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SARMATIAN PETRIFIED WOOD WITHIN "BURSUC FLORA" (MOLDOVA REP.)

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Abstract: This paper presents the taxonomic identification of a piece of silicified fossil wood found within Bursuc locality area as *Tetraclinoxylon romanicum* IAMANDEI & IAMANDEI, 2000, completing the extract of the floristic association described here from Early Sarmatian deposits and known as "Bursuc Flora". The presence of the fossil woods has never been explicitly showed but it is quoted that Shilkina has identified two samples of fossil wood of *Pinus* type. The fragment of petrified wood here identified represents a fossil correspondent of *Tetraclinis*, and has been already described firstly within the Badenian Xyloflora from Zarand and than, in the Early Sarmatian from Suceava region, Romania. The presence of this species within "Bursuc Flora" is an absolute newness, extending its paleoarea much to East, and generally confirms the previous conclusions regarding the paleoenvironment and the paleoclimate of this NE region of Moldova Republic, during Sarmatian.

Keywords: Early Sarmatian, Bursuc Flora, *Tetraclinoxylon*, Paleoclimate.

INTRODUCTION

A silicified piece of fossil wood found in Bursuc area, on the right bank of Dniester River, has been studied and identified (Textfig. 1).

Textfig. 1. Localization of the studied material.

The geological context shows Tertiary deposits that in the North-Eastern part of Moldova Republic have been attributed to the Sarmatian and, based on mollusks fauna an early and a late part have been separated (Saianov *et al.*, in Negru, 1972, p. 9). Within Dniester Valley and other tributary valleys from this region, close to Bursuc area, the Early Sarmatian, (named Volynian = Volhinian) in three lithofacies occurs (Roşca, in Negru, 1972, p. 9): 1. calcareous, 2. marly-argillaceous and 3. sandy-argillaceous. The last twos similarly present diatomitic and pyroclastic levels.

From here, from the right bank of the Dniester River, a rich Sarmatian carpoflora was found, described and named by Negru (1972), "Bursuc Flora". He has identified a lot of new species (partially revised later, see Stefârță, 1997) of the folowing genera: *Salvinia* (megaspores), *Pinus, Sequoia, Taxodium, Cupressus, Juniperus, Carpinus, Comptonia, Myrica, Celtis, Morus, Eucomia, Pyracantha, Acer, Paliurus, Vitis, Ampelopsis, Cornus, Swida, Cotinus, Zantoxylum, Ailantus, Buxus, Staphylea, Hypericum, Decodon, Alangium, Aralia, Olea, Lycopus, Physalis, Solanum, Sambucus, Betula, Ficus, Rubus, Typha, Sparganium, Potamogeton, Ruppia, Alisma, Cladium, Polygonum, Polycnemum, Nymphea, Eoeuryale, Cleomella* and *Carpolithus* sp.div. This association was confirmed by similar identification in the same region, at Severinovka, in Kamenka brook, on the left bank of the Dniester, within similar geological deposits (see Roşca, in Negru, 1972, p. 13-14).

Interesting results in the same fossiliferous area of Bursuc have been obtained by studies of foliar imprints by Ştefârță (1968-1994), well presented within a synthesis of all the previous researches, in this fossiliferous site, by Stefârță (1997). She described and identified many form-species of: *Osmunda, Pteridium, Pinus, Sequoia, Taxodium, Cupressus, Juniperus, Thuja, Cephalotaxus, Castanea, Quercus, Carpinus, Ostrya, Comptonia, Myrica, Parrotia, Liquidambar, Carya, Symplocos, Eucomia, Bumelia, Populus, Salix, Sterculia, Ulmus, Hemiptelea, Zelkova, Celtis, Morus, Daphne, Sorbus, Photinia, Pyracantha, Rosa, Punica, Cer-*

