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# Zitteliana

Reihe A

Mitteilungen der Bayerischen Staatssammlung  
für Paläontologie und Geologie

43



MÜNCHEN 2003

Zitteliana

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43

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## HINWEIS DES HERAUSGEBERS

Vom Jahr 2003 an erscheint die Zeitschrift *Zitteliana* in zwei Reihen.

Die *Reihe A: Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-412X) ersetzt die bisherigen „Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0077-2070). Die Bandzählung (zuletzt erschienen: Heft 42, 2002) wird fortgesetzt.

Die *Reihe B: Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-4138) führt die bisherige „Zitteliana - Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0373-9627) fort.

Hinweise für Autoren beider Reihen sind am Ende dieses Bandes enthalten.

## EDITORIAL NOTE

Starting in 2003 the journal *Zitteliana* is published in two series.

The *Reihe A: Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-412X) replaces the former „Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0077-2070). The numbering of issues is continued (last published: Heft 42, 2002).

The *Reihe B: Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-4138) continues the previous „Zitteliana - Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0373-9627).

Instructions for authors are included at the end of this volume.



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# First record of a Lecythidaceae wood (*Carinianoxylon brasiliense* gen. et sp. nov.) from the Tertiary of the New World (Brazil, Rio Paranaíba)

By  
ALFRED SELMEIER

## ABSTRACT

A new fossil dicotyledonous wood is described from the Tertiary of Maranhão, Brazil. The anatomical structure of this wood is similar to that seen in species of the extant neotropical genus *Cariniana* CASARETTO (Lecythidaceae), of which some 15 species grow in the forests of Brazil today. Based on the close resemblance with regard to minute anatomy to species of *Cariniana* CASARETTO, the fossil is named *Carinianoxylon brasiliense* gen. et sp. nov. *Carinianoxylon* is the first xylem-

anatomical record of the Lecythidaceae for South America (Neotropis); hitherto, petrified wood remains assignable to this family were only known from Tertiary sediments in the Palaeotropis, e.g. India (Assam, Mahurzari, Madhya Pradesh, Pondocherry) and Myanmar (Birma).

**Key words:** Brazil, Deciduous tree, Lecythidaceae, Tertiary, wood anatomy.

## KURZFASSUNG

Am Ober- oder Mittellauf des Rio Paranaíba, im südöstlichen Gebiet des Staates Maranhão, Brasilien, wurden im letzten Jahrhundert 24 versteinerte Holzreste gesammelt. Die Feinstruktur des vorliegenden Fossils ist anatomisch fast identisch mit der neotropisch verbreiteten Gattung *Cariniana* CASARETTO, Familie Lecythidaceae. Die mikroskopische Struktur wird ausführlich beschrieben und das Fossil als *Carinianoxylon brasiliense* n. gen., n. sp. benannt. Die Bäume der Gattung *Cariniana* wachsen noch heute mit etwa 15 Arten in den Wäldern Südamerikas (Brasilien, Kolumbien, Venezuela). *Carini-*

*noxylon* nov. gen. ist der erste xylem-anatomische Nachweis eines versteinerten Holzrestes der Familie Lecythidaceae aus Südamerika (Neotropis). Mineralisierte Hölzer der Familie Lecythidaceae wurden bis heute nur in tertiären Schichten der Paläotropis gefunden: Indien (Assam, Madhya Pradesh, Mahurzari, Pondicherry) und Myanmar (Burma).

**Schlüsselwörter:** Brasilien, Holzanatomie, Laubbaum, Lecythidaceae, Tertiär.

## 1. INTRODUCTION

The Bavarian State Collection of Palaeontology and Geology, Munich, houses an old collection of 24 specimens of petrified wood from north-eastern Brazil. This collection was assembled in the 19<sup>th</sup> century by Mr. VON LUEDERS, and donated to the palaeobotanist Prof. KARL MÄGDEFRAU during the mid-1950s. An old label attached to one of the original boxes provides the following information in printed letters: „Fossile Baumstrünke und Äste aus Brasilien vom Ober- und Mittellauf des Rio Parahyba (Süd-Piauhy und Südost Maran-

hão) stammend in Ger (...) [öllen ?] und an einem kleinen Berghang, inmitten von (...) - stücken und quarzitischen [m ?] Geröll. – leg. v. Lueders“. „Rio Parahyba“ and „Piauhy“ are old names that were used in the 19<sup>th</sup> century. Today, these localities are known as „Rio Paranaíba“ and the state „Piau“, adjacent on the east side of Rio Paranaíba.

In this paper, the first sample of VON LUEDERS' petrified wood collection is described and discussed.



