NEW TREES WITHIN THE MID-MIOCENE PETRIFIED FOREST FROM ZARAND, APUSENI MTS., ROMANIA

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Abstract: This paper presents some new contributions to the reconstruction of the arboreal vegetation and its paleoecology within Carpathians' region, during the Mid-Miocene. Recent field-researches in Zarand region, especially within the Prăvăleni-Ociu fossiliferous area, yielded a lot of samples of petrified wood. Many taxa were identified by the paleoxylotomical study of them and a complex arboreal association has been outlined, representing an extract from the Late Badenian vegetation covering the slopes of Tălagiu Lahar volcano. Three new trees from that Late Badenian Mixed Mesophytic Forest have been described in this paper: *Cinnamomoxylon* (HUARD) GOTTWALD 1997*, Fraxinoxylon crisii* n.sp. and *Fraxinoxylon komlosense* GREGUSS 1969 emend.

Key words: Mid-Miocene, Zarand, paleoxylotomy, fossil-forest, paleoclimate.

1. INTRODUCTION

As it's well known, during the Mid-Miocene, within Carpathians, an intense explosive volcanic activity carried on, particularly in the South Apuseni Mountains, determining good conditions for the preservation of a big quantity of wood remains, usually fossilized by permineralization (*i.e.* silicification, opalization).

That time, the Carpathians were an insular region within the Central Paratethys, situated at the collision zone of Apulian slab with the Eurasiatic one (see Panaiotu, 2001). That region was probably more southward than today during the Middle Miocene, so that paleolatitude imposed to the region a special zonal climate, most probably warm-temperate. Such a supposition perfectly agrees with the results of the last Romanian paleobotanical studies within Carpathians, which showed a series of Tertiary Floras marking successive stages, from a Pre-Miocene dominantly sempervirent "paratropical" vegetation to a Mid-Miocene mesophytic warm-temperate one and evolving to mesophytic temperate to the end of Tertiary (see Givulescu, 1997). These climatic changes were, certainly, the consequence of the continuous deterioration of the climate during Neogene, but of the dramatic paleogeographic changes within all the Paratethys too.

By our systematic researches in Zarand region, especially in Prăvăleni-Ociu fossiliferous area, we were able to reconstruct by paleoxylotomical study a complex Late Badenian arboreal association, representing an extract of the original

vegetation covering the slopes of the contemporaneous Tălagiu volcano generating lahar flows that destroyed the forest vegetating there, transporting and burying the wood remains into the neighbour basin.

A monograph of this fossiliferous site is comprehended in a Ph.D. Thesis (Iamandei, 2002, unpub.) and in a lot of published papers (Nagy & Mârza, 1967; Petrescu & Nuțu, 1969-1972; Iamandei, 2002; Iamandei & Iamandei, 1998-2005; Iamandei *et al*., 2005, 2006 in press) that indicate an association composed from species of the following form-genera identified there: *Tetraclinoxylon, Taxodioxylon, Sequoioxylon, Pinuxylon, Magnolioxylon, Cinnamomoxylon, Eucaryoxylon, Alnoxylon, Rhysocaryoxylon, Fagoxylon, Quercoxylon, Aceroxylon, Nyssoxylon, Paraphyllanthoxylon, Piranheoxylon, Icacinoxylon, Fraxinoxylon* and *Rhizopalmoxylon*.

In this paper three new identified taxa in Prăvăleni-Ociu area are described: *Cinnamomoxylon intermedium* (HUARD) GOTTWALD 1997, *Fraxinoxylon crisii* n.sp., *Fraxinoxylon komlosense* GREGUSS 1969 emend.

2. PALEOXYLOTOMY

Family **Lauraceae** JUSS.
Genus ***Cinnamomoxylon*** GOTTWALD 1997
Cinnamomoxylon intermedium (HUARD) GOTTWALD 1997
Plate I, Figs. 1-4; Plate II, Figs. 1-4

Synonymy: *Laurinoxylon intermedium* HUARD 1967.
Cinnamomoxylon intermedium (HUARD) GOTTWALD 1997.
Liquidambaroxylon pravalense IAMANDEI & IAMANDEI 1999.

Material: The studied material is represented by three samples of silicified wood, found within the Late Badenian volcano-sedimentary Tălagiu Formation, in Prăvăleni-Ociu area, Zarand region (South Apuseni). Those 3 pieces, of centimetric size, are now deposited in GIR Collection, within the Geological Museum, Bucharest, Romania, under the nos. 26,287; 26,385 and 26,395.

Macroscopically the samples have light-beige to dark brownish color and under a magnifying glass they show fibrous texture, annual rings, rays and vessels, typical for a dicot.

Microscopic description

Growth rings with less distinct boundaries, marked by 3-8 tangential terminal rows of parenchyma and fibers, devoid of vessels. The structure is half-ring-porous to diffuse-porous, the rays dilated at the annual boundary. Sometimes within the parenchyma cells scattered in the ground mass, solitary angular translucent big crystals are present, slightly disturbing the wood structure (especially in the specimen no. 26,395).

The vessels appear usually solitary but also in radial multiples of 2-4(5), or as clusters. The solitary pores have rounded shaped cross-section or irregularly star-like and have thick walls of 4.5-8 μm the double-wall. The radial/tangential diameters show 40-52(90)/25-40(60) μm. The vessels' density is 25-56 pores on sq. mm, sometimes more. The perforate plates are exclusively scalariform, with 10-30(40) fine bars (1-2 μm), spaced, frequently forked or anastomosed by vertical bars. The tilted plates are storied and continued by scalariform pitting on tails. The intervascular pitting is bordered, opposite, oval or horizontally elongate to, more frequently, scalariform - wide of 6-8 μm or more (to up to 16-30 μm the horizontal diameter and 2-5 μm the vertical diameter). The vertical walls usually show fine close tilted helical thickenings and, sometimes, the pitting can be superposed over the helical thickenings, giving a slightly irregular aspect (especially in specimen nr. 26,385). Short vascular elements, often difficult to measure, have 350-480 μm in length. Inside the lumina dark-red granular or yellowish content can be present and often tyloses are visible.

