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NEW JUGLANDACEOUS FOSSIL WOOD IN THE MIDDLE MIOCENE LIGNOFLORA OF PRĂVĂLENI - OCIU (SOUTH APUSENI)

Stănilă IAMANDEI[1], Eugenia IAMANDEI[1]

Abstract: This paper deals with some new arboreal taxa found in a mid-Miocene volcano-sedimentary formation from the Southern part of Apuseni Mts. We present here the description of four new Juglandaceous species. Their paleoecological significance is also discussed.

Keywords: Apuseni Mts., Zarand area, Middle Miocene, Tropical walnuts, Thermophilic flora, Crystalliferous parenchyma.

INTRODUCTION

The geological history of the Apuseni Mountains during Neogene is rather complex, marked by the born of some large gulfs in their western part, as well as of some small intramontane basins, and also by the triggering of a volcanic activity of dominant calc-alkaline andesitic composition, particularly in their southern part. The last studies concerning the Tertiary volcanic evolution in Apuseni Mountains, revealed for the Zarand area (South Apuseni), absolute ages of 12.4(+/- 0.7) to 13.4(+/- 0.6) m.y. (Rosu *et al.*, 1997). The tested enrooted eruptive rocks from here, were preceded and accompanied by volcano-sedimentary and dominant pyroclastic rocks with lava flows intercalated (i.e. direct products of a synchronous volcanic activity), gradually passing into volcano-sedimentary and sedimentary rocks, to the eastern, northern and western part, with paleontologically established ages, attributed to the Middle and Upper Miocene, up to Pontian time. Paleogeographically, these formations deposited in a marginal-insular and/or insular area represent a strato-volcanic structure of which basal volcano-sedimentary complex is followed by a big pyroclastic stack with intercalated lava flows, burying many remains of the synchronous rich arboreal flora. Into Zarand area, the pre- and post-volcanic sediments of lake-facies were attributed by some authors to the Lower Badenian up to Lower Sarmatian(?), probably with some discontinuities (Istocescu, 1971; Berbeleac *et al.*, 1984), and restricted to Middle-Upper Badenian - Lower Volhinian interval by Rosu *et al.*, (1997). After our research we think that, at least into the eastern part of Zarand, the volcanic formation is only Badenian.

The up to now identified fossil wood, coming from this rich in plant-remains volcano-sedimentary formation from Prăvăleni-Ociu area, outline an arboreal association with many tropical extant correspondents. This paper presents the study of some new identified arboreal taxa belonging to **Juglandaceae** family, as new species of the genera ***Eucaryoxylon*** and ***Rhysocaryoxylon***, also synthesizing the newest identifying principles of the Juglandaceous woods. It is very important to show that many of the new described taxa have tropical correspondents, like *Carya tonkinensis* and *Juglans neotropica*, which is consistent with some previous considerations about the paleoclimate of the Middle Miocene (Ticleanu, 1995; Givulescu, 1997). From the same area Nagy & Mârza, (1967), Petrescu & Nutu, (1969a, b, 1970, 1972), have identified some species of the *genera* ***Magnolioxylon, Icacinoxylon, Laurinoxylon, Perseoxylon, Juglandoxylon, Alnoxylon, Taxodioxylon***, and ***Sequoioxylon***. Our recently published or in press papers - Iamandei & Iamandei, (1998-2001), and the Ph.D. Thesis (Bucharest University) of one of the authors (S. Iamandei, 2002), comprises more identified taxa, as species of the genera: ***Tetraclinoxylon, Cupressinoxylon, Thujoxylon, Chamaecyparixylon, Sequoioxylon, Pinuxylon, Magnolioxylon, Cinnamomoxylon, Liquidambaroxylon, Eucaryoxylon, Rhysocaryoxylon, Fagoxylon, Quercoxylon, Alno xylon, Populoxylon, Salicoxylon, Nyssoxylon, Paraphyllanthoxylon, Pirahneoxylon, Acero-xylon, Fraxinoxylon, Rhizopalmoxylon***. This outlined association strongly suggests an warm-and-wet temperate climate, that corresponds to the almost warm-temperate pluvial forests with **Lauraceae** (see

[1] *Geological Institute of Romania, 1 Caransebes Street, 78344, Bucharest, Romania, e-mail: iamandei@igr.ro*

Givulescu, 1997), but with **Icacinaceae, Euphorbiaceae** and **Palmae** too. The here identified "Black Tropical Walnuts" and "Hickory", are very consistent The average temperature diagrams given by Ticleanu, (1995), and with such a conclusion.

Givulescu, (1997), for the region of intra- and extra-carpathian regions, based on the study of the Neogene vegetal associations in Romania, suggest that the pyroclastic fossiliferous formation from Prăvăleni-Ociu area is probably only Middle-Upper Badenian in age, as Rosu *et al.*, (1996, 1997) suggested.

SYSTEMATIC DESCRIPTION OF THE TAXA

Order **Juglandales** DUMORT.
Family **Juglandaceae** A. RICH. ex KUNTH
Genus ***Eucaryoxylon*** MÜLLER-STOLL & MÄDEL, 1960
Eucaryoxylon zarandense n.sp.
Plate I, Figures 1-9; Plate IV, Figures 1-3.

Diagnosis

Growth rings distinct, half-ring-porousness. Solitary vessels or in radial multiples of 2-3(5), having circular or tangential-oval to lenticular shape. Vascular walls thick, of 5-10 μm the double-wall. Radial/tangential diameters of (62)88-230/(62)130-266 μm. Density of 4-8 vessels/mm^2. Exclusive simple perforation on tilted plates. Alternate bordered pits of 9-12(15) μm diameter, apertures of 2-3 μm. Big tyloses, thin-walled and vascular elements of 260-340 μm long. Parenchyma as tangential, long, regular 1-3-seriate bands, few paratracheal, with hypertrophied crystalliferous cells, barrel-like, solitary or in short chains of 2-3, rarely more, of 30-50(80) μm, with solitary, polygonal, big crystals into. Almost all the axial or radial parenchyma has unchambered and unhypertrophied cells with solitary smaller, polygonal, rounded crystals, as numerous files sometimes biseriate. Rays 2(3)-seriate, rarely uni- or 4-5-seriate, having curly trajectory, molding the vessels. The 2(3)-seriates are 13-32 cells high or more, (90-380-673 μm) are fusiform, with short uniseriate endings of 1-4 marginal cells. Radially they seem to be homogeneous, with cells all procumbent, sometimes chambered and with rounded solitary crystals not very large, sometimes hypertrophied, of barrel type. The procumbent marginals are higher, of 33-45 μm. Fibers with polygonal cross-section, of 17-20 μm in diameter, with thick to very thick walls (4-12 μm double wall), with small to point-like lumina and are unpitted and unsepted.

Macroscopic description

The two studied samples were collected from Ociu area, one from the north side and the the other from the right bank of the Bisericii (Church) Brook, out of village, from a volcano-sedimentary formation. They have respectively the following size: 8/4.5/3cm and 5.5/4/2.5cm, and represent fragments of silicified wood, reddish-brown to ash-like in color. With a magnifying glass you can see, sometimes difficult, a fibrous structure, growth rings and medullar rays, very typical for a dicot.

Microscopic description

The growth rings are distinct, the structure of wood is relatively porous to clearly half-ring-porous, the vessels tend to diminish gradually the lumina from early to late wood, also the frequency. It is possible to observe a slight dilation of the rays when traversing the boundary of the growth ring and the tangential bands of parenchyma are long, regular disposed (scalariform type).