## 2. THE PETRIFIED *CARINIANA* WOOD FROM RIO PARANAIBA

Myrtales

Lecythidaceae

*Carinianoxylon* nov. gen.

Generic diagnosis: Growth rings distinct to indistinct. Vessels diffuse-porous, evenly distributed, small- to medium-sized, solitary or in radial multiples of 2-3-(6), occasionally occurs a tendency toward formation of tangential groups, 6-11 (mean 8) vessels per mm<sup>2</sup>, perforation plates simple; lumina with thin tyloses, intervessel pits alternate. Fibres moderately thick-walled. Axial parenchyma apotracheal in closely spaced tangential lines, 1-2 cells wide, forming a conspicuous reticulum with the rays; prismatic crystals in chambered axial parenchyma cells, long crystal-containing strands abundant. Rays 1-2-seriate, occasionally with uniseriate parts, homocellular, but with a tendency to become heterocellular, ray height 200-1780 (mean 552) µm; 9-11 rays per mm tangential.

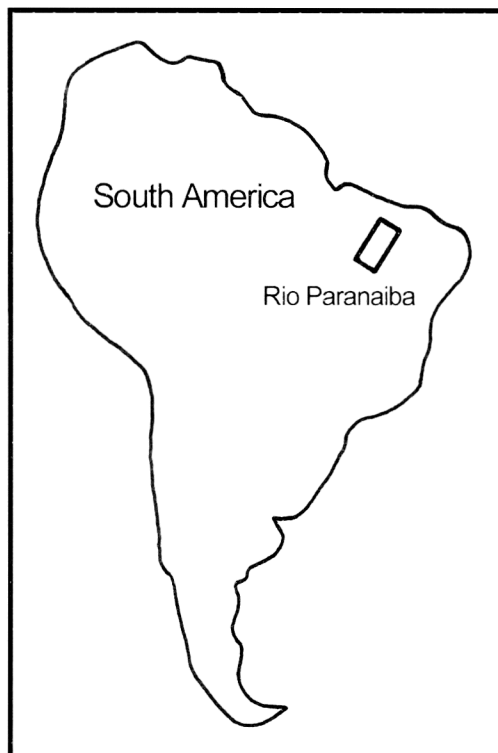


Fig. 1: Geographic position of the Rio Paranaiba, Maranhão, Brazil.

Type species: *Carinianoxylon brasiliense* sp. nov.

Etymology: The generic name indicates that the fossil displays significant anatomical features that have also been observed for the species of the extant genus *Cariniana* CASARETO. The specific epithet refers to Brazil, South America, the country where the fossil was discovered.

### 2.1 ANATOMICAL DESCRIPTION

*Carinianoxylon brasiliense* n. sp.

Fig. 2-5, Tab. 1-3

Locality: Upper to middle reaches of Rio Paranaiba, south-

eastern part of the state of Maranhão, Brazil (Fig. 1).

Geological age: Tertiary sediments. No further information available.

Material: Silicified and calcareous; length 21 cm, perimeter 32 cm. The color of the cut surface is yellowish-brown; 3 thin sections. Holotype: BSP 1964 XXV 39 deposited in the Bavarian State Collection of Palaeontology and Geology, Munich.

Description of the wood in accordance with the format given in the IAWA List of Features suitable for hardwood identifications (IAWA Committee 1989).

Minute anatomy: Secondary xylem of dicotyledonous wood; bark not preserved.

Growth rings barely distinct, recognizable through differences in vessel diameter between early- and latewood; seven growth rings, 2.4 - 4.3 (mean 3.0) mm wide.

Vessels diffuse-porous, evenly distributed, arrangement does not form a consistent pattern, macroscopically visible, vessels medium-sized, solitary and in radial multiples of 2-3-(6), a tendency toward formation of small irregular clusters can occasionally be observed, some multiples in diagonal orientation, solitary vessels oval to circular in cross-section, radial multiples generally flattened in the areas of vessels contiguous with the rays on both the sides; large solitary pores tangential 156-172 µm, small solitary vessels tangential 78-104 µm; large multiples tangential 182-273 (radial 442-496) µm, small multiples tangential 80-110 µm; vessel element length 84-364 (mean 225) µm; 7-9 vessels (early wood) and 10-14 vessels (latewood) per mm<sup>2</sup> (counting each vessel separately; WHEELER 1986); perforation plates simple; intervacular pits alternate, pits 5-7 µm, apertures slit-like ?; vessel element length 103-345 (mean 280) µm, thin-walled tyloses abundant. Vessel lumina often filled with numerous stratified quartz crystals.

