FOSSIL CONIFER WOOD FROM PRĂVĂLENI - OCIU, METALLIFEROUS MTS.

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Abstract. In this paper we present the study of some fossil woods, found in a Middle Miocene Volcano-sedimentary Formation predominantly pyroclastic, generated by the eruptive activity of Talagiul-Bratosin caldera, from the Zarand Basin. Metalliferous - Apuseni Mts. From the same formation many other arboreal coniferous and dicotyledonous taxa were described. The resulted assemblage comprises numerous warm-climate trees, but the abundance of Conifers found by us till now claims a nuanced attitude in this problem.

Keywords: Paleoclimate, Cupressaceae, Taxodiaceae, Pinaceae, pitting, cross-fields

INTRODUCTION

The predominantly pyroclastic formation from Prăvăleni-Ociu area, related with the volcano-sedimentary formation of the neighbor Zarand Basin of Apuseni Mts. (Metalliferous Mts.), considered here of Upper Badenian-Lower Sarmatian age (Berbelec et al. - 1984), preserves many wood fragments of trunks, branches or roots, a forest buried by the extracrater products of Talagiul-Bratosin caldera. It is from Prăvăleni that were described by Nagy & Márza (1967), Petrescu & Nutu (1970a,b, 1972), Iamandei (2000a,b,c, in press), Iamandei & Iamandei (1998, 1999, 2000) some fossil woods belonging to the genera Taxodiixylon, Sequoixylon Magnoliixylon, Icacinixylon, Larixixylon, Perseyxylon, Juglandixylon, Alnixylon, Carapoyxylon, Platanixylon, Liquidambarxylon, Paraphyllanthoxylon and Piranheoxylon. The tannin-stained wood samples were analyzed by the method of X-ray diffraction. The assemblage suggests a warm temperate climate, or warmer, because in this assemblage there are some trees that cannot suffer lower temperatures.

XYLOTOMICL DESCRIPITIONS

Family CUPRESSACEAE
Genus Tetracynixylon GRAMBAST 1951
Tetracynixylon romanicum n.sp.
Plate I, figs. 1 - 11.

Diagnosis: Growth rings weakly distinct, of 18-30 (65) cells thick, with gradual transition. Resin ducts absent. Polygonal-rounded tracheids, with circular to oval lumina of radial/tangential diameters = 14-28 / 12-20 μm, walls of (3)-5-16 (18) μm thick (double wall), 1224-1672 tracheids on sq. mm. Tangential pitting uniseriate, borders 4-7.5 μm in diameter and apertures of 2-2.5 μm. Radial pitting with ovate borders of 8-14 (16) μm in diameter and apertures of 2-4 μm, spaced or contiguous in 1-2 vertical rows, sometimes with crassulae. Slightly curved walls, molding the row of pits; the pitting is disposed over the oblique striations determining oblong windows; sometimes trabeceles. Parenchyma scarce, with vertical walls unpitted and slightly constricted at the cell endings; the horizontal walls are thin and smooth or weakly nodular (1-2 nodules). Rays uniseriate, of 1-2-6-23 circular cells high, and the frequency is 8-17 rays/μm.; they are homogeneous, the horizontal walls of 2-3.5 μm thick (double wall) and the tangential ones thin, smooth to slightly nodular; indentures indistinct; parenchyma cells of 7-16 μm high, the marginals taller (16-20 μm); the cross fields have 1-2(3) small cupressoid pitting, horizontally or diagonally disposed, and till 4-5 pits in two superposed rows or 1-3 in a horizontal or vertical row, in the marginal fields; the pits are round to oval, of 3-4 μm in diameter with circular to slit-like apertures.

Macroscopic description

The studied material comes from a volcano-sedimentary Formation of Upper Badenian-Lower Sarmatian age, from Prăvăleni area (Cremenea Hill). It is represented by some centimetrically silicified wood fragments, probably belonging to the same trunk, as the xylotomical identity of the studied samples shows; the fragments are brown to light-brown in color, with growth rings and a fibrous texture.

Microscopic description

Growth rings present, not always very distinct, marked by the (1)2-4-(18) tangential rows of thick-walled flattened cells in the late wood, frequently with dark content, contrasting with the early wood formed of big lumenized cells, with round, elliptical or angular intermingled; the rings are of 18-30(65) cells thick, and the transition is gradual. Resin normal ducts are absent, but sometimes there are irregular areas of resin tissue probably of traumatic origin or radial cracks, possibly appeared during the fossilization.