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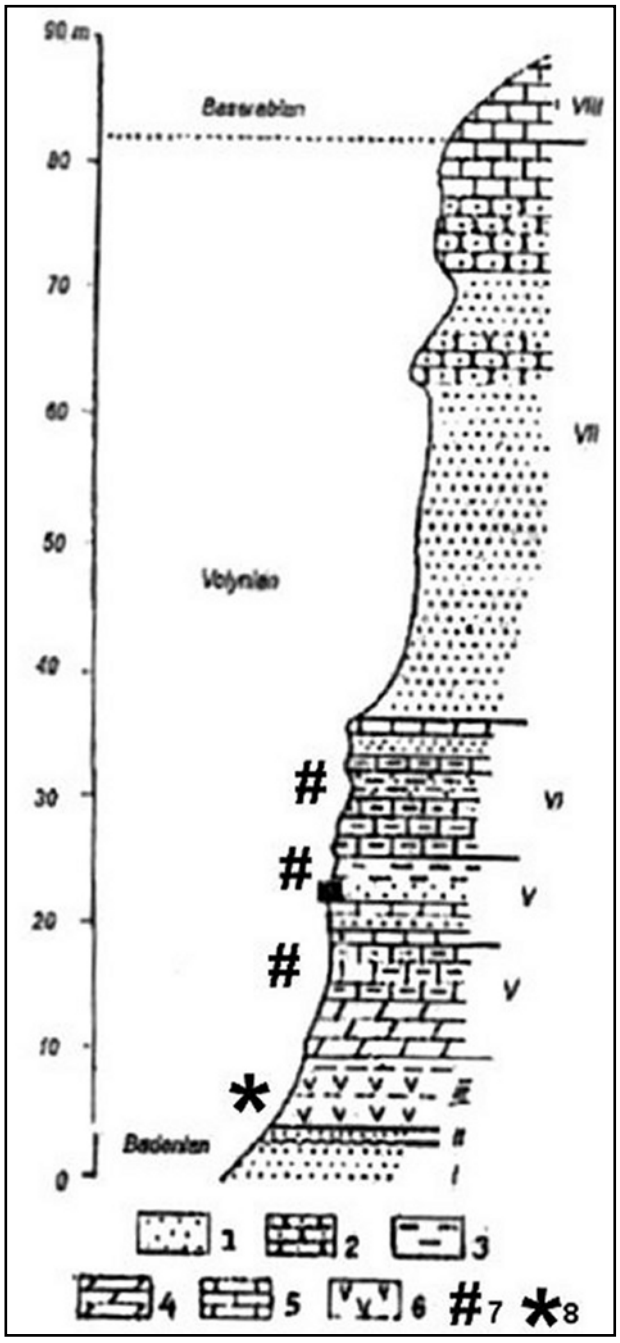
cis, Ceratonia, Gleditsia, Cedrela, Rhus, Berchemia, Hedera, Mastixia, Marsdenia, Periploca, Cocculus, Podogonium, Sapindus, Acer, Cedrela, Cotinus, Pistacia, Rhus, Berchemia, Ceanothus, Paliurus, Vitis, Ampelopsis, Cornus, Swida, Clematis, Berberis, Buxus, Mahonia, Phillyrea, Smilax, Dioscorea, Phragmites, Typha and *Chamerops.*

Taking into account those 71 form-species identified by Negru between 1968 and 1986, and the 90 form-species identified by Ştefârță between 1968 and 1994, all referring to 105 genera, it's concluded that Bursuc Flora represents the last phase of an "Oligocene-Miocene Chronoflora with *Mastixia"* that was already disappeared in the western part of East-Paratethys.



Textfig. 2. Section through Sarmatian deposits from Bursuc, in Râpa Nămălvii. (1-sand; 2-sandstone; 3-clay; 4-marl; 5-limestone; 6-volcanic ash; 7 -leaves, fruits imprints; 8 - fossil wood. (from Roşca & Cemîrtan, 2004, with modifications).