Fibres non-septate, oval to circular in cross-section, arranged in radial rows between rays, diameter in cross-section 11-20 µm, relatively thick-walled, wall thickness ca. 3 µm, no pits observed.

Axial parenchyma abundant, conspicuous, in narrow bands or lines of up to three cells, reticulate, regularly spaced and forming a sort of network with the rays, distance between the rays is approximately equal to the distance between the parenchyma bands, ranging from 7-9-(11) bands per mm radial, separated by about 6-8 rows of fibres, bands or lines 1-2-seriate common, occasionally 3 cells wide, diameter of parenchyma cells in cross section 13-16 µm; vertical height in tangential view 82-158 µm, tangential about 20 µm; paratracheal parenchyma rare, occasionally a few parenchyma cells associated with the vessels.

Crystal-containing strands present, over eight cells per strand (feature 94, IAWA List 1989); strands with subdivided parenchyma cells, in tangential section constituting of continuous series of long units, locally biseriate, strands occur on the margins of the apotracheal bands (tangential view), each of the individual cells containing a single crystal; subdivided individual cells vertical 16-34 (tangential 13-16) µm.

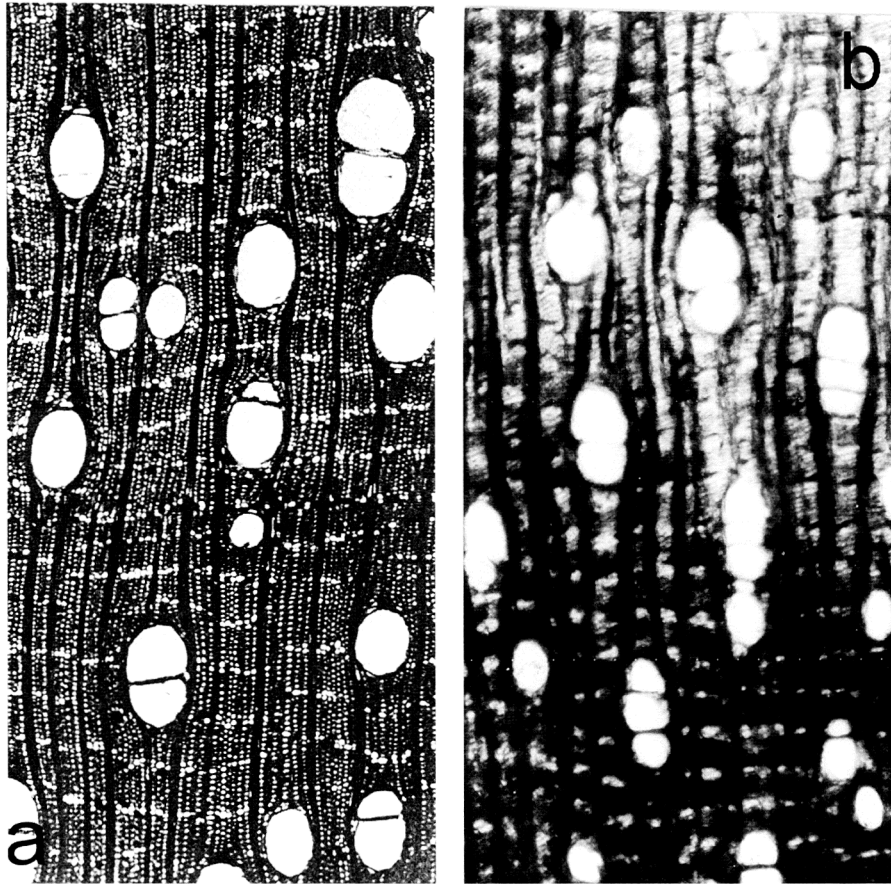
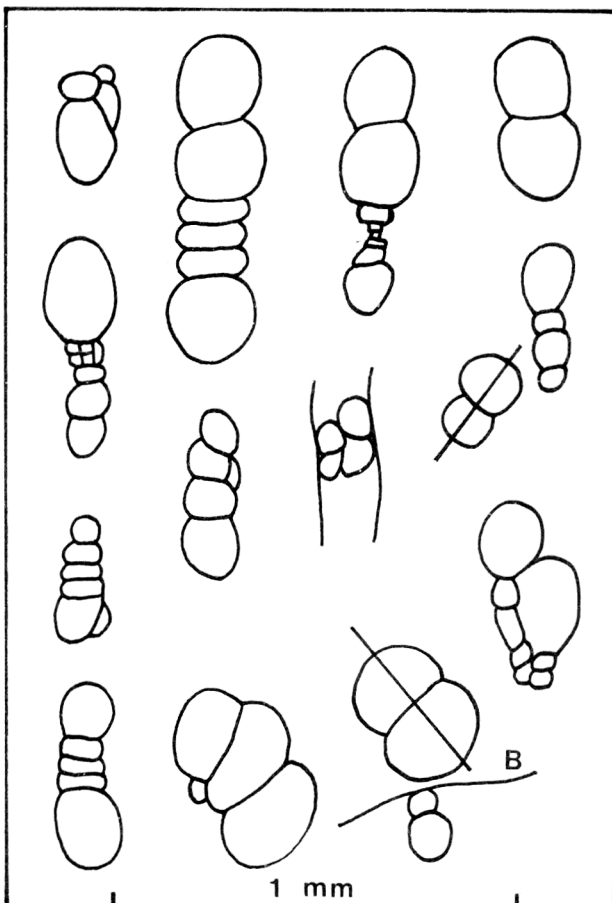