The vessels in cross-section appear as solitary pores or as radial multiples of 2-3(5). The solitary ones are circular to tangential-oval, even lenticular or radial-oval in shape. The vascular walls are thick, of 5-10 μm the double wall, but usually even the simple wall reach 6-10 μm in thickness. The radial/tangential diameters of the solitary pores have 88-230/130-266(355) μm, in the late wood smaller (60-80 μm), and the density is of 4-8 vessels on sq. mm., counting all the vessels, even from the groups (Wheeler et al, 1989). The terminal tilted plates are exclusively simple-perforated and the numerous bordered pits are alternate, of 9-12(15) μm in diameter, with apertures of 2-3 μm. The vessel elements are of 260-340 μm long. Sometimes into the lumina big, emaciated, thin-walled tyloses are present.

The wood parenchyma as could be seen in cross sections appear as long, tangential bands, of 1-2-3 cells thick, but also of paratracheal type, as some crushed cells around the vessels. The cell-diameter is of 14-17 μm, reaching 30-50(80) μm in the crystalliferous hypertrophied ones. Longitudinally the parenchyma from the apotracheal bands normally appear in strands longer than 4 rectangular vertical ordinary cells, thin-walled and of 14-17/65-90 μm. Frequently between them short chains of 1-3, rarely 4 crystalliferous hypertrophied cells appear, having solitary rhombic-rhombohedral large crystals, barrel-like, very typical for *Carya* genus. Almost al the parenchyma, either vertical or radial, have also unchambered and unhypertrophied crystalliferous cells, but with small, polygonal or rounded as numerous files, even biseriate.

The medullary rays – in cross section

appear as built from rectangular radial-elongated cells, usually full of dark granular remains. They are mostly biseriate, lesser uni- or triseriate, but sometimes 4-5-seriate can be met. The ray trajectory is slightly curled, molding and touching vessels. Tangentially the 2(3)-seriates have 13-32 cells (190-673 μm) in height; the rarer uniseriates, are of 10-15 cells high (200-320 μm). The ray cells appear usually vertically elongated, they have 12-16(23) μm the horizontal diameter and 20-25 μm the vertical one, and frequently have a dark brown granular content. Their density is of 12-14 rays on tangential horizontal mm. The multiseriate rays are fusiform and have short uniseriate endings, of 1-4 marginal cells. But radially they appear homogeneous, with cells all procumbent, sometimes chambered and with solitary rounded crystals not very big into. Between the unhypertrophied chambers solitary hypertrophied cells barrel-like appear, bearing a single big crystal into, similar to the axial parenchyma. Also it is visible that the marginals are slightly higher, reaching 33-45 μm, but are procumbent too.

The fibers – regularly disposed in radial files show, in cross section, a polygonal shape with rounded corners, of 17-20 μm in diameter. They have thick to very thick walls (4-12 μm the double wall), and small circular to point-like lumina. Longitudinally they doesn't seems pitted or septed, and their length was not possible to measure.

Affinities and discussions

The comparative study of the xylotomical features showed by our specimens suggest many affinities with the Juglandaceous woods, more precisely with the extant genera ***Juglans*** and ***Carya***. The similar features refer to the aspect and the size of pores in cross section, the exclusively simple perforations and the numerous alternate bordered pitting, the dominant banded parenchyma, less vasicentric, but crystalliferous and the relatively thin rays.

The extant Juglandaceae, after Manning in Dupéron, (1988), are represented by 7 genera and 59 species, pending of 2 subfamilies, **Platycaryoideae** and **Juglandoideae**, which have relatively disjunct areals in Eurasia and the twos Americas (see *Table 1*):

Table1

Subfamily	Tribe	Genera	Species	Phytogeography
Platycaryoideae	-	***Platycarya***	1	Japan, Korea, China,
Juglandoideae	**Engelhardtieae**	***Engelhardtia***	5	N-India,E-China, Malaysia, Indonesia, Philippines
		Oreomunea	2	Mexico, Central America
		Alfaroa	7	Mexico, Central America
	Juglandeae	***Juglans***	21	N+S America, Antilles, SE-Europe-E-Asia, Japan
		Pterocarya	6	Caucasia, Iran, Japan, China, Laos, Vietnam
	Hicorieae	***Carya***	17	East-USA, N-E - Mexico, E and S - Asia

Xylotomically speaking, ***Platycarya*** presents spirals on the walls of smaller vessels and of some tracheids; ***Engelhardtia, Alfaroa, Oreomunea*** have usually simple and scalariform perforations; after Kribs, ***Juglans, Pterocarya*** and ***Carya*** are three relatively similar genera (Dupéron, 1988). However the presence or the absence of the crystalliferous parenchyma, their aspect and the thickness of their vascular wall could represent generic differentiable criteria. So:

"***Carya*** has vascular walls always thick (>3 μm), crystalliferous parenchyma often present and with solitary crystals in some enormous cells, barrel-like, as short files of 1-2-3, and the apotracheal parenchyma appear as continuous bands.

"***Pterocarya*** has no crystalliferous parenchyma, the vascular walls are always thin (<3 μm), and the parenchyma appear as short bands, usually uniseriate.

"***Juglans***, after Miller (in Dupéron, 1988), present many cases:

- **The Gray Walnuts** (=**Trachycaryon** and **Cardiocaryon** sections) – the species *J. ailantifolia, J. cathayensis, J. mandschurica, J. cinerea,* have thin vascular walls and apotracheal short banded non-crystalliferous parenchyma; in some way it resemble to ***Pterocarya*;**
- **The English Walnut** (=**Dioscaryon** section), or Persian Walnut = *J. regia,* have the vascular walls rather thick, slightly more than 3 μm, have no crystalliferous parenchyma and the apotracheal parenchyma appear most often short-banded.
- **The Black Temperate Walnuts** (= **Rhysocaryon** section, p.p.) - the species *J. hirsuta, J. major, J. microcarpa, J. mollis, J. nigra, J. pyriformis, J. californica, J. hindsii,* have the vascular walls thick (>3 μm), crystalliferous parenchyma as short chains of cells bearing solitary crystals (<5), and the apotracheal parenchyma appear as continuous bands.
- **The Black Tropical Walnuts** (= **Rhyso caryon** section, p.p.) - the species *J. australis, J. boliviana, J. jamaicana, J. neotropica, J. olanchana, J. soratensis, J.*

steyermarkii, J. venezuelensis with the vascular wall thick (>3 μm), crystalliferous parenchyma as long chains of cells bearing solitary crystals (>5), and the apotracheal parenchyma appear as long bands.