The percentage of the elements of this Flora shows: 32% for East-Asian types, 27% for North-American types and 16% for Mediterranean types (in Ştefârță, 1997).

The same author concludes that this association indicates a Mediterranean type of climate (warm temperate) with these probable parameters: MAT=15^{0}C, MAR=22^{0}C (between +25^0 and +3^0), precipitations ca. 1000 mm, similar to the extant West-Mediterranean type.

Even if the presence of fossil wood within this fossiliferous site is not explicitly noted, Negru (1972) qouted an identification of Shilkina of a "*Pinoxylon* sp. (*Cembra* sectio)" based on the study of two samples (correctly: *Pinuxylon*).

During his paleontological researches in this region, one of the authors has found fossil wood within the cineritic level from the basal part of Sarmatian succession from Bursuc, (see the geological section in Râpa Nămălvii in Textfig. 2).

From there, a large fragment of petrified fossil wood (see Textfig. 2) has been found. By paleoxylotomical study, we identified it as a coniferous wood belonging to the form-species *Tetraclinoxylon romanicum* IAMANDEI & IAMANDEI. This taxon was firstly identified in the Late Badenian xyloflora of Zarand (Iamandei & Iamandei, 2000) and was found again within Early Sarmatian deposits from Suceava region, Romania (Iamandei *et al.* 2001).

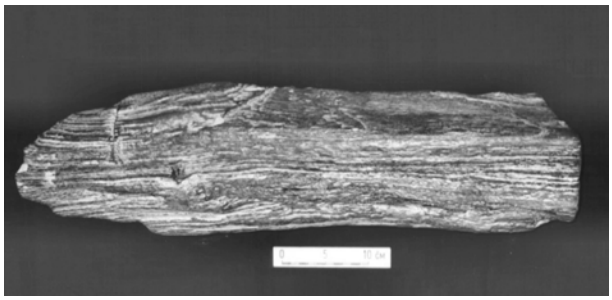
Since the extant equivalent, *Tetraclinis articulata* MAST., is living now in a very restraint area, within the extreme South of Spain, the North Africa and Malta (Greguss, 1955; Privé, 1973), the presence of this fossil form within "Bursuc Flora", firstly identified, extends its fossil area of life much to East and confirms the previous conclusions regarding the Mediterranean type of paleoenvironment and paleoclimate of the Northeastern part or Moldova Republic during the Early Sarmatian time.

PALEOXYLOTOMY

Family **Cupressaceae** RICH. (ex Bartling)
Genus *Tetraclinoxylon* GRAMBAST, 1951
Tetraclinoxylon romanicum IAMANDEI & IAMANDEI, 2000
Plate I, figs. 1 – 9.

Macroscopic description

The studied material originates in an Early Sarmatian (Volhinian) vulcano-sedimentary level from Bursuc, within the northeastern part of Moldova Republic, as a trunk-fragment preserving even the axial zone and has this size: 60/12/7 cm (see Textfig. 3).



Textfig. 3. General aspect of the specimen no. 26,722 from Bursuc.

The studied material and the standard slides are deposited in GIR Collection (located at the National Geological Museum from Bucharest), under the inventory no. 26,722.

Macroscopically the sample shows a light-beige color, a regular fibrous texture without vessels, thin rays and obvious annual rings, suggesting a coniferous wood.

Microscopic description

The growth rings are of variable thickness, between 9 and 61 rounded cells, gradually diminishing to the late wood that is represented by 3-5(7) rows of small cells, radially compressed and very thick-walled. Any resin ducts are absent.

The tracheids are round or rounded-polygonal in cross section, thick-walled to very thick-walled, of 6-10 µm the double wall, have round lumina sometimes slightly deformed, of 18-36/20-38 µm radial/tangential diameters. Their density is of 2250-2720 tracheids on sq. mm. that are disposed on 1-16 radial regular rows. The tangential tracheidal walls present, sometimes small abietinean pits of 12-14 µm with round to point-like apertures, usually spaced in a vertical row arranged. Radial pitting is well represented by uniseriate, rarely biseriate vertical rows of spaced or contiguous abietinean round pits of (13)16-21 µm in diameter with round apertures of 5-9 µm, smaller in the late wood, rarely equipped with small *crassulae*. Sometimes the tracheids show curved rounded endings. Granular resin remains or as plugs can be found inside the tracheid lumina and striations on the walls.