Fig. 2: Cross sections. – a: *Cariniana pyriformis* MIERS (WAGENFÜHR & SCHEIBER 1985), x 30. – b: *Carinianoxylon brasiliense* n. sp. x 45.



Rays predominantly 2-seriate, homocellular, 2-seriate rays sometimes marginal or in the middle section with uniseriate parts; ray height 208-1780 (mean 552)  $\mu\text{m}$ ; rays vertically 34 (2 cells)  $\mu\text{m}$ , 207 (10 cells)  $\mu\text{m}$ , 455 (24 cells)  $\mu\text{m}$ , 896 (52 cells)  $\mu\text{m}$ , 1241 (72 cells)  $\mu\text{m}$ ; individual ray cells vertical 17-19  $\mu\text{m}$ ; storied structure absent; (8) -9-11 per rays per mm tangential.

## 2.2 COMPARISON TO EXTANT WOOD TAXA

The conspicuous reticulate pattern formed by the apotracheal axial parenchyma and the rays, coupled with medium-sized vessels, solitary and multiples of 2-3, simple perforation plates, thin-walled tyloses, homocellular 2-seriate rays, and the occurrence of long, crystal-containing strands of cells in tangential view, permit assignment of this fossil wood to the family Lecythidaceae. Moreover, the crystalliferous cells that often occupy the complete length of the strand, and the locally biseriate strands in tangential view, represent two particularly characteristic features of the fossil that are also known to occur in species of the extant genus *Cariniana*. The wood structure of the fossil shows in nearly all microscopic details a clear resemblance to the genus *Cariniana* CASARETTO (trade names JEQUITIBA, ABARCO)..

Fig. 3: *Carinianoxylon brasiliense* n. sp., cross section. Examples of non-common vessel groupings. Vessels, rarely in multiples up to 6, occasionally with a tendency to form irregular small clusters, rarely in diagonal orientation. B = boundary of a growth ring.

Card key (BRAZIER & FRANKLIN 1961) of perforated cards for the petrified *Cariniana* wood from Rio Paranaíba: 6. 14. 33 (42). (43). 46. 54. 55. 62. 84. - (71, 81) are not applicable to fossil woods.

Comparison with microscope slides of extant wood: Detailed microscopic examination of the wood structure of various species of the Lecythidaceae was carried out to specify the nearest living equivalent to the fossil. Available Lecythidaceae genera in the XylotheC, Wood Research Institute, Technical University Munich (STERN 1988) are: *Asteranthus* (Brazil, 10 specimens), *Barringtonia* (Africa, 2), *Cariniana* (Brazil, 3), *Combretodendron* (Ivory Coast, 10), *Couratari* (South America, 14), *Couropita* (Surinam, 4), *Cytromia* (Brazil, 2), *Eschweilera* (Brazil, 15), *Gustavia* (Brazil, 4), *Lecythis* (Brazil, 12), *Petersia* (Africa, 8), *Petersianthus* (Philippines, 5), *Planchonella* (Philippines, 4), *Planchonia* (Philippines, 5).

Comparison with literature data: Descriptions and/or microphotographs (GREGORY 1994) of the wood structure of Lecythidaceae species: *Cariniana legalis* (MARTIUS) KUNTZE (BRAZIER & FRANKLIN 1961, KRIBS 1959, SCHMIDT 1951/52); *C. multiflora* DUCKE (DETIENNE & JACQUET 1983), *C. pyriformis* MIERS (DETIENNE & JACQUET 1983, ILIC 1991, KRIBS 1959, WAGENFÜHR & SCHEIBER 1985). Moreover, descriptions of the anatomy of *C. brasiliensis* CASARETTO, *C. estrellensis* (RADDI) O. KUNTZE, *C. integrifolia* DUCKE, genera *Couratari*, *Couropita* (RICHTER 1982), *Allantoma*, *Grias*, *Gustavia* (PARAMESWARAN & RICHTER 1984) and other extant taxa (CARLQUIST 2001, DIEHL 1935, METCALFE & CHALK 1950) were also consulted.