The tracheids show a round-polygonal cross section, even oval or deformed in the compression wood, and determining triangular or rhombic intercellular spaces; they have round or rounded lumina, with radial / tangential diameters of 14-28 / 12-20 μm, with frequently smaller intermingled; in the late wood the lumina are narrower (7-12 / 12-20 μm); the cell walls are thick to very thick, of (3)-5-8 μm (double wall) in the early wood to 12-18 μm in the late wood; frequency is 1224-1672 tracheids on sq. mm, or more. The tangential pitting is less frequent, with round ornate borders of 4-7.5 μm in diameter and circular apertures of 2-2.5 μm, spaced arranged in a single vertical row, sometimes slightly irregular, over the common oblique striations of the tracheid wall, determining oblong windows; sometimes crassulae are present. In the radial section the tracheids show rounded endings which seems to lean on the procumbent cells of the rays; the abietineous pitting shows rugosely ornate borders, of 8-14-16-18 μm in diameter with round apertures of 2-4 μm, to slightly elliptic in the late wood, similarly inclined; the pits are spaced or contiguous arranged in a single vertical row, rarely two, and sometimes are fairly flattened; rather rarely, between the spaced pits, crassulae can be seen.

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the tangential walls of the tracheids usually mold the pitting row, determining a series of cuvettes and a curved aspect, a typical cupressoid character; another particular aspect is given by the pitting sitting over the obvious and very oblique striations, sometimes crossed, determining oblong windows; in the late wood the tracheid endings are more tapered, and the pitting is smaller (8 μm in diameter) and more spaced in a vertical row, in some tracheids trabecculæ ore resin plugs can be seen.

Wood parenchyma in cross section rather scarce, as not very thin-walled cells with dark content, rounded to elliptic, smaller then the tracheids or equal in size, diffuse or in short tangential lines, more in the late wood. Longitudinally as rectangular cells, relatively thick walled (5-7 μm the double wall), unipitted and slightly constricted at the endings; the horizontal walls are thin (1.5-2 μm) and smooth to slightly rugose or sometimes weakly nodular (1-2 nodules); the cells' lumina have dark resin remains, granular to compact, sometimes as round or flattened globules or plugs.

The medullary rays seen in cross section are constituted by rectangular cells, scarcely simple pitted on their horizontal walls. They are uniseriate with rare short biseriations, of 1-11(23) cells high, frequently 2-8; the shape of the cells tangentially seen is circular or weakly oval, with 12-20 μm in diameter, someone pitted; the frequency is 9-14 rays on tangential mm. Radially they are homogeneous, constituted of procumbent parenchyma cells with relatively thin horizontal walls (2-3.5 μm the double wall), smooth to weakly rugose, and the tangential ones are thin, of 1-1.5 μm, smooth to slightly rugose or even nodular; indentsures indistinct or absent; the cells are (8)12-16 μm high, the margins taller (16-20-28 μm). In the cross fields there are 1-2(3) cupressoid small pits arranged either horizontally, or in diagonal or vertical pairs, more numerous in the marginal fields as 4-5 pits in two superposed rows, but also 1-3 in a single horizontal or vertical row; the pits are round to elliptic, even lenticular, oblique arranged, of 3-4 μm in diameter and the apertures circular to elliptic or slit-like, of 1 μm, included, oblique to vertical.

Affinities and discussions

The xylotomical characters of our specimens perfectly agree with those of the Cupressaceae Family, and some members of it are closer, as Libocedrus, Chamaecyparis, Juniperus, Calitris (Greguss 1955); the striations of the tracheidal walls, determined by the alteration of the microfibrillar structure of the secondary wall, probably during the fossilization, produce by the superposition of the pitting a series of oblong windows, similar to Platyspyroxylon (Greguss 1961, 1967). The comparison with already described cupressaceous fossil structures shows a great similitude with the genus Calitrixylon, described by Privé & Boureau (1988), but we have not described calitroid thickenings in our specimens, very specific to this genus; it is also true that not all the extant species of Calitris genus, present obviously this character, e.g. Calitris cupressiformis VENT., C. subata SCHLECH., C. oblonga RICH., C. intratropica BENTH. & HOOK. (Greguss 1955). Similar xylotomical characters also presents Palaecocallitrixylon limburgense, a species described by Greguss in 1970 revising the species Juniperoxylon silesiacum KRAUSEL & SCHÖNFELD 1924, a form very close to the extant species Calitris drumondii BENTH. & HOOK., devoid of juniperoid nodules and calitroid thickenings, but with a very special feature represented by the presence of some well developed tangential strands of parenchyma within the growth rings traversing much more bundles, not seen in our specimens. Another extant calitroid structure without calitroid thickenings is found only in Tetracentrinis, a monospecific genus (T. articulata MAST.) with a restricted biogeographic area in North Africa - Atlas Mts., South Spain and Malta (Greguss 1955, Privé 1973). The comparison with the already described species of the fossil genus Tetracentrinis described by Grabham (1951) indicates a great similitude with T. bourreaui GRAMBAST 1951, a structure described by the author from the Chattian of the Paris Bassin and T. vulcanense PRIVÉ 1973 described by Catherine Privé in 1973 from the Pliocene of Puy-de-Dôme, concerning the size and the distribution of the tracheids and the parenchyma, the aspect of the rays and the ray cells, but there are some dissimilarities as follows: tangential pitting with smaller ornate borders (4-7.5 μm in diameter vs. 5-14-15 μm), radial pitting also smaller and ornate (8-14 μm vs. 10-23 μm in T. vulcanense), the infrequent presence of the crassulae, very obvious in the species described by Privé; the horizontal walls of the axial parenchyma relatively thin, are smooth, slightly rugose or even nodular in our specimens, differently from the French fossil species, but identical with the extant species; also the ray frequency and the cross fields are different vs. the fossil species, but are very close to the extant one. Unfortunately we cannot compare our specimen with the species described by Chuadjaberdiev in 1984 from the Upper Cretaceous from Uzbekistan. After this comparative study we decided that our studied material represents a new species that we named Tetracentrinis romanicum n.sp.