The wood parenchyma appears, in cross-section, as apotracheal-disperse, usually as solitary empty cells between fibers having relatively thin walls, of 2-3 μm the double wall or, sometimes, round, big, hypertrophied, bright white, of 25-50 μm in diameter or slightly radially elongate, of 30-56/20-32 μm and with yellow to brown content or bearing solitary angular translucent big crystals. Also terminal parenchyma appears as some tangential terminal rows intermingled with fibers. Longitudinally the parenchyma appears in strands of 8-12 rectangular vertical cells with small simple pitting, hardly discernible, on their thin walls.

The medullary rays, in cross-section seen, show rectangular radial elongate cells, sometimes visibly hypertrophied and filled with yellow to brown content or, sometimes, with dark gums. At the growth-ring boundaries slight dilation is present, and the ray trajectory is linear, often touching vessels. The rays are 1-3(4)-seriate, and their frequency is of 7-11 rays on horizontal tangential millimeter. They have 5-29(40) cells in height, i.e. 115-600(787) μm, the uniseriates low. The ordinary ray cells show rather thick walls (4-5 μm the double-wall), have polygonal to rounded shape, are alternately disposed and are very unequal in size: 10-16 μm horizontally and 10-22 μm the vertically. The uniseriate endings have 1-5 cells, 1-3 of them being secretory cells, hypertrophied, thick-walled (5-8 μm the double wall), polygonal or vesicular, terminal or sub-terminal. When the secretory cells appear in the ray-body, they are pitted. When terminally disposed they are elongate, having 25-42(72) μm in wideness and 28-60(80) μm in height and dark-matte content. The ray-body cells are usually procumbent, of 10-16(22) μm high. The marginal ones can be square, of (16)25-30 μm high and the intermingled marginal secretory cells are higher or upright, of up to 95 μm, bearing bright-white or orange-colored or brown content and dark gum remains. Similar fine granular dark gum remains content may appear within procumbent hypertrophied body ray-

cells too. In the "cross-fields" of rays with vessels small-oval simple pitting of 3.5-6 μm is visible, slightly irregular or in 1-3 horizontal rows disposed. On the higher marginal cells, (4)7-10 scalariform superposed pits may appear, giving sometimes a reticular aspect.

The fibers constitute the major part of the ground tissue, and are disposed in 2-12 radial rather regular rows between two rays usually showing small intercellular spaces. The cells have polygonally-shaped section slightly rounded, thick walls of 5-8(12) μm the double-wall and wide lumina. Sometimes small-rounded fibers with point-like lumina can appear, representing probably the section of the tapered endings. Intermingled with parenchyma rows quadrangular fibers with slit-like lumina are present in the terminal wood. Longitudinally the fibers have bordered pits in a slightly irregular vertical row and are unsepted. **Fibro-tracheids** are present, wider, with slightly round endings, and oval-opposite pitting in two vertical rows, or scalariform.

Affinities and discussions

The xylotomical observed details in the studied slides are interesting by the presence of the hypertrophied secretory parenchyma cells, radial and axial too, with typical shape and disposition for **Lauraceae** (Metcalfe & Chalk, 1950; Greguss, 1959). The extant lauraceous species have a mainly tropical area of life, inside tropical America, Brazil included, South-eastern Asia, Australia and the pacific islands. *Laurus* is the only genus appearing in the European Mediterranean region. It's a rich family, having about 54 genera with 2000-2500 species. Between them the most known are *Persea americana* by its fruit (Avocado pear), *Cinnamomum* spp. by cinnamon and camphor-oil, *Lindera* by the aromatic oil named benzoin, or *Sassafras*, with a fragrant wood used in cabinet-making (Watson & Dallwitz, 1991).

Xylotomically two groups were admitted: Lauriodeae and Perseoideae, the first with tangential bands of parenchyma and only simply perforated plates, the second devoid of banded parenchyma and with scalariform or simple perforated plates.

Fossil woods of Lauraceae were described from the XIXth century, under different names, and were the object of many discussions and revisions. Name as *Laurinium* UNGER was used for lauraceous wood devoid of secretory cells (see Huard, 1967, p. 88), and *Ulminium* UNGER also (Wheeler, Scott & Barghoorn in Privé-Gill & Pelletier, 1981). They were remained in use but have been, step by step, abandoned for *Laurinoxylon*, name that shows clearly the appurtenance to Lauraceae Family. There are Süss & Mädel (1958) that have established the genus name for the lauraceous fossil wood as *Laurinoxylon* FELIX 1883, the other lauraceous generic names falling in synonymy.

However, after 1958 new lauraceous genera were described or reactivated and the discussions have continued. It was Gottwald (1997) that considered that

genera as *Perseoxylon* FELIX 1887, *Ocoteoxylon* SCHUSTER and *Machilusoxylon* BANDE emend. INGLE, have no sufficient xylotomic particularities to justify their separation from *Laurinoxylon* genus. In the same time, based on recent xylotomic studies on Lauraceae members, he admitted as valid genera, coexisting with *Laurinoxylon* FELIX, the new genera *Sassafrasoxylon* BREZINOVA & SÜSS, *Caryodaphnopsoxylon* GOTTWALD and *Cinnamomoxylon GOTTWALD*, which can clearly be related to the extant genera.

The fossil genus *Cinnamomoxylon*, initially was created by Greguss (1969), who described a badly preserved material, giving no description and diagnosis for a type-species or genus. Gottwald (1997) ignored this reality and described *Cinnamomoxylon* as a new genus based on the type-species *C. areolosum* GOTTWALD 1997. The diagnosis of this genus is based on the diagnosis of the type-species, as follows: "Porous wood structure to half-ring-porous, with solitary vessels and in short radial multiples, with mean diameter of >80 μm, simple or simple and short scalariform perforated plates, alternate pitting of 8-12 μm in diameter, sometimes with thin-walled tyloses, rays usually slightly heterogeneous, of 2-4 cells wide and 250-450 μm high, cross fields of I/II type (Richter), secretory idioblastic oil-cells, usually variable marginal, obviously wider, vasicentric, aliform to confluent parenchyma, thin to moderately tick-walled fibers, usually unsepted, or very rare, sometimes secretory idioblast between fibers". The extant correspondents of this genus are considered *Cinnamomumn* SCHAEFF., *Lindera* THUNB., *Litsea* LAM. and *Persea* MILL. Evaluating the already described species of *Laurinium/Laurinoxylon* Gottwald attributed to *Cinnamomoxylon* 12 species that "entsprechend vollständig und vergleichbar beschreiben und abgebildet" (Gottwald, 1997).