Comparison with codes: Card key (microscopic features) using the Copeland Chatterson type of perforated cards (BRAZIER & FRANKLIN 1961): *Cariniana legalis* (MARTIUS) KUNTZE: 6. 14. 33. (36). 42. 43. 46. 47. 54. 55. 62. 64 r. 71. 81. 84.

The significance of microstructural features (e.g. parenchyma distribution, type of inorganic contents, such as silica or Ca-oxalate crystals) in genera of Lecythidaceae have been evaluated with regard to their diagnostic value by RICHTER (1982) and PARAMESWARAN & RICHTER (1984). *Cariniana* is accorded an intermediate position close to *Couratari* and allied genera (Tab. 1).

Comparisons of the thin sections and anatomical descriptions of modern Lecythidaceae to the fossil indicate that the latter is structurally very similar to the extant species of *Cariniana* CASARETTO; the significant microscopic features correspond perhaps most closely to *Cariniana pyriformis* (MIERS) described by EBERHARDT SCHMIDT (1951-1952) and WAGENFÜHR & SCHEIBER (1985). The abundance of long, chambered crystalliferous strands is a characteristic feature of the New World (Neotropis) genera of the Lecythidaceae (Tab. 1), but is absent in those taxa (with the exception of *Foetida*) that occur in the Old World (Palaeotropis). Since the fossil wood from Brazil is very similar to that seen in the species of *Cariniana* CASARETTO (Tab. 2), it here is proposed to place it in a new form genus, for which the name *Carinianoxylon* nov. gen. is introduced, type species *C. brasiliense* n. sp.

Anatomy of Brazilian recent woody flora: Growth

Lecythidaceae		
Neotropical subfamily Lecythidoideae		Old World family Lecythidaceae
Group A genera	Group B genera	Genera
<i>Allantoma</i>	<i>Couropita</i>	<i>Abdulmajidia</i> <i>Asteranthus</i>
<i>Bertholletia</i>	<i>Grias</i>	<i>Barringtonia</i> *) <i>Careya</i> *)
<i>Cariniana</i> *)	<i>Gustavia</i>	<i>Chydenanthus</i> <i>Crateranthus</i>
<i>Couratari</i>		<i>Foetidia</i> <i>Napoleonaea</i>
<i>Corytophora</i>		<i>Petersianthus</i> <i>Planchonia</i>
<i>Eschweilera</i>		
<i>Lecythis</i>		
*) Intermediate A/B position although close structurally to <i>Couratari</i>		*) Seven mineralized wood samples described from India and Myanmar assigned to <i>Barringtonioxylon</i> nov. gen. and <i>Careyoxylon</i> nov. gen. by Indian authors (AWASTHI, BANDE, PRAKASH, et al.)
Crystal-containing strands with chambered parenchyma cells present		Crystal-containing strands with chambered parenchyma cells absent (except <i>Foetidia</i> )

Tab. 1: Anatomy of secondary xylem. - Microscopical differences of New and Old world families of Lecythidaceae according to DIEHL (1935) and RICHTER (1985).

rings and qualitative vessel features of the 22 most representative families of woody plants in Brazil (133 genera and 491 species), including two members of the genus *Cariniana*, i.e. *C. estrellensis* and *C. legalis* (Tab. 3), were analysed by ALVES & ANGYALOSSY-ALFONSO (2000).

The presence of growth rings in some 48 % of the Brazilian taxa demonstrates that the wood of many tropical species possesses an anatomical growth marker. Of all Brazilian species, 84 % are diffuse-porous. Trees are generally more likely to show vessels in multiples (clustering strategy) at higher latitudes and in environments where stronger oscillations in temperature and humidity occur. It is believed that the clustering of vessels improves the hydraulic conduction properties, which may be especially beneficial for the trees during periods of physical or physiological drought. Small vessel clusters do also occur in the fossil wood from Rio Paranaíba. Simple perforation plates were found by ALVES & ANGYALOSSY-ALFONSO (2000) in 95 %, but helical thickenings in only 2 % of the species.