Dupéron, (1988) made an inventory and a revision too of the fossil form-genera and the form-species already described, validating and emending them when necessary. He shows:

1. Fossil wood of ***Platycarya*** has not still found.
2. Genus ***Engelhardtioxylon*** (MANCHESTER) DUPÉRON, 1988; (Dupéron corrected the name ***Engelhardioxylon*** used by Manchester in 1981, 1983). This genus designates an wood of **Engelhardtieae**, having scalariform and simple perforations and crystalliferous axial and radial parenchyma; there is a great individual variability of these features, so it is no possible to separate the correspondent fossils of the extant genera ***Engelhardtia, Alfaroa*** *and* ***Oreomunea***.
3. Genus ***Pterocaryoxylon*** MÜLLER-STOLL & MÄDEL, 1960, comprises fossil equivalents of the extant species of ***Pterocarya*** and of some species of ***Juglans*** (the Asian species and an American species of the Gray Walnuts), with thin vascular walls, uniseriate short apotracheal parenchyma bands and without crystalliferous parenchyma.
4. Genus ***Eucaryoxylon*** MÜLLER-STOLL & MÄDEL emend. DUPÉRON, 1988 with porous wood, solitary vessels or in short multiples, thick to very thick vascular walls, simple perforations alternate intervascular pitting rather big, paratracheal and apotracheal parenchyma, as long, rather regular, 1-2(4)-seriate bands; sometimes crystalliferous parenchyma, with solitary crystals in barrel-like idioblasts or in short chains of 2-3; rays 1-3(5)-seriate; septed pith. It correspond to the extant species of ***Carya***.
5. *Genus* ***Rhysocaryoxylon*** DUPÉRON, 1988, is the fossil equivalent of the extant genus Juglans and it is characterized by a porous to half-ring-porous wood, with thick vascular walls, solitary vessels or in small multiples, simple perforated, with intervascular alternate, polygonal, relatively big pitting, apotracheal parenchyma as 1-2(4)-seriate, long, rather regular bands, paratracheal less abundant; the crystalliferous parenchyma appear as chains of shorter cells, a little bit bigger than the ordinary ones. The rays are 1-3(5)-seriate, slightly heterogeneous; septed pith. The species type is *Rhysocaryoxylon schenkii* (FELIX) DUPÉRON, 1988 (= *Juglandinium* schenki FELIX, 1884 = *Caryojuglandoxylon schenkii* (FELIX) MÜLLER-STOLL & MÄDEL, 1960).

Here you are (see *Table 2*) the generic key for juglandaceous fossil wood, after Dupéron, (1988).

Table 2

Features / Genera	Perforations	Parenchyma bands	Crystalliferous parenchyma	Vascular wall	Pith
Engelhardtioxylon	Simple + scalariform	-	-	-	-
Pterocaryoxylon	Simple	Short, uniseriate	Absent	Thin, <3 μm	Septed
Eucaryoxylon	Simple	Long, 1-2(-4)-seriate	+-, 1-3 barrel-like cells	Thick, >3 μm	Unsepted
Rhysocaryxylon	Simple	Long, 1-2(-4)-seriate	><5, + normal cells	Thick, >3 μm	Septed

As a conclusion, the following names of Juglandaceous fossil wood genera, previously used by various authors up to 1987 when paper was lastly revised, are definitively invalidated: ***Mirbelites*** Unger, ***Juglandinium*** UNGER, ***Juglandoxylon*** KRAUS, ***Juglansoxylon*** FALQUI, ***Jugloxylon*** STOPES & FUJII, ***Caryoxylon*** ANDREANSZKY, ***Juglans*** L., ***Carya*** NUTT., ***Pterocarya*** KUNTH (cited from Dupéron, 1988). Of the already described species the validity analysis shows only 19 valid species, some of them being generically reattributed and 5 specimens having only generic identification.

This discussion and the critical overview on the features of our studied material strongly suggest that we are face to an ***Eucaryoxylon*** species, since the observed details are perfectly consistent with the generic diagnosis, especially by the presence of the enormous crystalliferous cells, barrel-like. The comparison with some valid fossil species till now described (*Eucaryoxylon boureaui* DUPÉRON, 1976, *E. budense* GREGUSS, 1969, *E. crystallophorum* MÜLLER-STOLL & MÄDEL, 1960, *E. guembelii* MÜLLER-STOLL & MÄDEL, 1983, *E. moenanum* MÜLLER-STOLL & MÄDEL, 1983, *E. protojaponicum* (WATARI) MÜLLER-STOLL & MÄDEL, 1960), show many similar features, but they are not identical. Our studied specimens, particularly the designated holotype show some specific features like that: into a half-ring-porous structure the vessels are solitary or in short radial multiples, and their cross section is circular to oval, but frequently tangential-elliptic to lenticular, with diameters between 100-250 μm, and with a density of 4-8 vessels on sq. mm.; the perforated plates are surely exclusively simple, and the intervascular

bordered pitting alternate; the long-banded parenchyma are 1-3-seriate, the paratracheal few; all the parenchyma, either axial or radial is crystaliferous, frequently short chains of usually 1-3 enormous barrel-like cells bearing big, solitary, rhombic or rhombohedral crystals; the ordinary parenchyma chambered cells bear also small, solitary polygonal or rounded crystals, sometimes as rows, even biseriate. Fusiform rays usually 2-3-seriate, rarely uni- or 4-5-seriate have till 700 μm in height, and the uniseriate endings are short, of 1-4 marginal cells; therefore the rays are homogeneous; the fibers have thick to very thick walls and are not pitted or septed.

These features are rather different of the already described species, upper quoted. Especially the aspects of the crystalliferous parenchyma seem to be very different, by the presence of the barrel-like cells into rays, and the vertically the chains can reach sometimes more than 3 hypertrophied cells. The ordinary parenchyma cells are septed and also crystalliferous. These features are very similar in the second studied specimen, designated as paratype. In these conditions we think that we are faced of a new species that we named *Eucaryoxylon zarandense* n.sp., after the name of the provenance space.

Holotype – GIR Collection, nr. 26439, (specimen P.718 and 3 slides).

Paratype - GIR Collection, nr. 26422, (specimen 603, and 3 slides).

Locality – Ociu, Metalliferous Mts., România.

Horizon – Volcano-sedimentary Formation.

Age – Upper Badenian.

Genus ***Rhysocaryoxylon*** DUPÉRON, 1988

Rhysocaryoxylon pravalense n.sp.

Plate II, Figures 1-9; Plate IV, Figures 4-6.

Diagnosis

Growth rings distinct, of unequal wideness, in a porous to half-ring-porous structure. Vessels predominantly solitary and as radial multiples or clusters of 2-3(4-6). Their cross section is circular to slightly oval, with thick creased walls of 5-8(12) μm the double wall. The radial/tangential vascular diameters are of 63-105(133)/30-84(105) μm, the density is 37-68 vessels/mm^2. The tilted perforated plates are exclusively simple, the bordered alternate big intervascular pitting, of 12-16 mm in diameter, with horizontal-elliptic apertures, of 2-3 μm. The parenchyma as tangential slightly curled long bands of 1-3 cell wide, show vertical strands of 4-8 rectangular thin walled cells of 8-10/70-80 μm. The paratracheal parenchyma few, as big polygonal cells of 16-20 μm the side, seem as simple-pitted "bricks" around the vessel. The crystalliferous parenchyma appear as chambered cells, in long chains of more than 10 chambers, slightly hypertrophied and sometimes unequal in size, of (6,5)13-20(24) μm thick, and bearing usually solitary crystals of various shapes, apparently corroded and floating in a bright-white or dark cell-content. Rays usually 2-3-seriate, rarely uniseriate, and very rare 4-6-seriate, with slightly curly trajectory; tangentially of 13-19 cells high, i.e. 80-330(650) μm. The ray cells are round to vertical elliptic, of 11-20 μm wide horizontally and of 16-28 μm vertically and bear a brownish granular content. The ray-frequency is of 10-14 rays on horizontal tangential mm. The ray endings are short uniseriate, of 1-2 marginal cells; radially show all cells procumbent, the marginals higher and shorter, the cross fields simple pitted. Fibers polygonal in cross section, of (8)17-20 μm wide, with the cellular wall thick to very thick, unpitted and unsepted.

Macroscopic description

The studied material comprises some samples of fossil wood found on Cremenea hill on the path to Hoarna Tarnita brook (sample 197), and the other (sample 586) at the foot of the Cremenea hill, in the area of Prăvăleni village, under the cliff, in a volcano-sedimentary formation. The samples appear as centimetric fragments of gray color, having a fibrous structure. After processing the slides the remained material comprises two pieces of 5/5/3.8cm and 2.5/3.5/3cm from the first sample and two pieces of 5.5/2/1.5 and 5/1/1cm from the second.