In such conditions the form-genus *Laurinoxylon* FELIX comprehends all the fossil lauraceous wood that cannot be precisely attributed to a valid fossil genus, as it is specified upward. Gottwald (1997) considered that this genus is rather insufficiently defined by the original diagnosis of Felix (1883) when he described the type-species *L. primigenium*, (wood with big solitary vessels, in pairs or in short thin-walled or moderately thick-walled fibers in rather regular radial rows, parenchyma paratracheal aliform – sometimes tending to confluent, rays usually multiseriate, or uniseriates with typical shaped secretory cells that, sometimes, appear in the ground tissue also). This diagnosis was repeated again in the papers from 1887 and in 1887a when Felix described *L. aromaticum* and, respectively, *Perseoxylon antiquum*.

The presence in our studied structures of the enormous, spectacular oil-cells, visible in all the standard sections, within rays but within the axial parenchyma too, sustained by the other xylotomical features, regarding the shape and the distribution of the vessels, fibers and parenchyma in cross sections, the scalariform perforations and opposite to scalariform intervascular pitting, the pitted tracheids,

fibers and parenchyma, that represent typical features for the lauraceae of Perseoideae group, represented as fossils by the valid genus *Cinnamomoxylon* defined by Gottwald (1997).

The comparative study of our material with the majority of these quoted species led our attention to *Laurinoxylon intermedium*, described by Huard (1967) from some Miocene lignite of Arjuzanx (Landes, France), having rather identical features.

After this critical analysis we attribute the here studied material to the species *Cinnamomoxylon intermedium* (HUARD) GOTTWALD 1997, having an extant correspondent in *Cinnamomum*, a tree with widespread now in South-eastern Asia (Vietnam, India, Ceylon, Indonesia), a wet region dominated by monsoons. We have to remark that the sample no. 26,287 was previously wrongly identified as *Liquidambaroxylon pravalense* (Iamandei & Iamandei 1999), name now abolished, by synonymy.

Family **Oleaceae** HOFFMGG. & LINK
Genus ***Fraxinoxylon*** HOFMANN 1952
Fraxinoxylon crisii n.sp

Plate III, fig. 1-4

Material: We had for study a sample of petrified wood collected from Cremenea Hill to the Hoarna Tarnița Brook, in Prăvăleni locality area, from the Badenian volcano-sedimentary Tălagiu Formation. The studied material is now deposited in GIR Collection – at the Geological Museum, Bucharest, Romania, under the inventory number 26,399 – representing the holotype of a new species whose name was suggested by the ancient Latin name of the most important river from neighborhood, *Crisium*.

Macroscopically it's a silicified trunk fragment, dark-brown in color, with reddish tints. The sizes of the sample are 10/5/3 cm. By naked eye or by magnifying glass, fibrous texture, annual rings and thin medullary rays can be seen, all suggesting a Dicot.

Microscopic description

Growth rings distinct, narrow, of 1-5 pores wide, with distinct boundaries, showing a typical ring porous wood.

The vessels, in cross section, are solitary or in radial multiples of 2-3(5) pores, but usually in pairs. The solitary pores have circular or slightly oval section. The vascular wall is thick, of 4-6 μm (8-12 μm the double wall). The radial/tangential diameters for the solitary wide pores are 97-200/62-190 μm, and for the narrow ones is 42-75/40-70 μm. The mean density is 9-13 pores on sq. mm. 3-5 fibre-tracheids in 1-2 radial rows appear ad- and abaxial to the vessels.

Vertically, simple perforations on horizontal or inclined plates appear. The intervascular pitting is bordered, small (3-4 μm in diameter), alternate, relatively numerous, not touching one another. The pit aperture is point-like. Some vessels present small and wide tyloses, rather thick-walled, sometimes sclerotic. In the late wood narrow vessels with opposite pitting can be seen. Within the vessel lumina thickenings on the inner part of the wall are present and also deposits of granules or spherical agglomerate of dark granules, more or less closed, never compact. The vascular elements have 150-190(250) μm.

The wood parenchyma is abundant, of paratracheal-vasicentric type as complete 1-3-seriate sheaths or incomplete when the vessels are touched by the vessels. Also, of diffuse apotracheal type is present or as 1-2-seriate bands within the terminal wood. The parenchyma cells are thin-walled (2 μm the double wall) and, longitudinally storied, in strands of 4-12 upright rectangular cells, more visible close to vessels or in the late wood. Vertically the cell-walls are minutely pitted with opposite small pits (2 μm) as horizontal rows on the vasicentric polygonal big parenchyma-cells, slightly irregularly disposed on the others. Sometimes the cell lumina bear solitary crystals.

The medullary rays – seen in the cross sections, show rectangular radial elongate cells disposed on a linear trajectory, sometimes curled when touch the wide vessels. They appear mostly uniseriate, but biseriate also are present, and have 3-10 cells in height (30-120 μm). The cells are round or slightly vertical elongate and their mean diameter is 16 μm. The uniseriates present sometimes biseriate stories with the same wideness as the uniseriate part. The biseriates have 6-12 cells in height (100-152 μm) and their uniseriate endings have up to 7 cells, slightly different that those from the ray-body. The ray-density is of 12-14 rays on tangential horizontal millimeter. The rays show radial homocellular structure, from cells all procumbent of 16-20 μm high. In the "cross-fields" with the vessels they have small pits very similar with the vasicentric parenchyma: opposite, round, of 3-3.5 μm, having point-like apertures, alternately or slightly irregularly in 1-3 horizontal rows disposed.