### 2.3 COMPARISONS TO FOSSIL WOOD TAXA

Seven species of fossil wood that are considered to be related to the Lecythidaceae have been described to date from Tertiary localities in the Old World; these include *Barringtonioxylon deccanense* (SHALLOM, 1960), *B. eopectocarpum* (PRAKASH & DAYAL, 1964), *B. arcotense* (AWASTHI, 1969), *B. assamicum* (PRAKASH & TRIPATHI, 1970), *B. mandlaensis* (BANDE & KHATRI, 1980), *Careyoxylon kuchilense* (PRAKASH & TRIPATHI, 1970), and *C. pondicherriense* (AWASTHI, 1969, PRAKASH & BANDE, 1977). It is interesting to note that the



Anatomical features	<i>Cariniana brasiliensis</i> CASARETTI	<i>C. legalis</i> KUNTZE	<i>C. multiflora</i> DUCKE	<i>C. pyramidalis</i> MUESS	<i>Carinianoxylon</i> nov. Gen. Rio Paranaiba
<b>Growth rings</b>					
indistinct to distinct	+	+	+	+	+
<b>Vessels</b>					
diffuse porous	+	+	+	+	+
solitary or multiples 2-3	+	+	+	+	1; 2-3 (6)
tangential diameter 130-160 µm	+	+	+		
tangential diameter > 200 µm				+	156-273 µm
perforation plates simple	+	+	+	+	+
intervessel pits alternate, 7-11 µm	+	+	+	+	+
tyloses abundant	+	+	+	+	+
vessel number per sq. mm, 5-10; fossil wood: counted each vessel	+	+	+	< 5	6-11, mean 8
<b>Fibres</b>					
pits simple	+	+	+	+	?
<b>Axial parenchyma</b>					
apotracheal	+	+	+	+	+
tangential bands 1-2 seriate	+	+	+	+	1-2 (3) seriate
bands per mm radial 6-7	+	+	+	+	7-9
strands with solitary crystals, chambered strands	+	+	+	+	+
<b>Rays</b>					
large	+	+	+	+	up to 1.8 mm, mean 552 µm
2 (3) seriate	+	+	+	+	+
homocellular (+/-)	+	+	+	+	+
silica deposits		+		+	?
vessel-ray pits similar intervessel pits	+	+	+	+	?
7-9 rays per mm	+	+	+	+	(8)-9-11

Tab.2: Comparison of anatomical features of extant species of *Cariniana* CASARETTO, Lecythidiaceae, and the wood structure of *Carinianoxylon* nov. gen. from Rio Paranaiba.

	<i>C. estrellensis</i>	<i>C. legalis</i>	Silicified <i>Cariniana</i>
<b>Brazilian regions</b> (right)	Southern, Southeastern	Northeastern, Southeastern	Northeastern
<b>Wood features</b>			
growth rings	absent	present	present
vessel arrangement	diffuse	diffuse	diffuse
vessel grouping	solitary and multiples	solitary and multiples	solitary and multiples
perforations plates	simple	simple	simple
helical thickenings	absent	absent	absent
<b>Environmental features</b>			
climate	tropical	tropical	tropical ?
temperature	warm	warm	warm ?
humidity	humid	humid	humid ?
altitude	0-100 m	0-200 m	unknown
vegetation	dense forest	semi-deciduous seasonal forest, open forest	unknown

Tab. 3: Qualitative wood characters related to environmental features of *Cariniana estrellensis* and *C. legalis* in comparison with *Carinianoxylon brasiliense*. from Rio Paranaiba, Brazil. Parameters from extant species according to ALVES & ANGYALOSSY-ALFONSO (2000).

reports come exclusively from India and Myanmar (Birma). The extant genus *Barringtonia* FORSTER occurs scattered from the tropical regions of Africa through the Indo-Malayan region to Taiwan, northern Australia, and Polynesia. Species of *Careya* ROXBURGH are widely distributed in India, China, with some

forms also occurring in Sri Lanka. However, with regard to anatomy, the fossil wood from Rio Paranaiba does not resemble *Barringtonia* or *Careya*. Rather, the latter taxa differ in many anatomical details (e.g. ray structure, crystal-containing axial parenchyma strands) from *Carinianoxylon*.