The wood parenchyma is scarce in cross section as disperse rounded cells, smaller than tracheids, not very thin-walled and with dark content. Vertically balls of resin can be seen inside their lumina and the horizontal walls are not very thin and slightly rugose or even feebly knotted.

The medullary rays, in cross section seen, show long, rectangular cells, probably pitted. Tangentially they are uniseriate, rarely with biseriated stories, have 1-25 cells high, frequently 6-14 and the cells are circular to elliptic with tangential walls probably pitted. The ray-density is of 9-17 rays on tangential horizontal millimeter. Radially the rays are obvious homocellular, constituted by procumbent parenchymal cells with smooth and not too thick horizontal walls. The tangential ones seem to be smooth to rugose (or feebly nodular?). The indentures are indistinct or absent. The procumbent cells are of 13-15 µm high, the marginals taller, of 17-19 µm high. The cross-fields have 1-3 cupressoid small pits of 3-4 µm with oblique slit like apertures, solitary disposed or in horizontal row, or in diagonal pairs, more numerous in the taller marginal fields, as superposed rows or vertical pairs.

Affinities and discussions

The xylotomical features of the studied material much agree with those of the **Cupressaceae** Family, especially from the **Callitroideae** group (Vaudois & Privé, 1971). However it is not perfect similitude because there is a feature specific to this group, the obvious presence of the callitroid thickenings that are missing in our studied specimen. Even in the fossil *Callitrixylon* PRIVÉ & BOUREAU, 1968, this specific character is present. However, not all the extant species of *Callitris* VENT. obviously present this character, for example *C. cupressiformis* VENT., *C. sulcata* SCHLECH., *C. oblonga* RICH., *C. intratropica* BENTH. & HOOK. that are devoid of (see Greguss, 1955, p. 90).

A fossil genus for this type of wood is *Palaeocallitroxylon* described by Greguss (1970) revising the species *Juniperoxylon silesiacum* KRÄUSEL & SCHÖNFELD. The described species *Palaeocallitroxylon limburgense* (KRÄUSEL & SCHÖNFELD) GREGUSS, 1970, has an almost identical structure with the extant species *Callitris drumondii* BENTH. & HOOK. (see Greguss 1955), having no juniperoid nodules and callitroid thickenings but having another special feature represented by tangential strands of parenchyma, well developed inside the growth rings, crossing many interradial wood fascicles, and this feature is absent in our material.

Another callitroideous extant genus without callitroid thickenings is *Tetraclinis* (VAHL.) MAST., a monotypic genus: *T. articulata* MAST., known as the only species living in North Hemisphere, in a very restraint extant area.

Comparing the xylotomy of our material with that of the extant form and with the few already described form-species of the corespondent fossil genus *Tetraclinoxylon* GRAMBAST, probably representing different evolutionary stages, we found many structural similitudes. Thus *Tetraclinoxylon boureaui* GRAMBAST, 1951, the generotype described from the Chattian of Paris Basin and *T. vulcanense* PRIVÉ, 1973, described from the Pliocene of Puy-de-Dôme (France), seem to be very similar with one another and also with the extant species, by the size and the distribution of the tracheids and of the parenchyma, by the aspect of the ray cells, differing however by the size of the tangential and radial pits, by the frequency of the *crassulae* and by the aspect of cross-fields. Our material has some similar features but does not seem to be identical.