Microscopic description:

The growth rings have rather unequal wide but are distinct, the wood is relatively porous to typical half-ring-porous, the cell-wall of the fibers gradually thicken from early to late wood, and the vessel lumina and their frequency gradually diminish toward boundary.

The vessels in cross section appear as predominantly solitary pores, and radial multiples of 2-3(6) or clusters. The solitary pores are circular to slightly oval in shape, with the vascular wall usually creased and thick (of 5-10 μm the double wall), although the simple-wall of the solitary vessels can reach 6-8 μm in thickness. The vessel size is relatively uniform, the radial/tangential diameters of solitary vessels have 63-105(133)/30-84(105) μm, smaller in the late wood. The vessel density is of 37-68 pores on sq. mm, counting also the grouped ones as IAWA recommended [see Wheeler *et al.*, (1989)]. The slightly tilted terminal plates are exclusively simple perforated, and the intervascular bordered pitting is alternate, hexagonal, of 12-16 mm in

diameter, with horizontal-elliptic apertures of 2-3 μm. The vascular elements are 150-210 μm long, maybe more.

The wood parenchyma appear transversally as slightly curled tangential long bands of 1-3 cell thick, or scanty-paratracheal, as some crushed cells around the vessels, though sometimes not very evident. Longitudinally the ordinary parenchyma appears as strands of 4-8 rectangular thin-walled cells of 8-10/70-80 μm. The paratracheal parenchyma appear as simple-pitted polygonal big cells (side of 16-20 μm), like masoned bricks against the vessel wall. The crystalliferous parenchyma, are present as chambered cells with usually solitary crystals of various shapes, since they seem to be corroded. They are floating in the hypertrophied chambers filled with bright-white content. Sometimes apparently the crystal is missing, or the crystal is floating into a dark cell-content. Frequently the strands have more than 5 parenchyma cells (often of more than 10 crystalliferous chambers), very unequal in size, having 13-25(40) μm wideness. In other cases (as, especially, the paratype show), the ordinary parenchyma is less evident, although the strands also count more than 10 chambered crystalliferous cells.

The medullary rays – in cross section - have a slightly curly trajectory, molding and touching vessels and are composed from rectangular cells radially elongated, bearing some granular dark remains. Usually they are bi- and triseriate, rarely uniseriate or 4-6-seriate, and vertically are built from round to vertical-elliptic cells of 11-20/16-28 μm. The 2-3-seriates are built from 13-19 ray-cells, reaching 80-330(650) μm high, the uniseriates have 5-15 cells high, i.e. 100-160(825) μm. Sometimes there is a tendency of an echelon disposition, and the ray-frequency is of 10-14 on tangential horizontal millimeter. The fusiform-rays have short uniseriate endings of 1-2 marginal cells. Radially the rays appear homogeneous, with all procumbent cells of 6.5-8 μm high, the marginals higher (of 9-13 μm) and shorter, showing weak heterogeneity tendencies. The cross-fields with vessels show simple-pitting, small, round to oval-horizontal (sometimes oval-vertical as the paratype show), of 5-6.5 μm in diameter, usually in a horizontal row arranged.

The fibers, in cros-section seen appear as radial regular rows and have a polygonal shape with rounded corners, of (8)17-20 μm in diameter. The cell-wall is thick to very thick (5-8 μm the double-wall), the lumina being rather wide in early wood to small, circular or point-like in late wood. The fiber wideness also shows a gradual diminishing of the size from early to late wood. Longitudinally some fibers seem to have small bordered pits with point-like apertures, in 1-2 vertical rows, but are not septed.

Affinities and discussions

Comparative evaluation of the xylotomical features showed by the studied material suggested numerous affinities with those of **Juglandaceace** Family, especially of the extant genus ***Juglans***. We evaluated the xylotomy of the extant species of ***Juglans***, (Greguss, 1959; Schweingruber, 1991; Dupéron, 1988) and we concluded that the most similar type with our studied specimens is "the Black Tropical Walnut", particularly the extant American species *Juglans neotropica* DIELS.

We have seen at our designated as holotype specimen that the vascular walls are thick and the apotracheal long-banded parenchyma (in cross section) vertically show chains of more than 5 crystalliferous cells. The aspect of the crystalliferous parenchyma is nearly identical with that figured by Dupéron, (1988, p. 255, fig. 4) from the cited extant species.

The revision of the fossil Juglandaceous woods made by Dupéron allows us to attribute here studied material to the valid fossil genus ***Rhysocaryoxylon***, considering the aspect and the size of the vessels in cross section, their simple perforation and the bordered alternate pitting, the long banded crystalliferous parenchyma, the aspect and the structure of the medullary rays, and also of the fibers. The admitted valid species are the following six:

- *Rhysocaryoxylon schenkii* (FELIX) DUPERON, 1988
- *R. caucasicum* (GAYVORONSKY) DUPERON, 1988
- *R. fryxellii* (PRAKASH & BARGHOORN) DUPÉRON, 1988
- *R. tertiarum* (PRAKASH & BARGHOORN) DUPÉRON, 1988
- *R. treibelii* (CASPARY) DUPÉRON, 1988
- *R. pilinyense (GREGUSS) DUPÉRON, 1988*

The comparative analysis of the xylotomical features of our studied material with the original description of these validate species (Müller-Stoll & Mädel, 1960, 1983; Van der Burgh, 1973; Dupéron, 1988) showed many similarities but differences too, and determined us to consider that we are face to a "Black Tropical Walnut", probably a new species. Our designated holotype and paratype show almost identical features. They come from rather closed sites, but from slightly different stratigraphical levels. The species diagnosis presents briefly the features but it is good to repeat that the aspect of the crystalliferous parenchyma that appear as vertical chains of more than 10 chambers slightly hypertrophied

an unequal in size with usually solitary crystals of various shapes, sometimes corroded, floating into a bright white or dark content, as you can see at *Juglans neotropica* DIELS. (see Dupéron, 1988, fig. 4).

With all these considerations we think we can call this studied material *Rhysocaryoxylon pravalense* n.sp., after the name of the locality of provenance.

Holotype - GIR Collection, inv. nr. 26400, (specimen 197, and 3 slides)

Paratype - GIR Collection, inv. nr. 26423 (specimen 586, and 3 slides)

Locality - Prăvăleni, Metalliferous Mts., România.

Horizon - Volcano-sedimentary formation.

Age - Upper Badenian.

Rhysocaryoxylon ocii n.sp.

Plate III, Figures 1-9; Plate IV, Figures 7-9.

Diagnosis

Growth rings unequal in wideness, distinct, in a half-ring-porous structure, with long tangential parenchyma bands. Vessels as radial multiples of 2-3(5) and as solitary pores circular to radial-oval in shape, with thick walls (6,5-8 μm double-wall, but often the simple-wall is of 5-8 μm thick); the radial/tangential diameters are (21)33-147/(21)37-126 μm. the density is of 15-25 pores/mm^2; the tilted perforated plates are exclusively simple, the intervascular bordered hexagonal small pitting are alternate, diameter of (6)8-10 μm, the apertures of 1.5-2 μm. The elements have 530-620 mm in length. The apotracheal parenchyma appear as 1-3(4)-seriate continuous bands, terminally also, and scanty-paratracheal; longitudinally the strands have more than 5 chambered crystalliferous cells, the vasicentric parenchyma as quadrangular big cells around the vessels, usually not very obvious. The predominantly biseriate rays, sometimes with triseriate stories have 10-16 cells in height (250-375 μm), and the rarer uniseriates have 6-9 cells in height (84-135 μm); the ray-frequency is 6-12 rays on a tangential horizontal millimeter; the homogeneous rays with heterogeneity tendency have thin-walled cells, all procumbent of (9)15-20 μm high, the marginals slightly higher: 20-30 μm; the cross-fields shows many round to oval simple pits of 4-5 μm on 1(2) horizontal rows. The fibers in radial regular rows arranged, have polygonal cross section of 12-17-20 μm in diameter, thick to very thick walls, small to very small round lumina, even point-like and are unpitted and unsepted.

