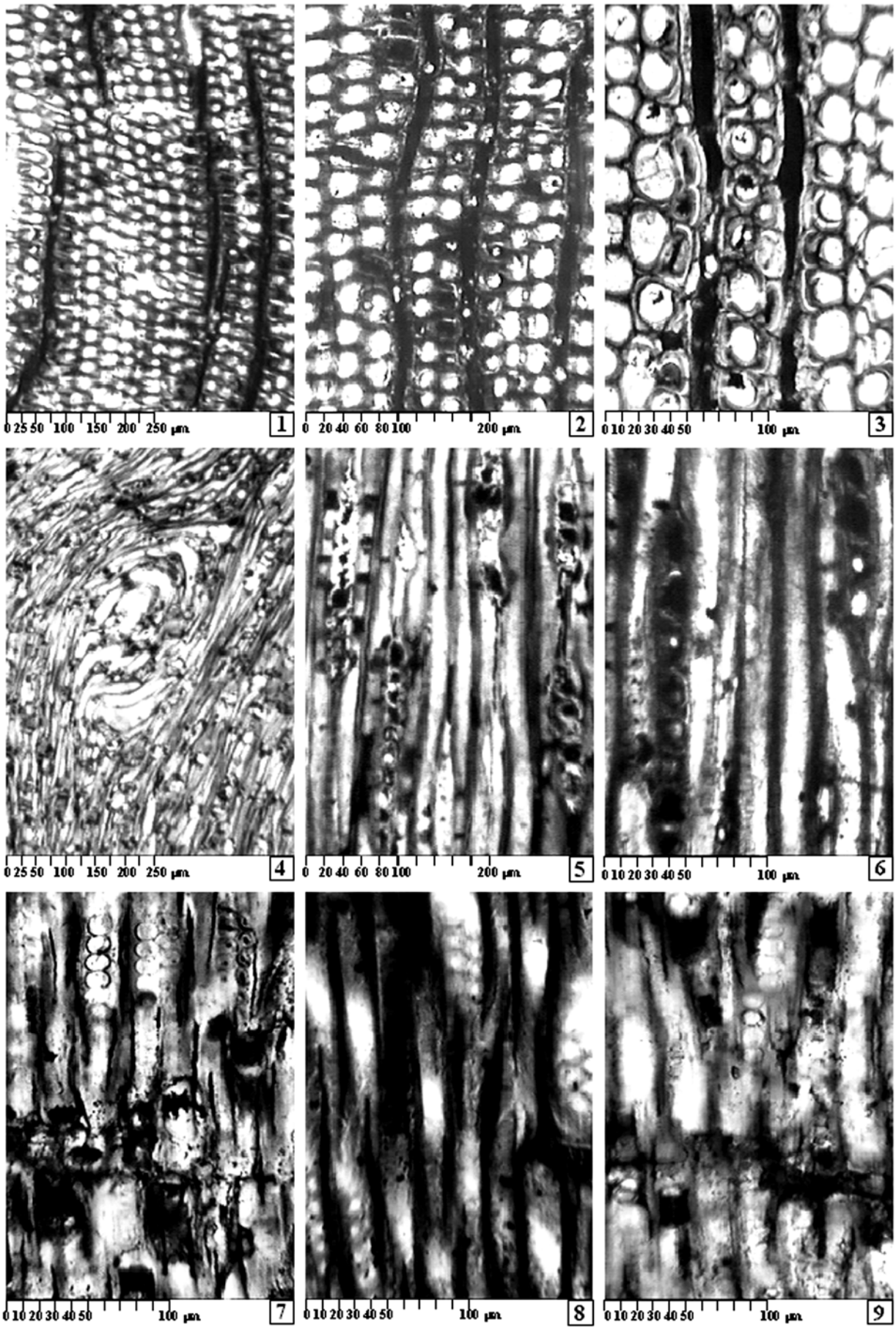
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