Holotype - nr. 26339 and 3 slides, in G.I.R. Collection, Bucharest.
Locality - Prăvăleni, Cremenea Hill, Metaliferous Mts., Romania.
Horizon - Volcano-sedimentary Formation.
Age - Upper Badenian - Lower Sarmatian.
Genus Chamaecyparixylon CHUADJABERDIEV 1958
Chamaecyparixylon cf. polonicum (KRAUSEL) CHUADJABERDIEV 1958
Plate II, fig. 1-8.

Macroscopic description

The studied sample was found in Prăvăleni area, in the right bank of Hoarna Tamita Brook, in a predominant pyroicastic Formation of Upper Badenian - Lower Sarmatian age and represents a silicified wood fragment, brown-gray in color, lighter in the outer parts, with a fibrous texture, and the following size: 6/6,5/3,5 cm.

Microscopic description

Growth rings rather indistinct because of the disturbed structure, even disorganized, of the wood, but are relatively thick, probably more than 60 cells, marked by some rows of thicker walled cells. Normal or traumatic resin ducts are absent.

Tracheids rounded-polygonal in cross sections, sometimes deformed, and with intercellular spaces; their lumina of 32-44 / 25-4-38 μm (rd / td), arranged in 1-12 radial rows with larger or narrower tracheids solitary or in radial rows interspersed, all between two rays; their cell walls are 4-6-12 μm thick (double wall) and the frequency is of 2200-2500 tracheids on sq. mm. The tangential pitting is absent or very rare, as slightly
disordered smaller pits, of 9-12 μm in diameter, with oblique narrow elliptic apertures. The radial pitting is abietineous, 1-2-seriate, without crassulae, with borders of 12-19 μm in diameter and round apertures of 5-6 μm. The vertical walls are slightly molding the rows of pits and get a curved aspect; striations are present.

The axial parenchyma is diffuse, with rounded-rectangular cross sections, equal or smaller than the tracheids, more visible or even abundant in the tangential section. The vertical walls are simple irregular pitted and constricted at the endings of the cell. The horizontal walls are thin and smooth or slightly rugose and pitted. The resin content is granular or as balls.

The rays are uniseriate, sometimes with 1-3 biseriate stories of the same width as a single cell, and of 1-19(28) cells high; the frequency is of 9-13 rays on tangential mm. The ray cells are round or slightly flattened, with granular resin content, and there are laterally triangular intercellular spaces. The rays are homogeneous, the cells of 12-16 μm high, the margins taller (16-24 μm) have the horizontal walls smooth, relatively thick, of 3-6 μm or slightly more (double wall), and the tangential walls are vertical to oblique or arcuate, smooth and thin (1.5 μm), sometimes pitted; indents are indistinct or absent. The cross fields present 1-2-3 cupressoid or small taxodioid pits in a horizontal row or in vertical pairs. In the marginal fields there are 2-3 in a vertical row or 4-6 similar pits in two superposed rows. Their borders are round to oval, of 7-9 μm in diameter, and the apertures are circular, of 3-4 μm or elliptic to vertical slit-like. In the fields with the axial parenchyma, there are 2-5 small, round or larger, horizontal elongated simple pits, in vertical pairs.