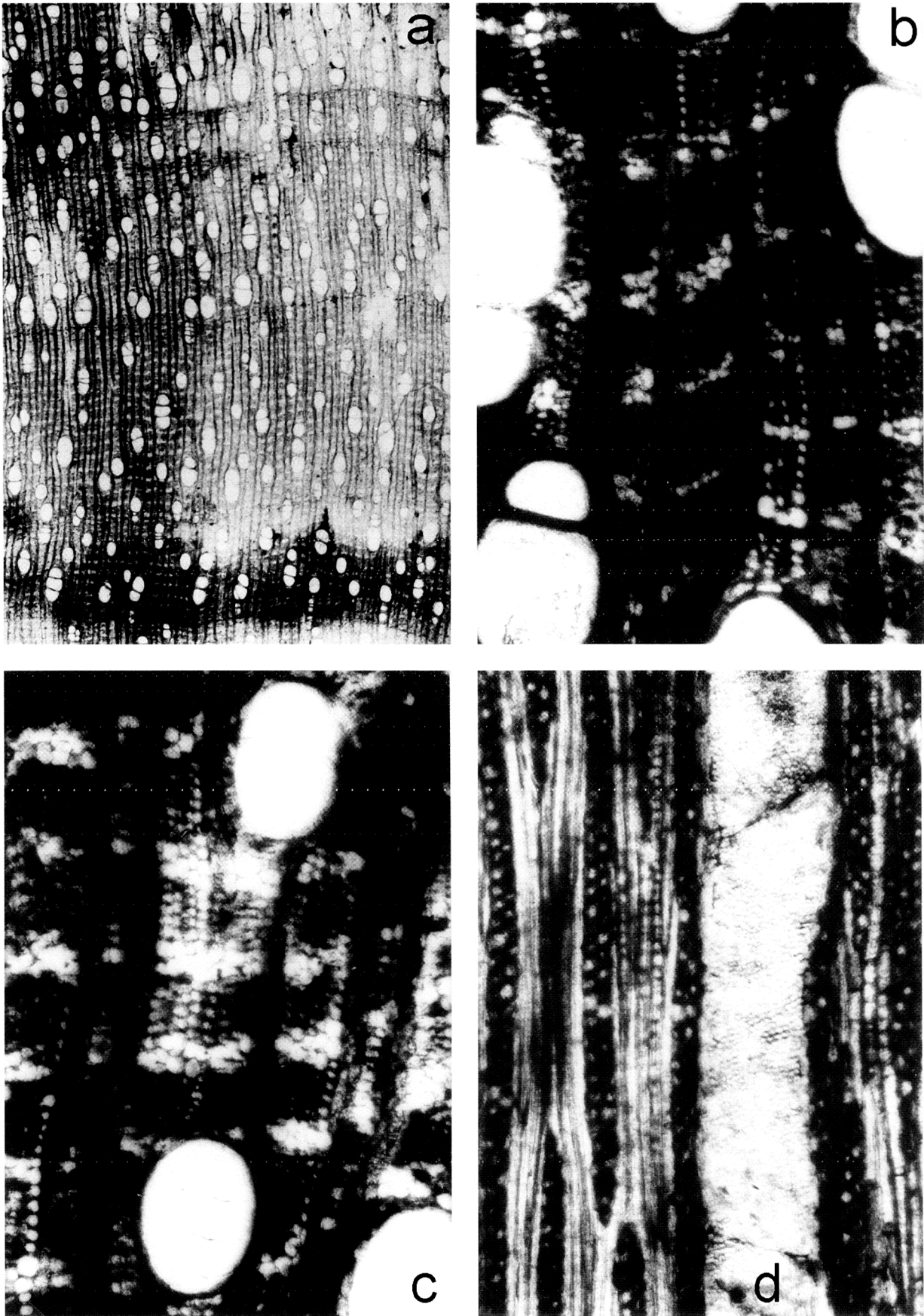


Fig. 4: *Carinianoxylon brasiliense* n. sp. – a - c: cross sections. – a: indistinct growth ring boundaries, vessels evenly distributed, tangential parenchyma bands form a reticulum with the rays. x 10. – b: axial parenchyma apotracheal in tangential bands, partly indistinct visible as a result of mineralisation processes. x 120. – c: tangential parenchyma bands 1-2-(3)seriate, 5-8 rows of thin-walled fibres between two parenchyma lines in radial direction. x 130. – d: tangential section. Vessel with simple perforations and alternate intervessel pits, rays 1-2seriate. x 130.