Macroscopic description

The here studied material was found in Ociu village area, in a volcano-sedimentary formation, and is constituted from two silicified wood fragments of centimetrical size. The remains after the slide preparation have 7/8/3cm (the sample 235, with inv.nr. 26403) and 5.5/3/2.5cm (the sample 802, with inv.nr. 26456). They represent probably a trunk or a thick branch fragments and is striped with beige to darker-beige, or brown to reddish in colors. At magnifying glass it is visible the fibrous structure, the annual rings and the medullary rays, typical features for a dicot.

Microscopic description

The growth rings are unequal in size but distinct. The wood structure is half-ring-porous, the vessels gradually diminishing their lumina from very big in the early wood to very small in the late wood and their frequency diminish too. The tangential bands of parenchyma appear almost continuous and the space between diminish in the late wood, but usually their presence is not very obvious.

The vessels in cross section appear as solitary pores or as radial multiples of 2-3(5). The solitary pores are circular to radial-oval in shape, but when grouped they are deformed, usually tangentially. The vessel walls are thick, or very thick. i.e. 6.5-8 μm the double wall, but 5-8 μm the simple wall in some solitary vessels. The radial/tangential diameter for the solitary pores are of (21)33-147/(21)37-126 μm. Their density is of 15-25 pores on sq. mm., in the late wood smaller. The perforations are exclusively simple, on inclined plates. The intervascular pitting is bordered and alternate, small hexagonal to slightly deformed, of 6-8-10 μm in diameter, with apertures of 1.5-2 μm. The size of the vascular elements is very difficult to evaluate, but the paratype shows 530-620 μm, which seems to be possible.

The wood parenchyma – in cross section appear as long 1-3(4)-seriate bands, not very obvious and more clearly it appear as terminal parenchyma. As paratracheal parenchyma is very scarce. Longitudinally it can be seen as vertical strands of more than 8 chambered cells not hypertrophied. The paratracheal parenchyma (more evident into the paratype) as quadrangular big cells, some of them slightly trapezoidal, of 27-40 μm high and 24-32 μm the horizontal diameter, "masoned" as bricks around the vessel walls. They present numerous small simple pits of 1-2 μm wide, corresponding to the vascular alternate pitting, sometimes visible by transparency. Thus the pitting vessel-parenchyma cell is of half-bordered type. Sometimes, close to vessels also appear vertical chains of chambered parenchyma cells with more than 10 slightly hypertrophied chambers, filled with an white-

bright content, hardly guessing the outlines of a crystal into, probably solitary. These aspects are more visible in the paratype-specimen.

The medullary rays – in the cross section appear built from rectangular radial elongated cells, some of them bearing dark-brown granular remains. They are usually biseriate, with slightly curly trajectory, molding and touching vessels. Tangentially the biseriates, sometimes with triseriate stories show 10-16 cells in height, i.e. 250-375 μm or more, by vertical compounding reaching 600-700 μm (also seen into the paratype-specimen). The uniseriates are rarer, have 6-9 cells in height, i.e. 84-135 μm. The ray-cells appear usually round to vertically-elongated, having 10-17(20) μm as horizontal diameter and 10-22(25) μm in height; the ray-frequency is of 6-12 rays on a horizontal tangential millimeter. Tangentially the rays appear fusiform and have small uniseriate endings, from 1-2 bigger cells. Radially they appear homogeneous, with a weak heterogeneity tendency and are built from thin-walled cells (2-3 μm the double wall), all procumbent, of (9)15-20 μm high, the marginals higher (20-30 μm). The cross fields sometimes show the pitting: many round to oval small pits, of 4-5 μm on 1(2) horizontal rows.

The fibers in cross section are regularly arranged as radial rows, showing polygonal shape with rounded corners, and 12-17-20 μm in diameter. Their walls are thick to very thick, their lumina small to very small or point-like and do not seem to be pitted or septed.

Affinities and discussions

The xylotomical study upon these specimens show many characters which seem to have most affinities with the extant juglandaceous wood, particularly from ***Juglans*** genus, as Greguss, (1959), and Schweingruber, (1990) described and figured. Taking into account the revision of the Juglandaceous fossil woods already described (Dupéron, 1988), we can say that our material is of **Rhysocaryon** type, more precisely from "Black Tropical Walnut" group, because it presents thick vascular walls, usually scarce parenchyma as long bands of 1-3(4) cells thick, vertically as long chains of chambered crystalliferous cells, even not very obvious. Dupéron, (1988) show that ***Juglans*** from **Trachycaryon** and **Cardiocaryon** section have thin-walled vessels, ***Pterocarya*** also but without crystalliferous parenchyma, ***Juglans*** from **Dioscaryon** section, knew as "English or Persian Walnut", (*Juglans regia*), have the vascular walls not very thick (of 3-4 μm) and short-banded, non-crystalliferous parenchyma.

Only six fossil juglandaceous fossil species of this type, described by the xylotomical studies, were validate by Dupéron, (1988), and we add yet two, described in this paper. Also we add a dubious species, originally described by Greguss, (1969) as ***Pterocaryoxylon*** and atributed by Dupéron, (1988) to ***Rhysocaryoxylon*** too. The comparative analysis of the observed feature in our material with the original description of valid species or found again and revised by Müller-Stoll & Mädel, (1960, 1983), Van der Burgh, (1973), Dupéron, (1988), surely indicate the group of walnut with long chains of crystalliferous parenchyma cells. We took into account all these described species that present some structural differences from ours:

- *Rhysocaryoxylon schenkii* (FELIX) DUPERON, 1988;
- *R. aff. schenkii* (FELIX) DUPÉRON, 1988;
- *R. fryxellii* (PRAKASH & BARGHOORN) DUPÉRON, 1988;
- *R. tertiarum* (PRAKASH & BARGHOORN) DUPÉRON, 1988;
- *R. treibelii* (CASPARY) DUPÉRON, 1988;
- *R. caucasicum* (GAYVORONSKY) DUPÉRON, 1988;
- *R. pilinyense (GREGUSS) DUPÉRON 1988 (with chains of 6-8 crystalliferous chambers);*
- *R. pannonicum* (MÜLLER-STOLL & MÄDEL) DUPÉRON, 1988, attributed, after a short description to ***Pterocaryoxylon*** by Greguss, (1969). Also the specimen described by Petrescu & Blidaru, (1972) from the Badenian-Lower Sarmatian formation of Beius basin, as identical with *Pterocaryoxylon pannonicum* MÜLLER-STOLL & MÄDEL, 1960, having paratracheal and long 3-5-seriate bands of parenchyma (see Plate V, figs. 17-18). *Juglandoxylon* sp., described by Petrescu & Nutu, (1970) was revised by Dupéron, (1988) and considered as *?Pterocaryoxylon* sp. since it haven't any crystalliferous parenchyma described.
- *Rhysocaryoxylon cf. pannonicum* (MÜLLER-STOLL & MÄDEL) DUPÉRON, 1988 (described as ***Pterocaryoxylon*** by Greguss, (1969), on a bad preserved specimen, having short parenchyma chains, probably being from the "Temperate Black Walnuts".
- *R. pravalense* n.sp., an also "Black Tropical Walnut", in this paper, slightly different of this.