Affinities and discussions

The xylotomical characters of the studied specimen, i.e. the shape, the size and the distribution of the tracheids, the parenchyma, the rays and the ray cells suggest that it is a member of Cupressaceae Family. As it hasn't calilroid thickenings, it cannot belong to Calilridae Group (sensu Greguss 1955); the thin and smooth horizontal walls of the axial parenchyma show that it cannot belong to Cupressoideae Group, which presents here nodular or even dentate aspects; also it cannot belong Juniperidae Group, because our specimen is devoid of the juniperid nodules on the tangential walls of the ray cells. It is in the Thujidae Group that we found much more similarities, especially with the extant Chamaecyparis and Thuja (see Greguss 1955). Using the identification keys of Vaudois & Prévé (1971), we have seen that the distinction between Chamaecyparixylon and Thujoxylon is very difficult, and it is reduced to the presence or the absence of the axial parenchyma and the indents. Our specimen has rather abundant axial parenchyma, and the presence of the indents is doubtful, so we believe that we have described here a Chamaecyparixylon. The description of our specimen perfectly agrees with the diagnosis of Chudajderyev 1958, commented and annotate by Vaudois & Prévé 1971. Some characters seem not to be identical with Cupressinoxylon polonicum (KOSTYNIUK) KRAEUSEL, described by Zalewski (1953), in respect with the slightly nodular horizontal walls of the parenchyma, and the radial pitting that can be also biseriate, as Schönfeld admitted (in Vaudois & Prévé - 1971), and as in our specimen appears. After these discussions we think that our specimen can be named Chamaecyparixylon cf. polonicum (KRAEUSEL) CHUDAJDERDYEV 1958.
The medullary rays seen transversely are relatively rectilinear or slightly deviated and constituted by rectangular elongated cells, sometimes crushed, with simple pitting irregularly dispersed on the horizontal walls. They are uniseriate with short biseriation, rarely entirely biseriate, and have (1)2-20(32) cells high: the ray cells usually empty, are circular or elliptic, rarely squared with rounded corners, of 12-15-20 μ; sometimes sieved by simple pitting; usually lateral intercellular spaces are obvious; the density is (3)5-10 rays on tangential mm.

Radially they are homogeneous, the ray parenchyma cells are of 14-18 μ high, the marginals taller (20-40 μ); the horizontal walls relatively thin (2-3-5 μ double wall), smooth and pitted, the marginals have the outer walls slightly sinusous; the tangential walls vertical or fairly arcuate are thin, of 1.2 μ, smooth or slightly rugose, rarely weakly nodular and do not produce indentsures; the cross fields present typical taxodioid pitting, sometimes with coporoid pits, tending to a glyptostrobid pattern, of 6-9 μ in diameter, round to oval in shape, 1-3(4) in a horizontal row arranged, the pairs slightly diagonal; the apertures are large elliptic, oblique to horizontal of 3-6 μ or narrower, of 2-3 μ, oblique to vertical in the late wood; the marginal fields have 1-3 similar horizontal to 4-6(8) in two rows, slightly irregular. Inside the ray cells there is sometimes a dark content.