The Pliocene form *T. vulcanense* PRIVÉ was identified by Sakala (2003) by the study on a Late Eocene wood from Kuclin, Czech Republic, innitially described as *Podocarpoxylon helmstedtianum* GOTTWALD by Brezinova *et al.* (in Sakala, 2003). It presents very similar cupressoid crossfield pitting and round thick-walled tracheids.

Other already identified species, *Tetraclinoxylon anglonae* BIONDI, 1979 and *T. lusitanense* (VALIN) SÜSS, 1997, come from regions close to the area of the extant taxon and are very similar with it.

Another species, *T. velizelos*i SÜSS, 1997, described from Late Oligocene-Early Miocene from Lesbos Island (Greece), has rounded tracheids in cross section, with abietinean radial pitting in 1 or in 2 rows arranged when opposite, and with *crassulae*. There are no callitroid thickenings. Wood parenchyma is sparse, with thin and smooth horizontal walls to feebly knotted. The high uniseriate rays (1-48 round cells) have sometimes biseriate stories and lateral intercellular spaces but no indentures. The cross-fields have 1-4 cupressoid pits with vertical to oblique slit-like apertures, in one row horizontally arranged. Even if it is very similar, our studied material does not perfectly agree with this combination of features.

However, the species *T. romanicum* IAMANDEI & IAMANDEI 2000, described from South Apuseni (Zarand Mts.), Romania, has a structure almost identical with the here studied specimen. Thus, like in the holotype, we observed growth rings variably sized with gradual transition and devoid of any resin duct. The tracheids are striated, thick-walled, with round lumina, slightly larger, of 18-36/20-38 µm the radial/tangential diameters and up to 2720 tracheids on sq. mm. Radial pitting abietinean of (13)16-21 µm apertures 5-9 µm, usually spaced or contiguous in 1(2) vertical rows, rarely with *crassulae*. Sometimes tangential pitting, smaller, of 10-12 µm. Parenchyma scarce, unpitted, horizontal walls thin, slightly rugose or feebly knotted. High uniseriate rays of 1-25 circular cells, 9-17 rays on sq. mm, homocellular, smooth horizontal walls, feebly knotted tangential walls, no indentures. Cells 13-15 µm high, marginals higher, cross fields with 1-3 small cupressoid pits, more numerous within taller marginal fields.

Since the features of the fossil wood from Bursuc, Moldova Republic, are almost identical with the original diagnosis of the species we decided that this material can be attributed to *Tetraclinoxylon romanicum* IAMANDEI & IAMANDEI, 2000.

CONCLUSIONS

The identification on xylotomical basis of a fossil form of *Tetraclinis*, within the Early Sarmatian Flora of Bursuc, together with the whole foristic association already identified by other kind of paleobotanic studies between 1968 and 1994 by Negru and by Ştefârță define a Mediterranean vegetation, locally maybe with aspects of Machia or Garriga types (Călinescu *et al.*, 1972; Baas, 1991; Ştefârță, 1997), with small trees and many bushy plants and herbs but with many mesophytic taxa also, representing probably the vegetation of deep valley (Țicleanu N., 2005, personal communication).

This association suggests a warm temperate paleoclimate (Wolfe, 1971) of mediteranean type (Ştefârță, 1997).

On the other hand, our present identification is very important because it pushed more to East the extension of the paleo-area of the species *Tetraclinoxylon romanicum* IAMANDEI & IAMANDEI initially identified within the Late Badenian from Zarand, found again within the Volhinian from Suceava region and in this paper identified within the Volhinian from the right bank of Dniester, at Bursuc.