After this critical analysis we consider our here studied material coming from an unknown new species of "Black Tropical Walnut", with long vertical chains of crystalliferous chambers, exceedind 5. Since it have slightly different features combination than the known valid species and here described our species we propose for this new species the name *Rhysocaryoxylon ocii* n.sp., after the name of its

originally locality.
Holotype – in GIR Collection, inv.nr. 26456, specimen 802 and 3 slides.
Paratype – in GIR Collection, inv.nr. 26403, specimen 235 and 3 slides.
Locality - Ociu, Metalliferous Mts., România.
Horizon – Volcano-sedimentary formation.
Age – Upper Badenian.

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PLATES

Plate I

Figures *1-9.* - *Eucaryoxylon zarandense* n.sp., holotype.
Fig. 1, cross-section: blurred growth-ring boundary, solitary or grouped pores, rays, scalariform long-banded parenchyma, x50.
Figures 2-3, cross-section: solitary tangentially lenticular or oval pores, fibers, rays, banded scalariform parenchyma, x100.
Fig. 4, tangential section: fusiform 1-3-seriate rays, pitted vessels, simple-perforated plates, x100.
Fig. 5, tangential section: high fusiform 1-3-seriate rays, crystalliferuos parenchyma, x200.
Fig. 6, tangential section: vessel with simple-perforated tilted plate, vasicentric simple-pitted parenchyma, x200.
Figures 7-9, radial section: cross-fields with vessels or axial parenchyma, chains of 1-3 barrel-like crystalliferous parenchyma, x200.

Plate II

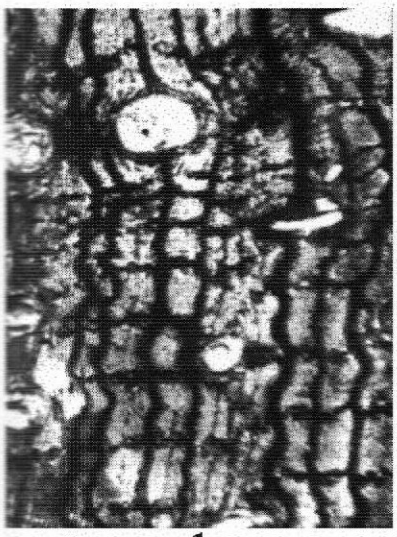
Figures *1-9.* - *Rhysocaryoxylon pravalense n.sp.*, holotype.
Figure 1, cross-section: half-ring-porosity, evident boundary, solitary creased-wall vessels, or grouped, rays, x50.
Figures 2-3, cross-section, growth-ring boundary, 1-3-seriate rays, solitary or grouped, thick-walled fibers, x100.
Figures 4-6, tangential section: fusiform 1-3-seriate rays, ordinary and crystalliferous chambered parenchyma as long chains (>5), x100.
Figures 7-9, radial section: cross-fields, alternate intervascular pitting, simple-perforated plates, crystalliferous parenchyma, x200.

Plate III

Figures *1-9.* - *Rhysocaryoxylon ocii* n.sp., holotype.
Figure 1, cross-section: limit of the growth-ring evident, usually grouped vessels, rays, x100.
Figures 2-3, cross-section: solitary and grouped vessels, fibers, rays, x200.
Figure 4, tangential section: 1-2-seriate rays, vessels with tyloses inside, x100.
Figure 5, tangential section: 1-2-seriate rays, x200.
Figure 6, tangential section: alternate intervascular pitting, x200.
Figures 7-9, radial section, cross fields with vessels, pitted, storied simple-perforated plates, x200.

Plate IV

Figures *1-3.* - *Eucaryoxylon zarandense* n.sp., paratype.
Figure 1, cross-section: growth-ring boundary, scalariform parenchyma, solitary or grouped vessels, rays, x50.
Figure 2, tangential section: tilted simple perforated plate, crystalliferous parenchyma, alternate intervascular pitting, x100.
Figure 3, radial section: chains of 1-3(4) barrel-like crystalliferous axial parenchyma, x100.
Figures *4-6.* - *Rhysocaryoxylon pravalense n.sp.*, paratype.
Figure 4, cross-section: growth-ring boundary, solitary vessels or grouped, rays, x50.
Figure 5, tangential section: fusiform rays, intervascular pitting, x100.
Figure 6, radial section: cross-fields, pitting, x200.
Figures *7-9.* - *Rhysocaryoxylon ocii n.sp.*, paratype.
Figure 7, cross-section: growth-ring boundary, parenchyma, vessels, rays, x50.
Figure 8, tangential section: 1-2-seriate rays, x100.
Figure 9, radial section: simple-perforated storied plates, cross-fields, x100.



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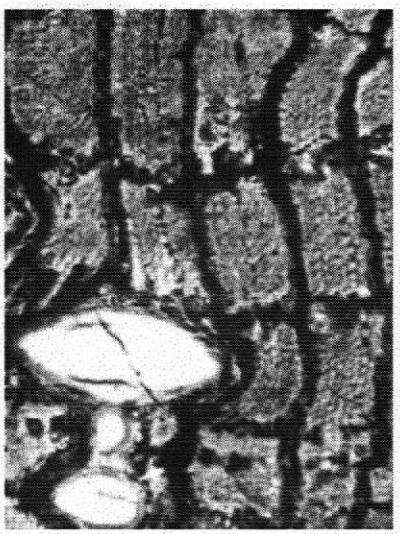

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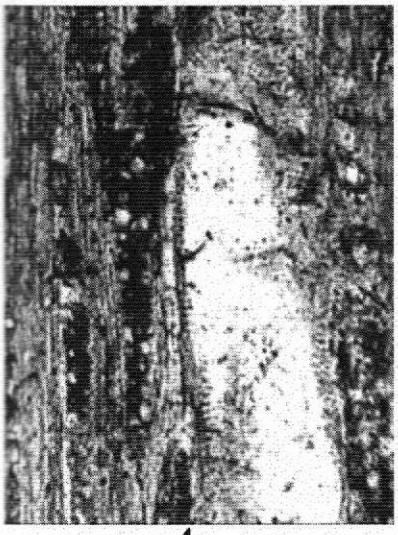

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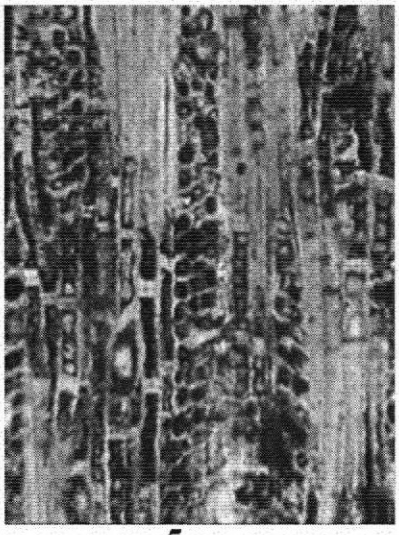

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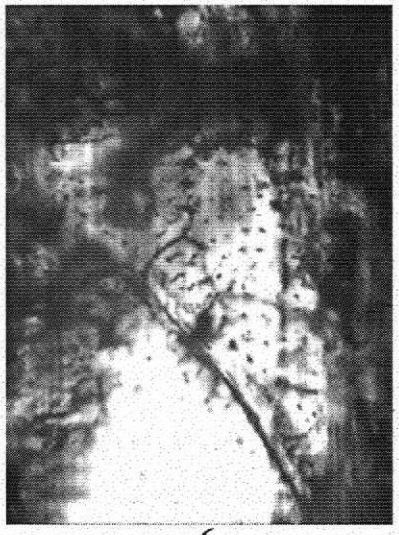