Affinites and discussions

The xylotomical details of these specimens agree with those of the Taxodiaceae Family, that is the presence of the radial opposite pitting in 1-3 vertical rows and with crassulae and the typical taxodioid (to slightly glyptostrobid) cross fields. The comparison with the fossil forms already described shows great similarities with the genera Sequoioxylon TORREY and Taxodioxylon (HARTIG) GOTHAN. The distinction between these two genera is problematic enough, since some of the paleoecologists contest the validity of the genus Sequoioxylon TORREY, considering that the diagnosis of Taxodioxylon genus is sufficiently comprehensive and the establishment of new competency domains can complicate the fossil wood identifications. Some details of our specimens remember of Metasequoia glyptostroboids HU & CHENG (see Greguss 1955), an extant tree discovered in 1943 in China. The comparison with the fossil forms described by Greguss in 1967, showed some similitudes with Metasequoioxylon sp. and lesser with M. hungaricum GREGUSS 1967; so, the growth rings of 5-20 cells high, with some rows of thick-walled cells in the late wood, with larger cells interspersed of 70 μ in diameter, with rays not very tall keeping resin mass inside their cells, horizontal walls of the axial parenchyma smooth and pitted and granular content in the parenchyma cells. The comparison with Taxodioxylon metasequoianum described by Schönfeld in 1955 and renamed by Greguss in 1967 as Metasequoioxylon germanicum (SCHÖNFELD) GREGUSS 1967 is also unsatisfactory, our specimens having axial parenchyma cells usually devoid of pitting, and the cross fields are different. Also unsatisfactory is the comparison with Metasequoia milleri ROTHWELL & BASINGER 1979 described from Allenby Formation (Middle Eocene, British Columbia - Canada), as is quoted by Basinger (1981), concerning essentially the cross fields. Otherwise, according with Petrescu (written comm., 1999), "in relation with the leaves or shoots remains reported, it is very possible that Metasequoia have been missing from the Tertiary European flora and probably the woods described by Greguss are reworked from older formations". The comparison with Sequoioxylon cf. germanicum GREGUSS 1967 does not work too, but it has suggested to us another way, the S. gypsaceum forms described by Greguss (1967), in which the growth rings are not always very distinct but present, the axial parenchyma is tending to be terminally distributed, are simple pitted, have granular content and horizontal walls smooth; the tracheids present sometimes resin content, are thin-walled in the early wood, and are variable in size, some of them reaching 100 μ in diameter, without spiral thickenings on the longitudinal walls, but with 1-2-3 rows of pits, with distinct crassulae, like in extant species Sequoia sempervirens ENDL.; the rays usually uniseriate, with the height of 2-18 round to oval cells, of 13-15-20 μ in diameter; the cross fields have 1-3-5 taxodioid pits in 1-2 horizontal rows; sometimes seems to appear transverse tracheids. S. gypsaceum (GOEPP.) GREGUSS 1967 described by Petrescu & Dragaslan (1971) from the Oligocene of Susănești (Romania) seems to be the closest to our specimens. Also the Taxodioxylon gypsaceum described by Gottwald (1992) from the Eocene of Helmstedt (Germany), present xylotomical details very similar to our specimens even if not identical. Very similar features describe also Bucurcu et al. (1988) for T. gypsaceum from an Upper Miocene lignite deposit of Capvern, Hautes Pyrénées, Prive Gill (1977, 1990) from the Oligocene from Limagne and Razel (Allier, France) and Nagy (1969) for a specimen found in Romania, at Clit, in an Oligocene Formation. The here studied specimens, devoid of resin ducts but frequently with resin tissue probably of traumatic origin, with tracheidal abietinose 1-3-seriate pitting, with conspicuous crassulae, with axial parenchyma relatively abundant with resin balls and plugs and horizontal walls usually smooth and thin, rarely with 1 weak nodule, with uniseriate rays frequently with biseriate stories and cross fields typical taxodioid sometimes tending to glyptostrobid, are very similar to extant Sequoia structure. This kind of wood have been described as fossil under the name Taxodioxylon gypsaceum (GOEPP.) KRAUS & GREGUSS 1967 (=T. sequoianum (MERCKLIN) GOTHAN 1906). Greguss (1967) considered it equivalent to Sequoioxylon TORREY 1923 and renamed it Sequoioxylon gypsaceum (GOEPP.) GREGUSS 1967. Huard (1965) showed that Taxodioxylon gypsaceum are grouping many divers forms, all of them equivalent to the extant Sequoia sempervirens ENDL., and it was broadly distributed in the Northern Hemisphere (Eurasia and North America) during the Tertiary. The genus Sequoioxylon TORREY 1923 was created on a traumatic fossil wood structure, describing traumatic resin ducts, but Krausel (1949) rejected it. However Greguss (1967) proposed to use it for all the structures related to the extant genus Sequoia and characterized by the horizontal walls of the axial parenchyma perfectly smooth, rarely slightly thickened or rugose or very weakly nodular, radial pitting 1-3-seriate with conspicuous crassulae and cross fields with 1-3 taxodioid pitting (or slightly podocarpoid or circular), in a horizontal row, rarely in vertical pairs, more numerous in the marginal fields and in two rows, rarely alternate or slightly irregular. He attributed to this genus the species gypsaceum, medullare, podocarpoides, germanicum, and to other numerous forms described on a bad preserved material as Sequoioxylon sp., Roy & Stewart (1971) have accepted as justified this proposal.
and have described a S. gypsaceum from Cypress Hills Formation (Oligocene, Saskatchewan - Canada), returning on the Taxodium gypsaceum described by Ramanujam & Stewart (1969) from Edmonton Formation (Upper Cretaceous, Alberta - Canada), and proposing to rename it as Sequoioxylon gypsaceum. The genus name was used also by Petrescu & Popa (1971), and Petrescu (1978) for similar structures described in Romania, with the species gypsaceum and giganteoideae, the last renaming the taxon described by Huard (1966) and equivalent to the extant species Sequoia gigantea DECAISNE. GREGUSS (1967) considered that the name Taxodium should remain reserved only to the structures characterized by the presence of numerous nodular thickenings on the horizontal walls of the axial parenchyma, a very typical aspect of the extant genus Taxodium. Quoting Bailey & Faull, Privé-Gill (1977) warned about the great variability of the ray characters in the extant Sequoia. And even if the aspect of the axial parenchyma seems to be extremely variable at the extant Sequoia (Privé-Gill 1977), this taxon is also morphologically and ecologically different from Taxodium, and we must keep in mind that as fossil Taxodiaceae there are already established the genera: Taxodiocladus HARTIG 1848 emend. GOTHAN 1905, Glyptostrobocladus CONVENTZ 1884, Metasequoioxylon GREGUSS 1967, Cryptomerioxylon GREGUSS 1967 now considered directly related with the extant genera Taxodium, Glyptostrobus, Metasequoia, Cryptomeria, although Taxodiocladus often is used as taxodiaceous wood, eventually difficult to identify. In these conditions we think that the use of the genus Sequoioxylon TORREY 1923 is legitimate because it is confirmed that it represents the fossil correspondent of extant genus Sequoia, its diagnosis established by Torrey (in 1923) we can say that was emended by GREGUSS 1967, who did not consider the presence of the traumatic structures as taxonomic detail. Ramanujam & Stewart (1969) emphasized that "the apparent absence of traumatic resin canals, however, should not be a deterrent in a determining the affinities of the fossil taxodiaceous woods, if they otherwise show all the minute structural details" (p. 117). Anyhow, when describe a fossil taxon it is compulsory to relate it with the extant taxa. After this critical discussion we attribute the here studied material to the form-species Sequoioxylon gypsaceum (GOEPP.) GREGUSS 1967.