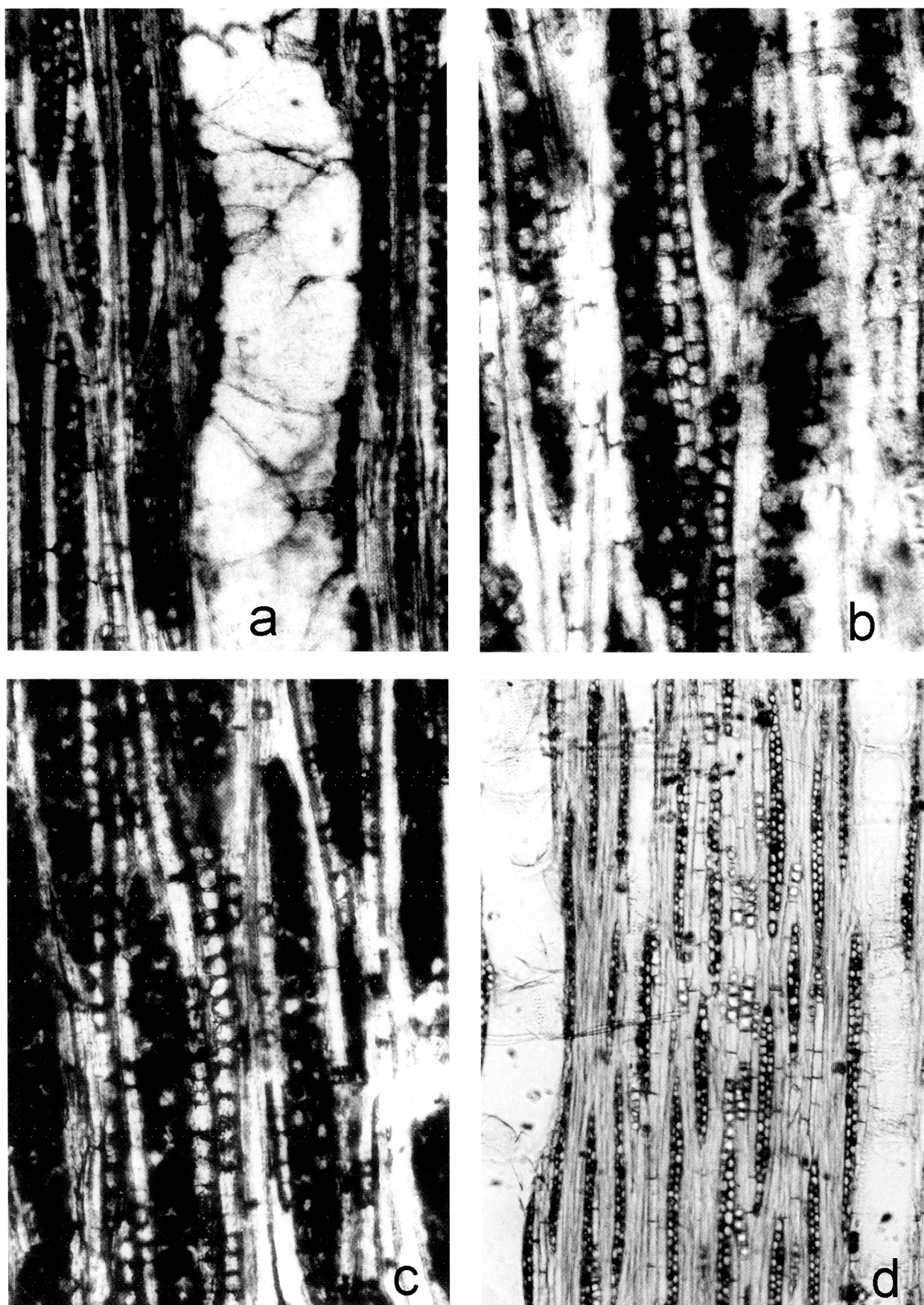


Fig. 5: Tangential sections. a – c: *Carinianoxylon brasiliense* n. sp. – a: vessel with abundant thin-walled tyloses and numerous 1-2-seriate rays. x 140. – b: two-seriate crystal-containing chambered parenchyma strands visible in a long vertical distance. x 190. – c: prismatic solitary crystals in uni-seriate chambered parenchyma cells. x 190. – d: tangential section of *Cariniana pyriformis* (RAKF No.1178, Robledo 1) for comparison. Vessels with thin-walled tyloses, rays 1-2-seriate, crystal-containing axial parenchyma strands with chambered cells. x 140.

### 3. LECYTHIDACEAE

The members of the Lecythidaceae are small to exceptionally large trees, widely distributed in tropical regions on both hemispheres; the timber is of some commercial importance. Best known products are the so-called "Brasil nuts" of *Betholletia excelsa* and *Supucaia* (paradise nuts), produced by *Lecythis paraensis*.

The Eocene, about 55-34 million years ago, represents an intermediate between the present-day and the initial radiation

of angiosperms in the Early Cretaceous. No wood remains of Lecythidaceae have been reported to date from the famous European Eocene locations of Geiseltal, Messel, or the London clay. One of the most diverse fossil plant assemblages (145 genera, 173 species) with fruits, seeds, leaves and more than 700 wood samples is the Eocene Nuts Bed Flora of the Clarno Formation, Oregon, USA. However, even from this exceptionally rich flora, representatives of the Lecythidaceae have not been reported to date (WHEELER & MANCHESTER 2002).

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