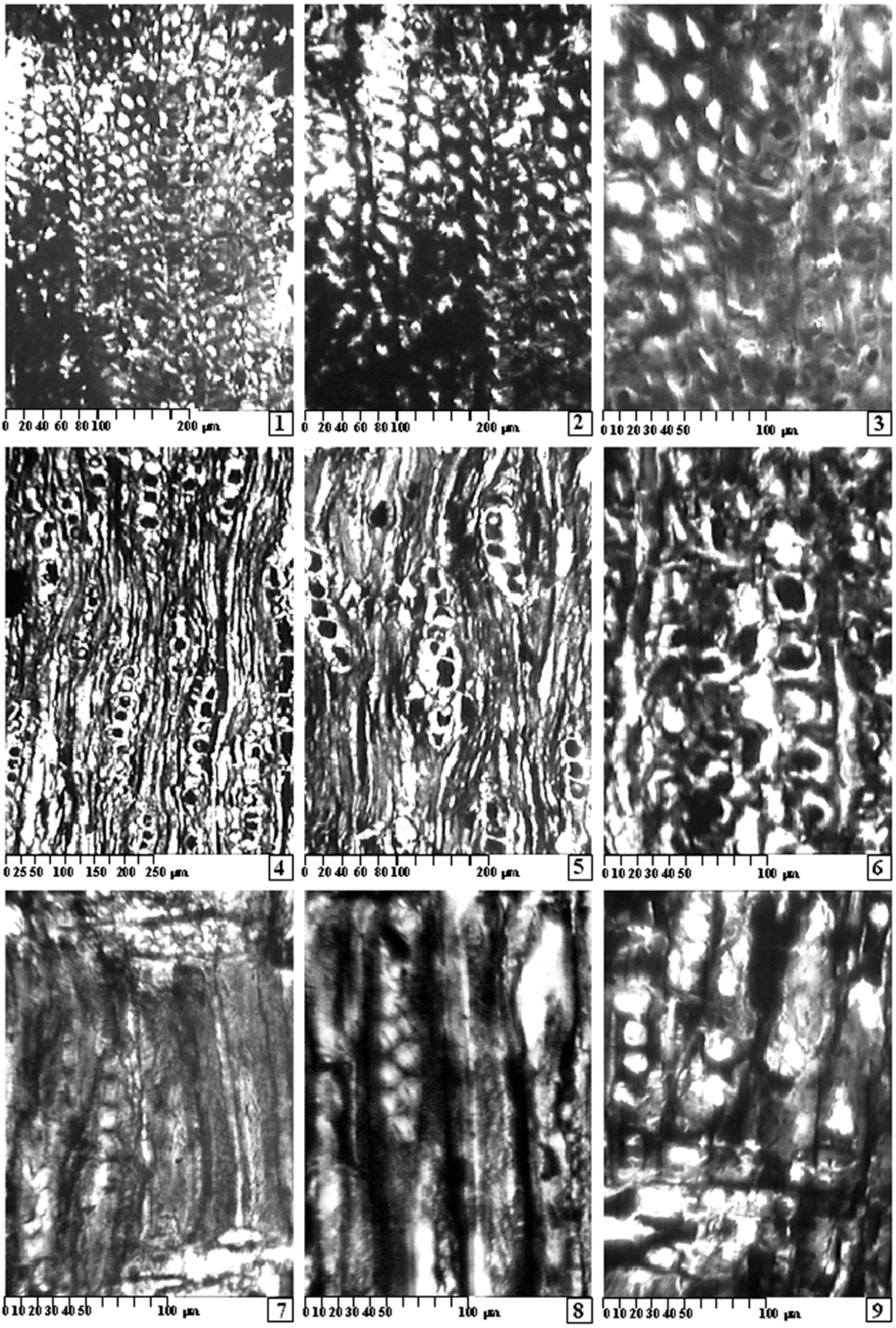
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