Material - is found in G.I.R. Collection, specimens nr. 26341, 26342, 26343, 26344, 26345, 26346, 26347, 26348, 26349 and 27 slides.

Locality - Pražáleni, Metalliferous Mts., Romania.

Horizon - Volcano-sedimentary Formation.

Age - Upper Badenian - Lower Sarmatian.

Family PINACEAE

Genus Pinuxylon GOTHAN 1906

Pinuxylon marinesii n.sp.

Plate IV, figs. 1-9

Diagnosis: The growth rings are distinct, thick of 105-160 cells, early wood is 2/3; with gradual transition; normal axial resin ducts especially in the transition and final wood, circular to oval, rad / tgd=60-117-220 / 60-110-190 μm, radial resin ducts of 22-84/30-80 μm, epithelial cells relatively thin-walled (1.5-3.5 μm double wall), in 1-2 layers, and pitted. Rectangular to polygonal tracheids in cross section, lumina diameters (r / tg) of 20-70 / 20-60 μm, cell walls of 3-5-8(12) μm double wall, frequency of 460-713 tracheids on sq.mm. Tangential pitting scarce, spaced, smaller (8-13 μm in diameter), circular to elliptic apertures; radial pitting with ornate borders, of (8)15-23(28) μm in diameter, 1(2)-seriate with slightly irregularities, spaced or contiguous, sometimes with crassulae, circular apertures of 6-10 μm to vertical elliptic in the late wood; trabeaculae, striations. Parenchyma absent or very rare, transverse walls slightly oblique, thick, smooth, nodular or dentate. The rays are 1-2-seriate, of 2-14 cells high, ray cells round to elliptic, of 7.5-28 μm in diameter; fusiform ducted rays of 18-20(35) cells high; the frequency is 4-6 rays on tg., heterogeneous rays, parenchyma cells of 20-25 μm high, with horizontal walls thin (1.5-3.5 μm double wall), pitted, smooth or slightly rugose; the tangential walls not too thin (1-3 μm), slightly rugose or nodular (6-7 nodules), even dentate; indents indistinct or absent. The cross fields have 1-3(4) taxodioid small pits of 4-8 μm in diameter, with circular to oval apertures of 3-6.5 μm, and horizontal, diagonal, in superposed pairs, or triangular arranged. Transverse tracheids marginal or internal, of 6-32 μm high, outer walls wavy and smooth to slightly denticulate, without spiral thickenings, with 2-4 irregular disposed round pits of 6-8 μm in diameter and circular to elliptic apertures.

Macroscopic description

The studied samples were found in Ociu locality area, in Marinus Brook, in a volcano-sedimentary formation predominantly pyroclastic of Upper Badenian - Lower Sarmatian age, and is represented by two pieces of silicified wood, one of them (26350) representing a big trunk of 56/35/22 cm. The second of 10/5.5/4.5 cm, representing probably branch fragment. They are brown-gray to reddish or yellowish in color and fibrous texture. With naked eye or with a magnifying glass growth rings and the axial resin ducts can be seen, typical in some Pinaceae.

Microscopic description

Growth rings very conspicuous, thick of 105-160 cells, the early wood is 2/3; the transition is gradual, the final wood is represented by 2-7 flattened thick-walled cells. Normal axial resin ducts usually solitary are present inside the ring, especially in the transition wood and close to the boundary of the ring, determining it to be slightly undulate; they are circular or oval in cross section, with radial / tangential lumina diameter of 60-117-220 / 60-110-190 μm, and have 7-9(10) epithelial cells relatively thin-walled (1.5-3.5 μm double wall), in 1-2 layers, with longitudinal walls pitted, and often filled of resin. The radial resin ducts, usually circular, are of (22)28-84 / 30-80(98) μm in diameters, also with thin-walled epithelial cells and with dark content.

The tracheids have polygonal, mostly rectangular shape, with rounded corners, sometimes slightly irregular, determining rhombic or square intercellular spaces; the radial / tangential diameters of the lumina are of 20-70 / 20-60 μm, and the cellular wall of 3-5(8) μm (double wall); frequently very large tracheids intermingled between the normal ones; in the transition wood the smaller cell lumina are circular to slightly flattened; the frequency is of 460-713 tracheids on sq.mm. Tangential pitting is scarce, the pits are of 8-10(13) μm in diameter and round to vertical elliptic apertures, of 4-6 μm. Radial pitting is abiestine, with large borders sometimes radially ornate, of 15-23(28) μm in diameter, in a single vertical row arranged, rarely with horizontal contiguous pairs, or tending to alternate, smaller in the
late wood (8-14 μm in diameter), spaced or vertically contiguous, rarely separated by crassulae, having circular apertures of 6-10 μm in diameter, smaller and vertical elliptic in the late wood; sometimes in their lumina tracheidae and resin remains appear, and in the late wood, on some of the tracheids, there are oblique or crossing striations.