The fibers in 2-9 radial regular rows disposed have polygonal cross section variably sized (12-15 up to 20-25 μm), determining intercellular spaces. The lumina is polygonal-rounded large in cross-section and the walls are relatively thin (3-5 μm the double wall). Longitudinally they are short, storied in the early wood, small bordered pitted, spaced, irregularly disposed in a vertical row. In the early wood, they are septate.

Affinities and discussions

Analyzing the xylotomical features showed by the here studied specimen, we found that they are very similar to those of the extant genus *Fraxinus,* from Oleaceae. This family, grouping trees, shrubs and lianes, is usually cosmopolite (living in tropical to temperate, but not cold regions) and includes genera as

Jasminium, Osmanthus, Forsythia, Syringa, Ligustrum, Forestiera and *Olea* (Watson & Dalwitz, 1991).

From the extant species of *Fraxinus*, it is obvious that our specimen is, xylotomically, almost identical with *F. americana* L., as it was figured by Greguss (1959) and Schweingruber (1990). This species is now spread in the European Mediterranean region, and presents the following xylotomical features: ring porous structure, solitary or in small multiples medium-sized not very thick-walled vessels, almost horizontal simple-perforated plates between short vascular elements, alternate intervascular pitting, paratracheal parenchyma and banded, storied, relatively numerous uni- and biseriate rays, the uniseriates presenting frequently biseriate stories with the same wideness of the uniseriate ray part.

The *Fraxinoxylon* HOFMANN genus was defined after the description of *F. prambachense* HOFMANN, 1952, the type species described from the Upper Oligocene of Prambachkirchen (Austria), that shows: ring-porous wood with very conspicuous growth rings boundaries, with large vessels in early wood and small ones in the late wood, solitary and in small radial multiples (2-4), short vascular elements, small alternate pitting slightly arcuate disposed, simple perforated plates, parenchyma paratracheal, vertically as short rectangular to square cells, uniform thin rays, curling after vessels, 1-2-seriate, of up to 18 cells high, slightly heterocellular, the marginals procumbent or upright; libriform fibers thick-walled.

There are few already described species of *Fraxinoxylon*: except the type species of Hofmann (1952) that quote other two forms previously described by her and Greguss (1969) described some forms and quoting Andreánszky (1959) and Szeky-Fuchs (1959) for two other similar previous identifications, all of them coming from the Tertiary of the Central Europe. Comparing our material with *F. prambachense* HOFMANN, we found many similitudes concerning the shape, the size and the distribution of the structural elements. This species was initially considered by the author the perfect correspondent of the extant species *Fraxinus excelsior*, similar to other specimens previously described (in 1939 and in 1944), by the same author from the same place and identified as *Faxinoxylon sp*. (see Hofmann, 1952). The form *Fraxinoxylon* cf. *Fraxinus excelsior* L. identified by Greguss (1969) from the Pleistocene of Pestszentlörinc (Hungary), having only short descriptions in the legend of the plates and seems to be xylotomically identical with the extant species *F. excelsior* having 1-2-seriate rays, abundant parenchyGreguss quoted as identical the forms described from Hungary by Andre ma (fig. 4/PlateXCI, fig. 3/Plate XCIII), and homocellular rays (fig.4/Plate XCIII). ánszky and Szeky-Fuchs. Some petrified wood coming from Zarand-Prăvăleni area was recently attributed to the same species (Iamandei *et al*., 2006, in press).

Another species, *Fraxinoxylon komlosenese* GREGUSS, 1969, described from the Sarmatian of Füzérkomlós (Ungaria) has different features of the type species of the genus and of the here studied material also. The recent fossil wood described from Prăvăleni area was attributed to this species (Iamandei *et al*., 2006, in press), as another material identified in the present paper.

Our here studied specimen presents typical ring porous wood, vasicentric, diffuse and terminal parenchyma, uniseriate and biseriate numerous rays, pitted and septate fibers. These features are identical with with that described and figured for of the extant *Fraxinus americana*, by Greguss (1959) and by Schweingruber (1991).

After this comparative study we decided that our specimen represents a new fossil species named by us *Fraxinoxylon crisii* n.sp., after the ancient Latin name of the river (*Crisium*) in whose neighborhood it was found.

Diagnosis of *Fraxinoxylon crisii* n.sp.:

Derivatio nominis: from Crisium, the Latin name of the neighbor river;
Locus typicus: Prăvăleni;
Stratum typicum: Tălagiu fm., volcano-sedimentary;
Type specimen: holotype, GIR Coll. – inv.nr. 26,399.

Growth rings distinct, with ring-porous structure, vessels solitary or in radial multiples of 2-3(5), usually paired, circular to oval in section, thick-walled (8-12 µm the double wall), with rd/tgd = 97-200/62-190 µm for the large pores and 42-75/40-70 µm for the narrow ones. The mean density is 9-13 pores on sq.mm. Horizontal or inclined simple perforated plates, small bordered pitting of 3-4 µm, alternate, numerous, spaced, with point-like apertures. Opposite pitting on the narrow vessels. Small and large thick-walled tyloses, sometimes sclerotic. The vascular elements are short, of 150-190(250) µm. Axial parenchyma abundant, paratracheal-vasicentric, 1-3-seriate sheaths. Apotracheal parenchyma diffuse or fine bands terminally. Vertically it appear as storied thin-walled cells, in strands of more than 8 cells, short rectangular, pitted, sometimes crystalliferous. Low rays, of up to 3-10 round cells, the uniseriates with biseriate stories keeping the same wideness, and biseriates with high endings of up to 7 cells. Frequency of 12-14 rays on tg. horiz. mm. Homocelular rays with cells all procumbent, of 16-20 µm high. In the "cross fields" with vessels, round small alternate pitting in 1-3 horizontal rows. Fibers, with unequal polygonal section of 12-15.....20-25 µm, with meats. They present rounded polygonal lumina, relatively thin walls (3-5 µm the double wall), are storied, pitted and septate.