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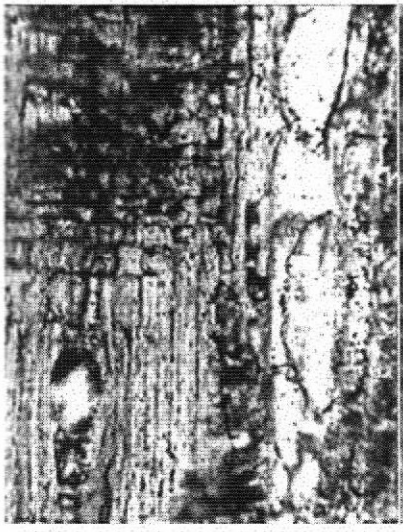

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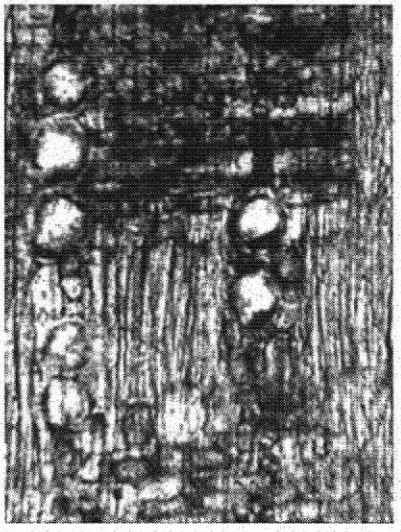

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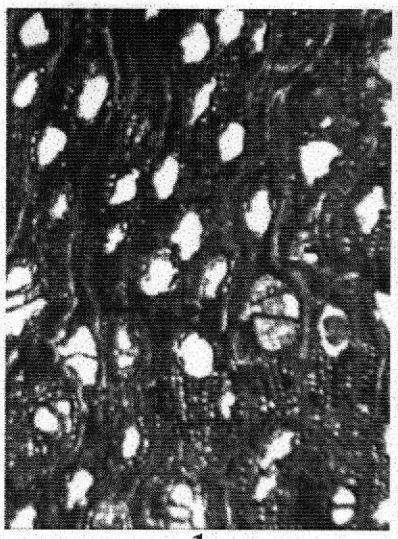

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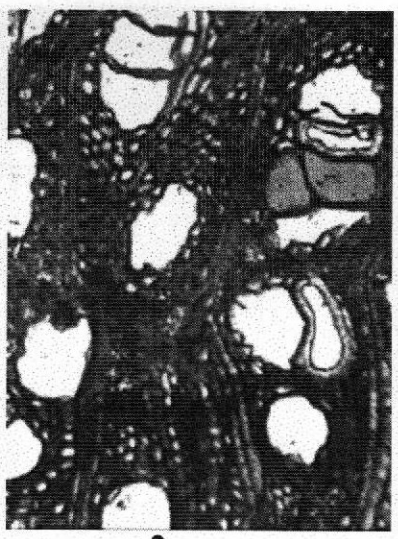

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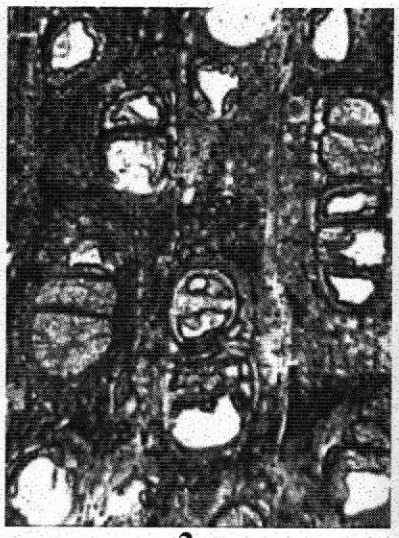

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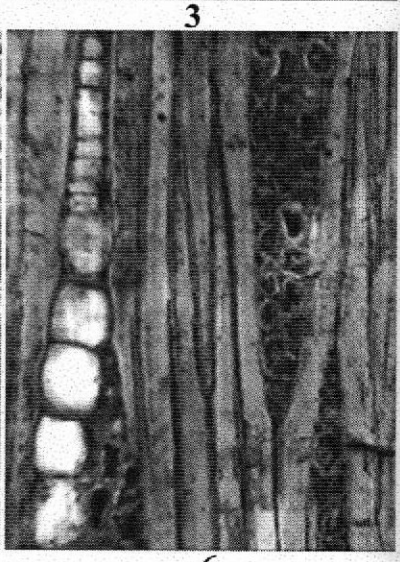

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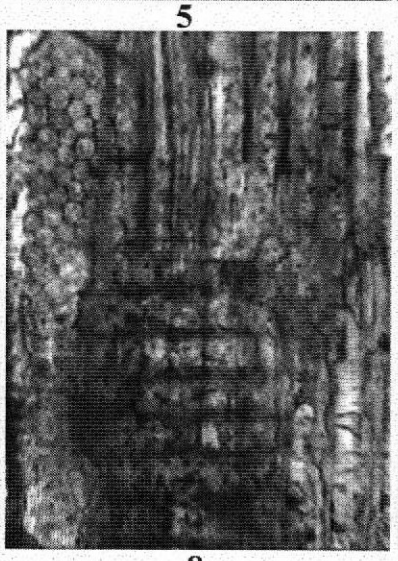

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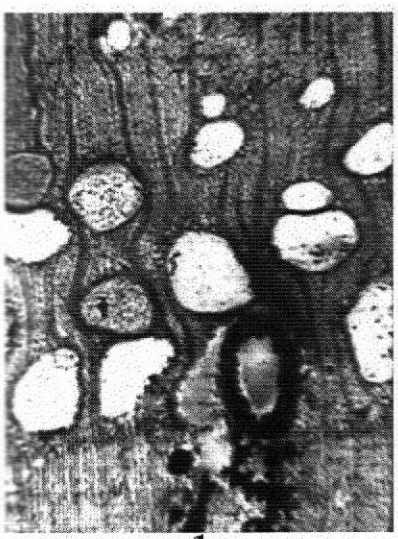

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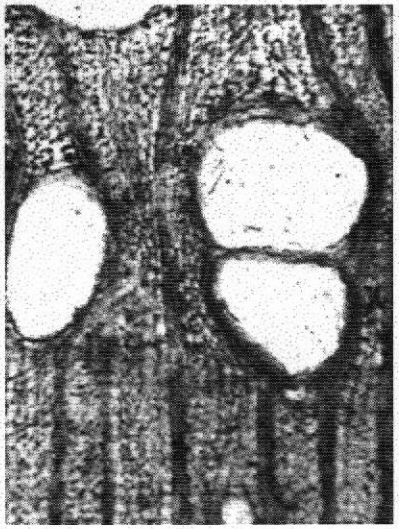

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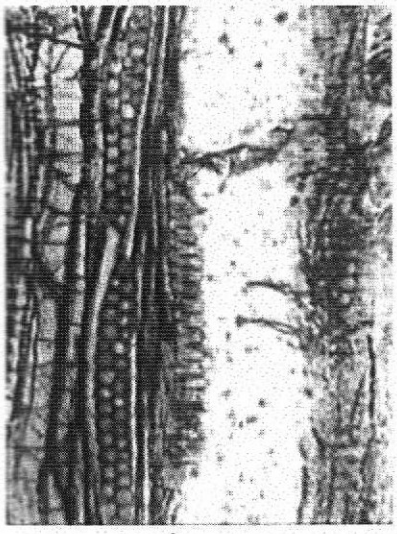