The axial parenchyma is usually absent, rarely in the longitudinal sections can be seen rectangular vertical cells with transverse walls relatively thick and slightly oblique, unpitted, smooth or nodular, rarely dentate. The tangential walls uncontracted, but radially seems to have rare small piceoid pits with oblique slit-like apertures. Resin content usually absent.

The medullary rays in cross section are constituted by rectangular cells to elliptic elongated, with dark content, and the horizontal walls small bored pitted; tangentially they have round to oval cells, sometimes laterally compressed, of 7.5-11 to 20-28 μm in diameter, some of them simple pitted; the rays are either uniseriate with frequent short biseriates, or biseriate of 2-9-14 cells high and the ducted rays have a fusiform aspect, of 18-20(35) cells high, the multisierate part of: 2-4 cells thick and the uniseriate terminations of 2-3 cells high; sometimes lateral intercellular, triangular spaces are visible; the density of 4-6 rays on tangential mm. Radially the rays show their heterogeneity: the parenchymatous procumbent cells of 20-25 μm high, with thin horizontal walls (1.5-3.5 μm double wall), smooth or slightly rugose, pitted and tangential walls of 1-3 μm, slightly rugose or nodular (6-7 nodules), even dentate and with indistinct or absent indentures; the cross fields present 1-3(4) small taxodioid pits, of 4-6(8) μm in diameter, with circular to oval apertures of 3-6.5 μm, horizontally or diagonally arranged, or in superposed pairs, sometimes triangular; the transverse tracheids usually marginally disposed, have 8-16 to 28-32 μm in height and the outer walls slightly wavy, without spiral thickenings, smooth or with small denticules to the inner part of the cell, with 2-4 round pits in the cross fields slightly flattened in the narrower tracheids, of 6-9 μm with circular or slightly elliptic apertures when flattened, and relatively irregularly arranged; with the same characters some tracheids appear among the parenchyma cells from the ray body; in the cross fields with the axial parenchyma there are 1-2 small simple pits, circular to oval of 4-7 μm in diameter, diagonally or horizontally arranged.

Affinities and discussions

The presence of the normal axial and radial resin ducts and their aspects was very important in the generic identification of our fossil woods, because it is known that only a correspondent of the extant Pinus, Pseudotsuga, Picea and Larix can be. Pinus have generally large axial ducts and the radial ones very typical. More than that, the epithelial cells are thin-walled, sometimes lysed. Epithelial cells thick-walled are found in Pseudotsuga (5-7 cells around the resin duct), in Picea (8-10) and in Larix (10-14). Our specimens present 7-9(10) epithelial cells around the ducts, not very thin-walled (1.5-3.5 μm double wall), so we started the comparison with some extant Picea species. Some similarities we found with P. engelmanni (PARRY) ENGELM. (Greguss 1955), especially because of the ornate borders of the radial pitting, and with P. maximowiczii REGEL, (Greguss 1955) that however has transverse tracheids with typical dentate thickenings. The comparison with some forms of Picea xylon already described by Hofmann (1952), Schönfeld 1956 in Privé & Brousse (1969), Petrescu & Dragstan (1971) and E. Samuel (in Donzé & al. 1971), was not satisfactory, showing details that are missing in our specimens, but firstly because of the different type of the resin ducts. In our specimens the axial resin ducts are very large, till 220/190 μm, and the radial tracheids have smooth walls or with small denticules to the inner face of the cell wall, more similar to the genus Pinus of Haploxylon-type, from the Groups Cembra, Aristata (Parraya), Masoniana, Radiata or Pinea (see Greguss 1955). The comparative study showed that the xylotomically most similar extant species is Pinus pinea L. The fossil forms of Pinuxylon described by Greguss in 1954, (Pinuxylon primum, secundum, and tertium), very similar to extant Pinus albicaulisoides (?), present cross fields with typical large pinoid pits, not seen in our specimens; Pinuxylon sp. described by Petrescu (1970) has rays of 4-8 cells high, and pinoid pitting in the cross fields. Pinuxylon sp. described by Combé et al. (1973) has fenestriform pinoid pitting in the cross field, different that in our specimens. P. nightigalense VOZENIN-SERRA 1971 (Vozenin Serra - 1971), seems to be closer by the structure of our studied specimens, having the axial ducts of 102-216/92-216 μm, taxodioid to ovoid pitting in the cross field, transverse tracheids usually marginal, with thin walls but without denticulations. P. parvifolias (GOTHAN) KRÄUSEL emend. VAN DER BURGH 1964 described by Privé (1976) seems also very close to our specimens, having radial pitting 1-2(3)-seriate, with crassulae and rays of 1-36 cells high. The same species described by Gotwald (1966), and is also similar. Pinuxylon sp. described by Privé-Gill et Wakefe (1980), very close to P. parvifolias seems to be very similar to the extant species Pinus pinea L., like our specimens are. So, the comparative analysis with the already described structures does not show an identity with them. It must be remarked the large axial resin ducts usually solitary in our specimens, the radial pitting uniseriate, with ornate borders spaced or contiguous, rarely in slightly irregular pairs, tending to biseriate alternate, the small taxodioid pits in the cross fields. For these reasons we decided that the studied specimens represent a new species that we named Pinuxylon marianii n.sp., after the origin site, Marinias Brook. We have designate as holotype the specimen nr. 26348, found now in G.I.R. Collection, Bucharest.