Fraxinoxylon komlosense GREGUSS 1969 emend.
Plate IV, fig. 1-4

Synonymy: *Fraxinoxylon komlosense* GREGUSS (Greguss, 1969).
Ternstroemioxylon kräuselii SCHÖNFELD (Iamandei & Iamandei, 2000).

Material: The here studied sample of fossil wood was found in Ociu locality area in the Late Badenian volcano-sedimentary Tălagiu Formation, in Ociu area, Zarand region (South Apuseni). The remained material after the slides' preparation, together with the slides, is deposited in GIR Collection, in the Geological Museum, Bucharest, Romania, under the inv. nos. 26,356.

Macroscopically it is a small sized piece of silicified wood, of 5/4/1.5 cm and is brown-rusty in color. At magnifying glass it shows fibrous texture, annual rings, vessels and rays, suggesting a dicot.

Microscopic description

Growth rings distinct, narrow and with boundaries marked by terminal parenchyma, determining a typical ring-porous structure.

The vessels, in cross section seen, are almost exclusively solitary, rarely as radial pairs, are circular or slightly oval in shape and have thick walls, of 4-9 μm the double wall or more. In the early wood, big vessels are present sharply passing to narrower solitary in the late wood (ring-porosity). The radial/tangential diameters of the big solitary pores are of 130-210/130-210 μm. The small ones are of 85-130/67-130 μm. Even if it is not too significant the density for the big vessels is 13-17 vessels on sq. mm. Often the solitary pores are continued by radial rows of 2-6 fibro-tracheids, making clusters, usually in the late wood. The perforated plates are exclusively simple, horizontal to slightly inclined. Bordered pitting is numerous alternate to opposite hexagonal or oval, of 7-8 μm in diameter, slightly elongate especially on tails or on narrower vessels, when they are smaller, of 3.5-5 μm in diameter, having point-like apertures. Fine helical thickenings on the vertical walls and granular gum remains inside the vessels may be present. The vascular elements are 80-210 μm long, or shorter.

The wood parenchyma is abundant and of many types: paratracheal-vasicentric as complete sheaths of 2-3 cells thick, or incomplete when the vessels are touched by rays. Rarely is aliform, unilaterally winged. Banded apotracheal parenchyma as variably thick bands is also present, developed on some interradial bundles or as terminal parenchyma, as continuous and regular bands of some cells thick intermingled with fibers. Vertically the parenchyma appears fusiform, storied, in strands of 2-6 rectangular cells, thin-walled, the vasicentric one is usually empty and numerously simply minutely pitted.

The medullary rays are fine, constituted from rectangular cells radially elongate, sometimes having granular dark remains in late wood, following a slightly sinuous trajectory and, usually, touching vessels. The ray frequency is 4-7 rays on tangential horizontal millimeter. Tangentially the rays are 1 to 4 cells wide, frequently triseriate, with tendency of "echelon" arrangement. The uniseriates have sometimes biseriate stories of the same thickness as the uniseriate part and their height is of 6-7 cells. The 2-3(4)-seriate are higher, having 8-52 cells high (125-437 μm). The cells are round or slightly vertically elongate, sometimes showing dark content. Radially they are heterocellular, the ray-body with cells all procumbent or square, of 11-14.5 μm high and a single row of marginal upright cells. In the "cross-fields" with the vessels small round simple pits in 2-3 horizontal rows appear.

The fibers in cross section are polygonal, not uniform in size (12-20 μm in diameter), having thin walls (2 μm the double wall), thicker in the late wood. The pitting seems to be bordered, small (6-7 μm), usually irregularly disposed in a vertical row, radially more numerous. Sometimes vascular fibro-tracheids appear, forming clusters, usually in the late wood.

Affinities and discussions

The xylotomical features of this specimen are most similar with those of the extant genus *Fraxinus* having a typical ring-porous wood. From the extant species of *Fraxinus,* xylotomically, the closest form to our specimen is *F. ornus* L., a species with a restricted life area in the Mediterranean Europe. It can be seen that the generic features: ring-porosity, mean-sized solitary vessels or grouped in small multiples, with simply perforated almost horizontal plates limiting short vascular elements, with alternate intervascular pitting, paratracheal parenchyma and banded, numerous fine rays and pitted libriform fibers. Other features like almost exclusively solitary vessels and 1-4-seriate heterocellular rays, are typical for the extant species *F. ornus* (see Greguss 1959, Schweingruber 1990).

As it is known there are few forms described till now and attributed to *Fraxinoxylon* genus. Comparing our specimen with *F. prambachense* HOFMANN 1952, and with other forms described by Hofmann (1944), by Greguss (1969) and by Iamandei et al. (2006, in press), considered as equivalents of the extant species *Fraxinus excelsior,* we found similitude but not identity. Also is good to remark the dissimilarities with the species described within the present paper, *Fraxinoxylon crisii* that has fine rays, only uni- and biseriates.

Closest to the structure of our studied specimen is *Fraxynoxylon komlosense* GREGUSS, 1969, described from the Sarmatian from Füzérkomlós (Hungary), even if the description this species is defficitary. Trying to compensate we have attentively studied the plates and the caption of plates, having no possibility to see the original material of Greguss. So, in the figs. 1-3/Plate XCI and 1/Plate XCII solitary pores or in short radial multiples can be seen, numerous vascular pitting, terminal and paratracheal parenchyma, (1-)3-4-seriate heterocellular rays, in fig. 3/Plate XCI there are square and upright marginal cells. The fig. 1/PlateXC present a typical reticulate parenchyma it's erroneously considered *Fraxinoxylon.* The diagnosis made by Greguss is not very clear. However we recently described another material coming from the same area (Prăvăleni), from Ţibuleac Collection, also attributed to this species, having almost identical features, with small biometric variations (Iamandei *et al*., 2006, in press).

So, after this critical survey we attribute this studied material to the species *Fraxinoxylon komlosense* GREGUSS 1969, and because our studied specimen presents clearly all these features, identical with the extant species *Fraxinus ornus* L., we emendate the insufficient diagnosis given by Greguss in 1969. Also we specify that the present material was initially wrongly described as *Ternstroemioxylon kräuseli* SCHÖNFELD (Iamandei & Iamandei, 2000), identification now abolished by synonymy.