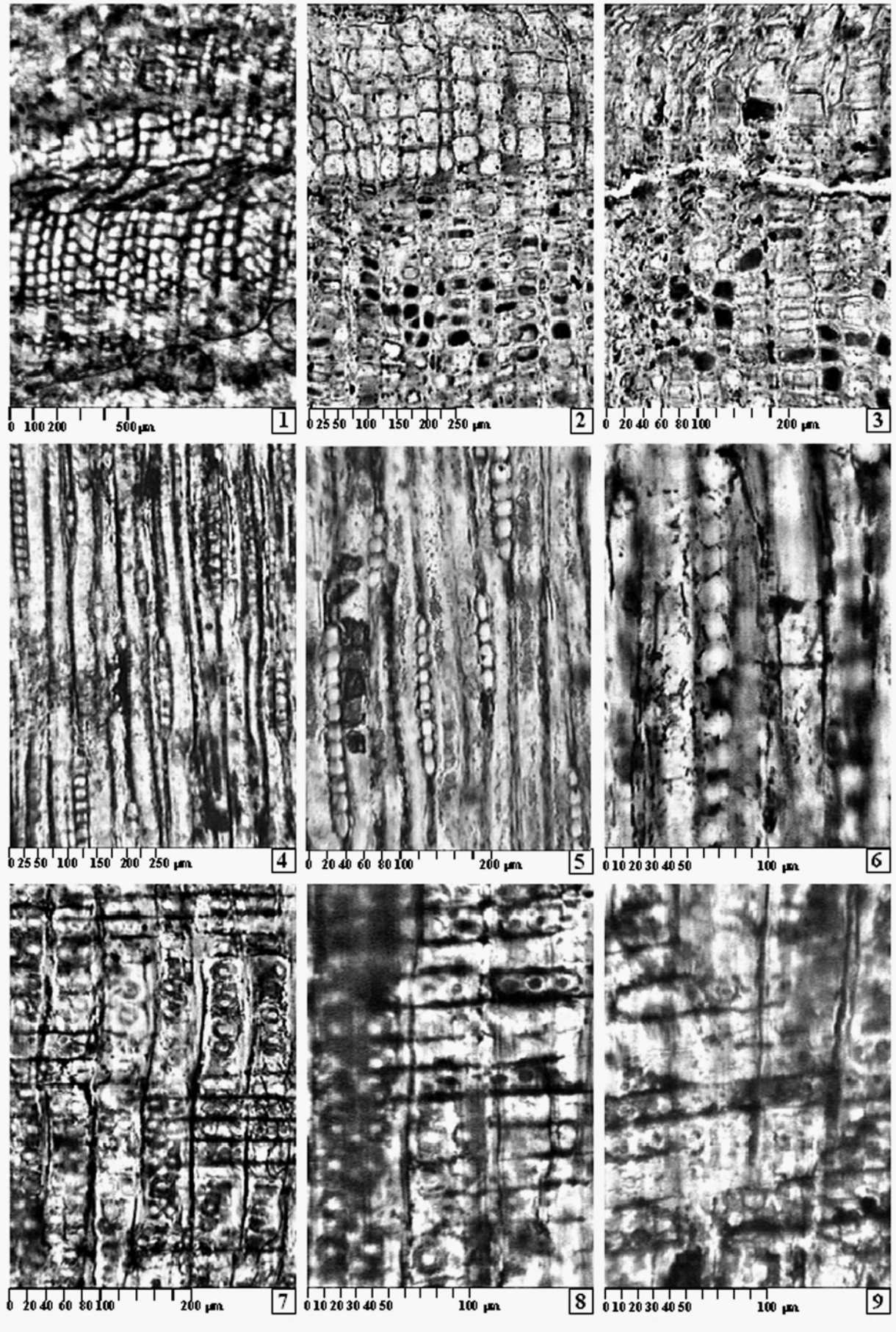
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