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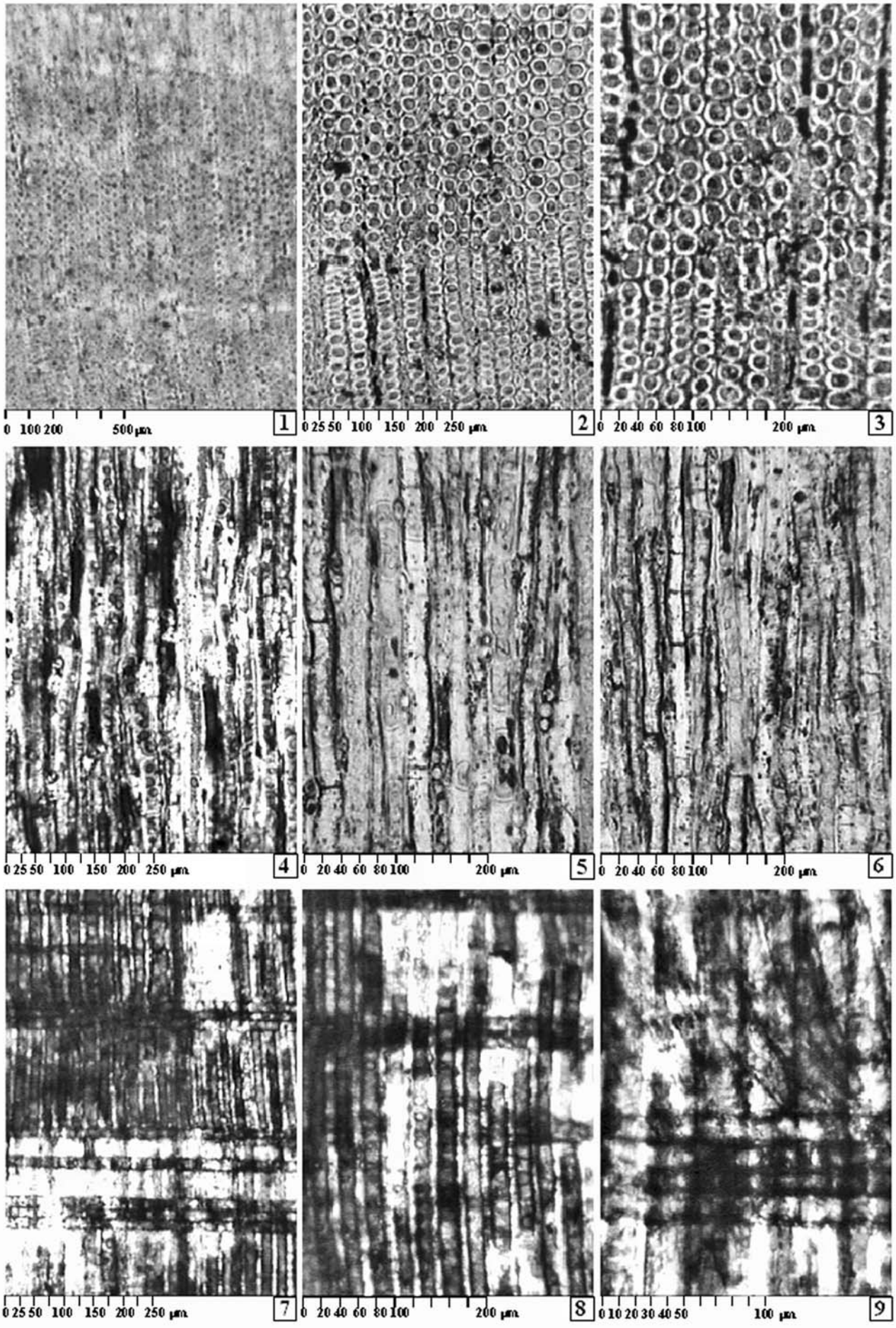
CAPTION OF PLATES
(graphic scale)

PLATE I
Figs. 1-9. *Tetraclinoxylon romanicum* IAMANDEI & IAMANDEI 2000, material.

Figs, 1-3. Cross-section, aspects of thick-walled tracheids, rays and scarce parenchyma.
Figs. 4-6. Tangential section, pitted tracheids bad preserved, rare parenchyma and uniseriate rays.
Figs. 7-9. Radial section, uniseriate pitted tracheids, badly preserved cross-fields.

PLATE I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