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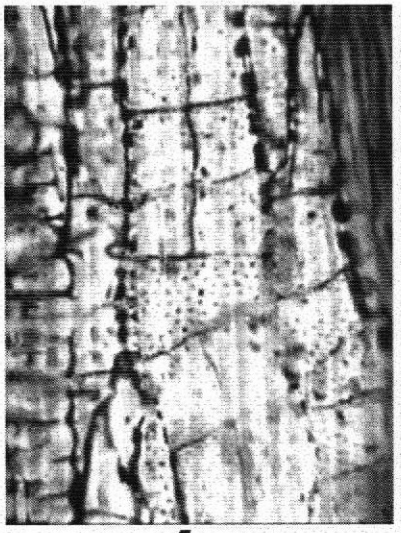

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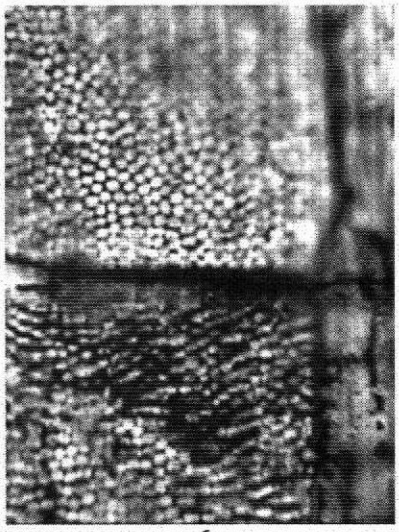

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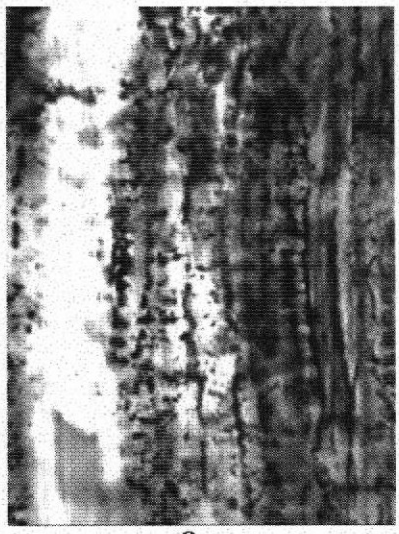

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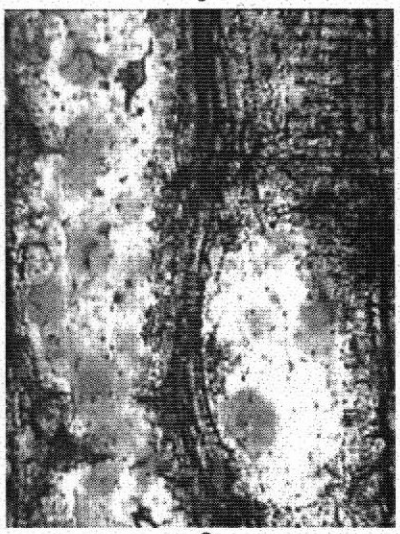

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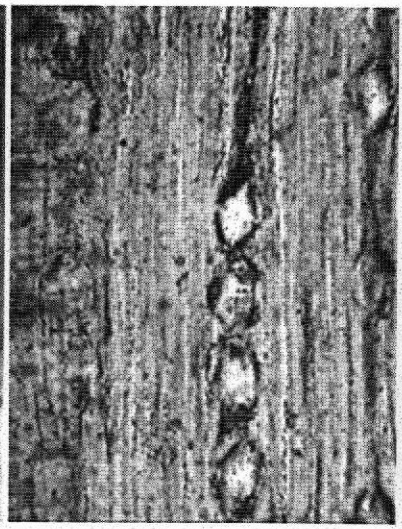

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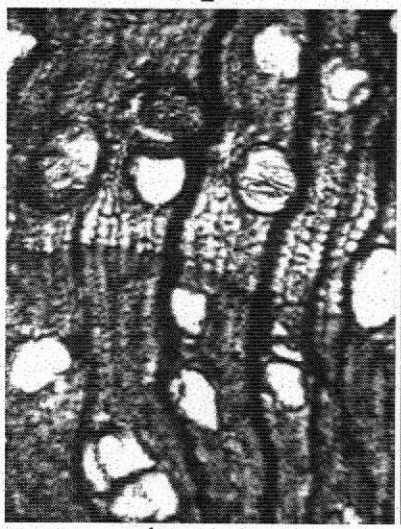

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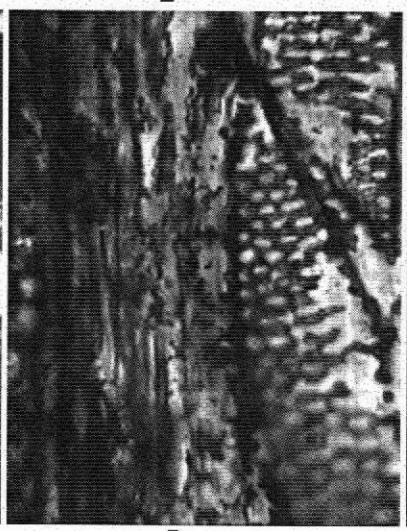

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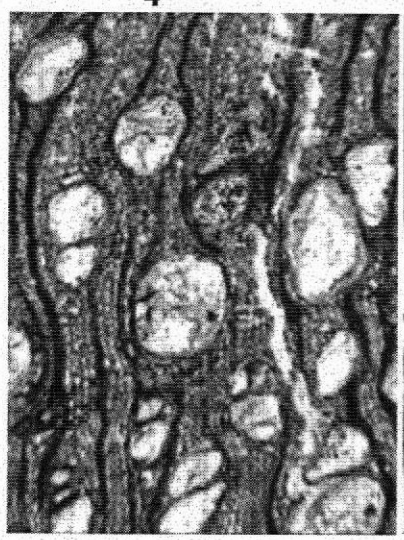

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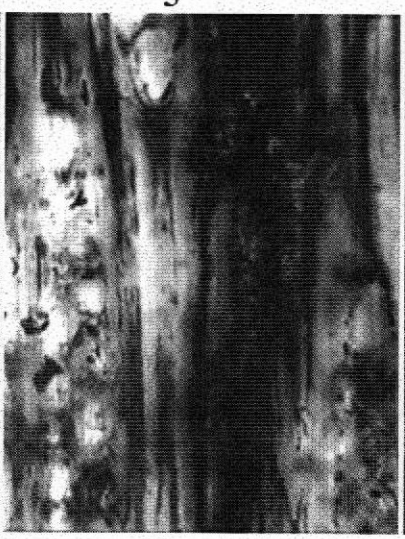

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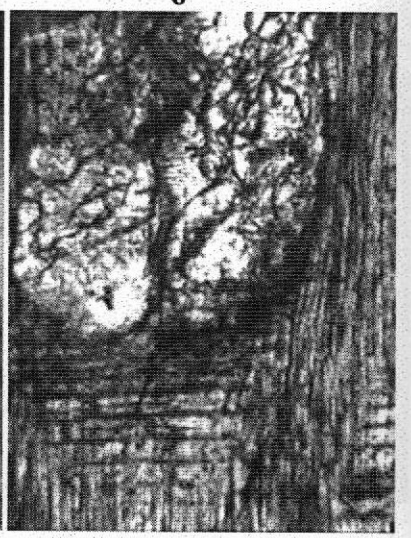

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