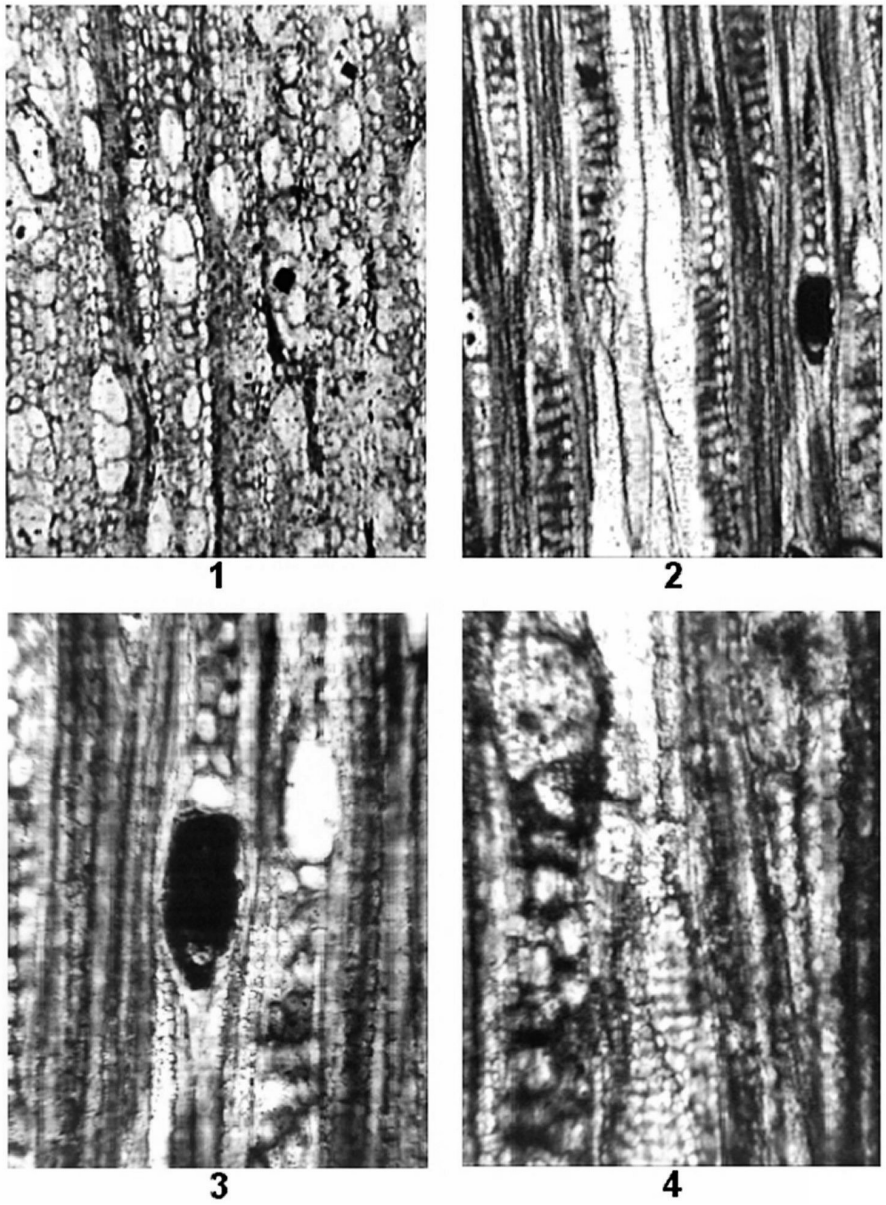

Plate I

Figs. 1-4: *Cinnamomoxylon intermedium* (HUARD) GOTTWALD 1997.

Fig. 1. Cross section: linear 1-2-seriate rays, solitary and grouped vessels fibers; x100;

Fig. 2. Tangential section: 1-2-seriate rays with big secretory cells; x100;

Fig. 3. Tangential section: biseriate rays showing big secretory cells, pitted fibers (detail); x200;

Fig. 4. Tangential section: biseriate rays showing big secretory cells, pitted fibers, intervasculare pitting subopposite to alternate; x200.