Holotype - G.I.R. Collection, specimen nr. 26350 and 3 slides.

Syntype - G.I.R. Collection, specimen nr. 26351, and 3 slides.

Locality - Ociu, Marinias Brook, Metaliferus Mts., Romania.

Horizon - Volcano-sedimentary Formation.

Age - Upper Badenian - Lower Sarmatian.

CONCLUSIONS

The reduced number of fossil trees identified till now in Prăvăleni-Ociu area, allows only partial estimations about the here buried vegetal association, and also about the paleoenvironment and paleogeography of this area, during the late Badenian and early Sarmatian. This association comprises some species of Taxodiaceae, Taxodiaceae Sequoioxylon, Pinuxylon, Magnoloxylon, Icacinoxylon, Lauroxylon, Perseoxylon, Juglandoxylon, Alnoxylon, Carapoxylon, Platanoxylon, Liquidambaroxylon, Paraphylanthoxylon, Piraneoxxylon described by Nagy & Mára 1969, Petrescu & Nutu 1970a,b, 1972.
lamandei 2000a,b,c. lamandei & lamandei 1998,1999. The majority of these trees claims a warm climate, there are even some tropical taxa between, and a part of them live no longer in Europe; we think that during the Middle Miocene there was a warm temperate climate (or warmer) and rather wet. It must observed that there are trees living on a firm ground, probably on the sunny slow slopes of the ancient Tâlăgiu Volcano, and the here described conifers suggest such a storying of the arboreal vegetation. Also it is good to note the eastern extent of the paleobiogeographic area of Tetracinoxyylon genus during the Middle Miocene; species of this genus were already described in the Upper Cretaceous from Turkmenistan; Oligocene, here in Romanian Middle Miocene and in the Pliocene from France, but the extant correspondent living now only in a very restricted area, in the North of Africa, the South extreme of Spain and Malta.

REFERENCES


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PLATES

Plate I
Figs. 1-9. Tetracliniodoxylon romanicum n.sp.
Figs. 1-3 - Cross section: growth rings, thick walled tracheids, rays; x75, x150, x300.
Figs. 4-6 - Tangential section: low rays, round ray cells; x75, x200.
Fig. 6 - Tangential section: tangential pitting; x300.
Fig. 7 - Radial section: radial pitting, striations; x300.
Figs. 8-11 - Radial section: radial pitting, striations, tracheids with rounded endings "leaning" on rays, cross fields; x75, x85, x85, x300.

Plate II
Figs. 1-6. Chamaecyparisclo fol. polonica (KRAUSEL) CHUDAJBERDYEV 1958
Fig. 1 - Cross section: growth ring, polygonal tracheids in the early wood; x50.
Figs. 2-3 - Tangential section: rays, parenchyma; x75, x250.
Figs. 4-6 - Radial section: cross fields, radial pitting, parenchyma; x50, x75, x250.

Plate III
Figs. 1-9. Sequoiodoxylon gypsaceum (GOEPP.) GREGUSS 1967
Figs. 1-3 - Cross section: conspicuous growth rings, thin walled tracheids in the early wood, thick walled tracheids in the late wood, parenchyma; x50, x200, x200.
Figs. 4-6 - Tangential section: rays, biserate ray, parenchyma with smooth horizontal walls; x50, x150, x150.
Figs. 7-9 - Radial section: radial pitting, crassulae, cross fields; x150, x200, x200.

Plate IV
Figs. 1-9. Pinusxylon marinai n.sp.
Figs. 1-3 - Cross section: growth rings, resin ducts, tracheids in the early and late wood; x50, x50, x75.
Figs. 4-5 - Tangential section: uniseriate and ducted rays, tangential pitting; x75, x150.
Figs. 6-9 - Radial section: striations, radial pitting, cross fields, transverse tracheids; x250, x250, x250, x150.