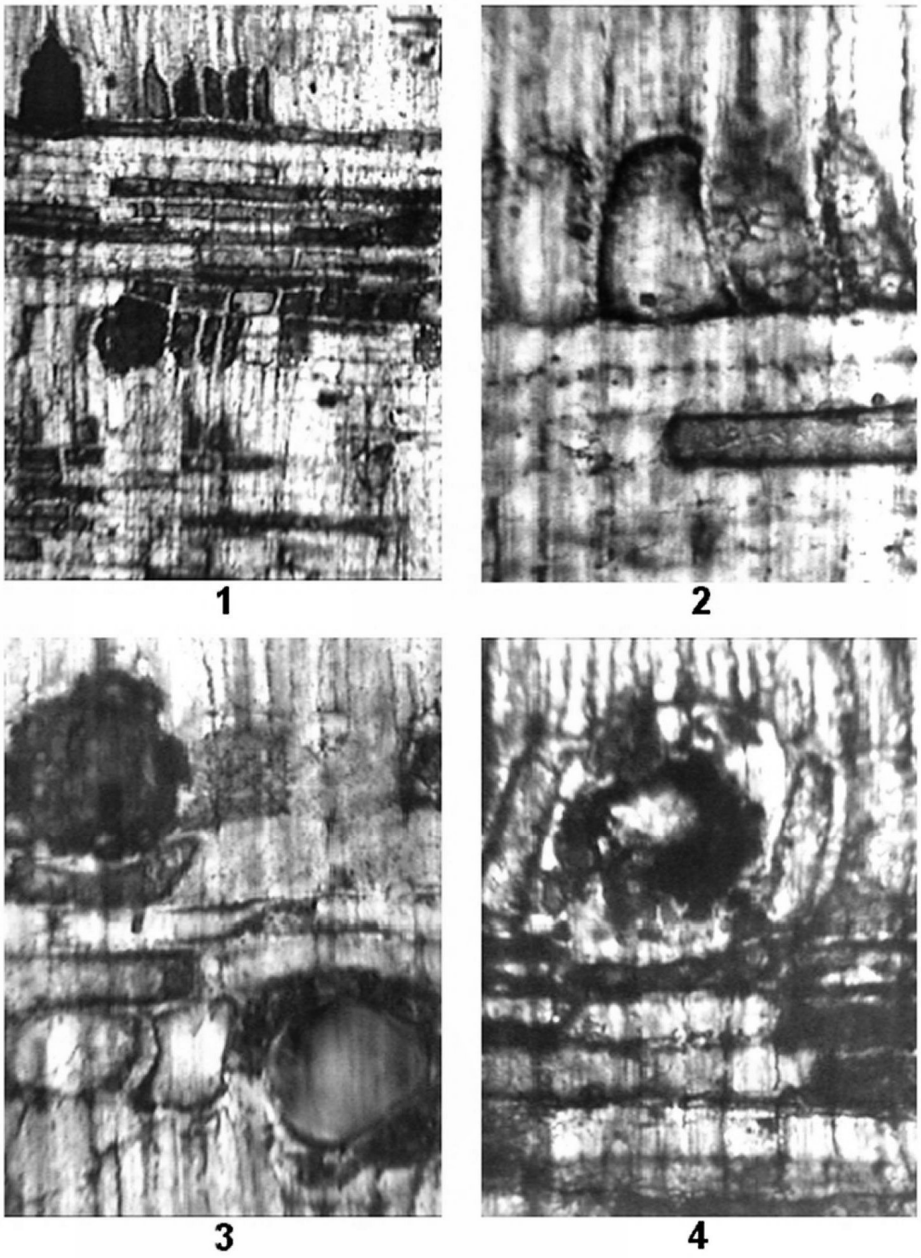

Plate II

Figs. 1-4: *Cinnamomoxylon intermedium* (HUARD) GOTTWALD 1997.
Fig. 1. Radial section: cross fields and upright secretory marginal cells; x100;
Fig. 2. Radial section: cross fields and upright pitted secretory marginal cells; x200;
Fig. 3, 4. Radial section: cross fields and upright and round big secretory marginal cells; x200.

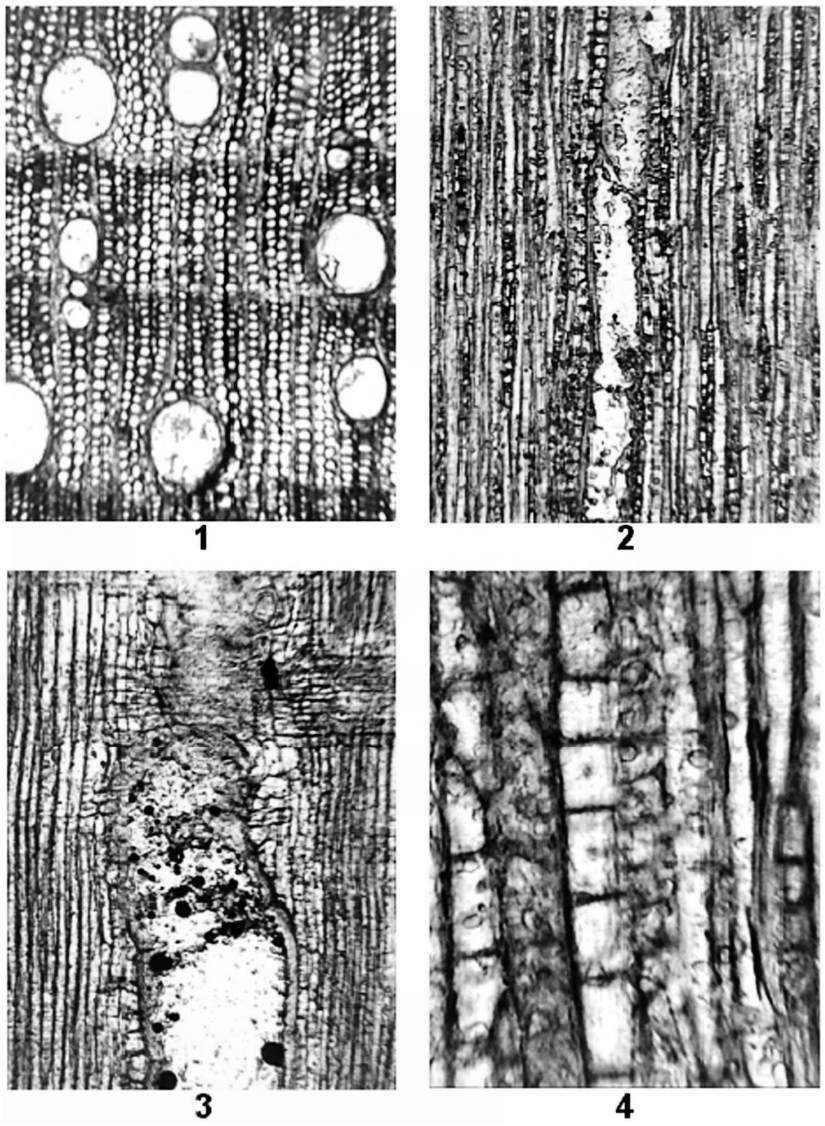

Plate III

Figs. 1-4. *Fraxinoxylon crisii n.sp.*, (holotype).

Fig. 1. Cross section: not very broad growth rings but with distinct boundaries, ring porous wood structure, fine rays, circular thick-walled vessels; x50;

Fig. 2. Tangential section: 1-2-seriate rays only, fibers, axial parenchyma and vasicentric, sometimes crystalliferous, vessels with simple-perforated, horizontal or tilted plates, x50;

Fig. 3. Radial section: cross fields, thick-walled vessel with simple-perforation and granular content, vasicentric parenchyma, fibers; x50;

Fig. 4. Radial section: axial parenchyma, fibers; x200.

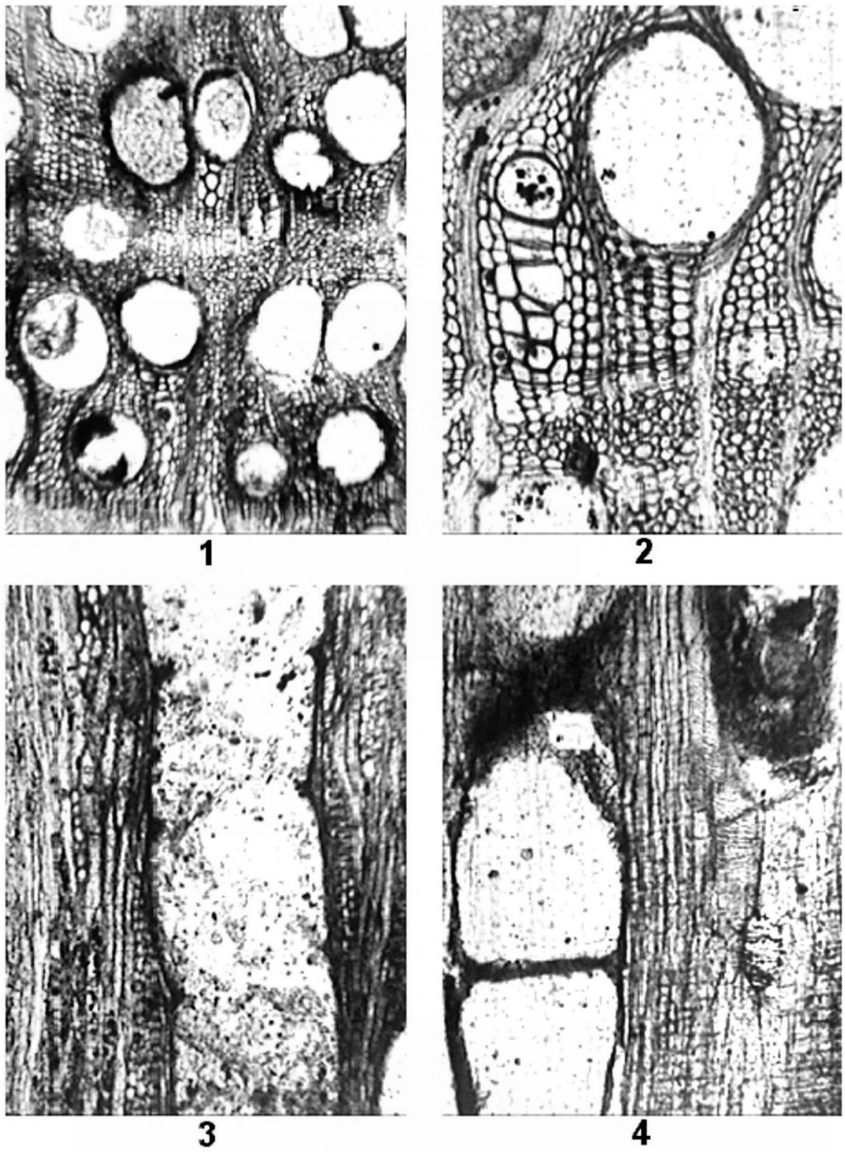

Plate IV

Figs. 1-4. *Fraxinoxylon komlosense* GREGUSS 1969 emend.

Fig. 1. Cross section: ring-porous wood structure, narrow growth rings with distinct boundaries, solitary vessels; x50;

Fig. 2. Cross section: round section of the vessels, relatively thin-walled fibers, terminal parenchyma, fine rays; x100;

Fig. 3. Tangential section: fine rays and 3-4-seriate, fusiform, thick-walled vessels, fibers; x100;

Fig. 4. Radial section: simple-perforated horizontal or tilted plates, vasicentric parenchyma, cross fields, fibers; x100.

Emended diagnosis of *Fraxinoxylon komlosense* GREGUSS 1969:

Secondary ring porous wood with distinct growth-rings, terminal parenchyma, almost exculsively solitary vessels circular to oval, thick-walled, r/tg diameters 130-210/130-210 µm for the big vessels, and 85-130/67-130 µm for the small ones, simple perforated plates, alternate to opposite, small hexagonal bordered pitting, elongate on tails or on the narrower vessels, fine helical thickenings, short vascular elements. Parenchyma is abundant, paratracheal-vasicentric aliform or unilateral-wingged, as complete or incomplete 2-3-seriate sheaths, banded-apotracheal or terminal as continuous fine bands. Vertically it appears fusiform and storied, in strands of 2-6 short rectangular pitted cells. The fine rays of 4-7 fine rays/ tg.horiz.mm usually 1-3(4)-seriate, the uniseriates with biseriate stories of same wideness and 6-7 cells high. The 2-4-seriate have 8-52 cells in height. Radially appear heterocellular, the body-cells all procumbent or square, of 11-14.5 µm high, and a single row of marginal upright cells. In the cross-fields with vessels, numerous small round pits in 2-3 horizontal rows. Libriform fibers of polygonal cross-section, thin-walled, pitted, more numerous radially and sometimes fibro-tracheids are present.

3. CONCLUSIONS

A new material of fossil wood coming from Prăvăleni-Ociu fossiliferous region of South Apuseni mts. was xylotomically studied four species were identified and described: *Cinnamomoxylon* (HUARD) GOTTWALD 1997, *Fraxinoxylon crisii* n.sp. and *Fraxinoxylon komlosense* GREGUSS 1969 emend., even if some of them are already known from other previous studies in the same geological site.

Evaluating the ecological requirements of some paleotropical taxa representing about 15-16%, and taking also into account the paleogeographic and latitudinal reconstructions, we concluded that this vegetation represents a "Mixed Mesophytic Forest" with Lauraceae and Conifers, altitudinally storied, vegetating in a warm-temperate climate, rather wet, by comparison with the extant vegetation of similar floral composition, growing within geographically similar conditions (Wolfe, 1975).

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