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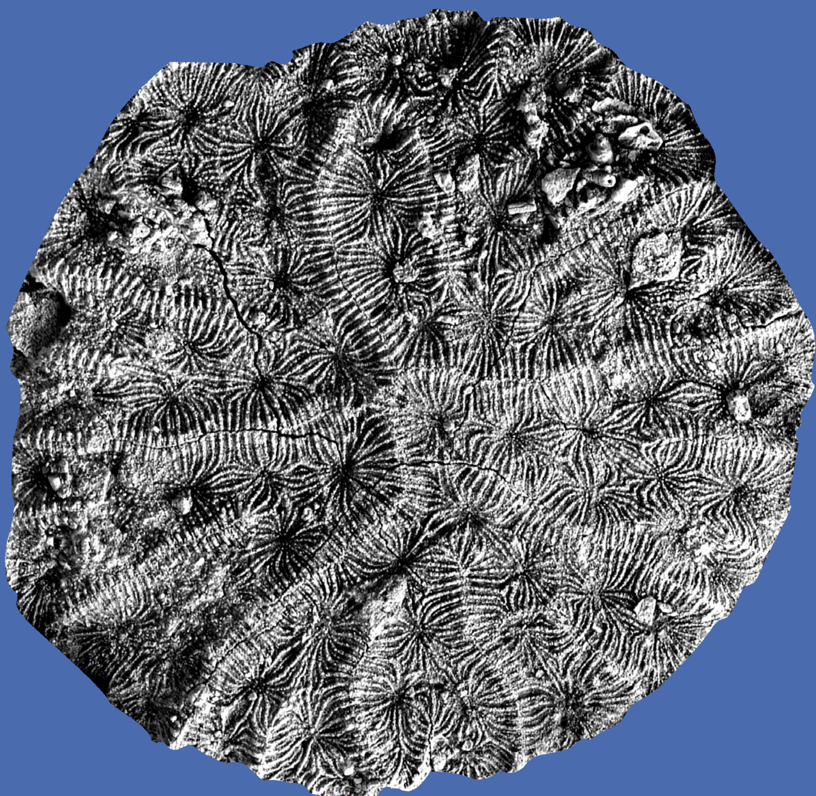

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Cover Illustration: Coral *Collignonastraea meandra* (d´Orbigny, 1850) from the Toarcian (Lower Jurassic) of the Kuh-e-Shisui area (Iran); PIW2004III 40. For details see Pandey & Fürsich: Jurassic corals from the Shemshak Formation of the Alborz Mountains, Iran, pp. 41-74 in this issue.

Umschlagbild: Koralle *Collignonastraea meandra* (d´Orbigny, 1850) aus dem Toarcium (Unterjura) der Gegend um Kuh-e-Shisui (Iran); PIW2004III 40. Für weitere Infomationen siehe Pandey & Fürsich: Jurassic corals from the Shemshak Formation of the Alborz Mountains, Iran, S. 41–74 in diesem Heft.

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A silicified wood from the church of St. Laurentius in Zeholfing (Bavaria, Germany) – an unusual link between archeology and paleontology

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Abstract

A silicified wood specimen of *Cedreloxylon cristalliferum* Selmeier, 1987, is described from an archeological site in southern Germany. The wood was found in a late 11th century church foundation. The circumstances of this discovery illustrate that the church builders did not recognize the nature of this piece of rock. The geologic age of the wood is probably Miocene. Based on the well-preserved cellular structure a specific determination is possible. Comparison with extant relatives of *C. cristalliferum* provides insights into the climatic conditions that existed during the life of this plant.

Key words: *Cedrela*, Miocene, wood anatomy

Kurzfassung

Ein fossiles Kieselholz der Art *Cedreloxylon cristalliferum* Selmeier, 1987 aus einer archäologischen Grabungsstelle in Süddeutschland wird beschrieben. Es wurde bei der Verlegung eines Kirchenfundamentes im 11. Jahrhundert verwendet. Die Fundumstände zeigen, dass den Erbauern die besondere Beschaffenheit des Gesteinsstückes nicht bewusst war. Ein miozänes Alter des Holzes gilt als wahrscheinlich. Aufgrund der gut erhaltenen Zellstruktur ist eine Artbestimmung möglich. Der Vergleich mit rezenten Verwandten der Art gibt Hinweise auf die klimatischen Bedingungen, die geherrscht haben als diese Pflanze gelebt hat.

Schlüsselwörter: *Cedrela*, Miozän, Holzanatomie

1. Introduction

Interdisciplinary collaboration between archeologists and paleontologists is relatively common today. For example, paleontologists are often asked by archeologists to examine remains of prey, domestic animals, or crop of ancient cultures. On the other hand, archeologists may confirm the stratigraphy of fossiliferous Pleistocene localities by dating the artefacts. However, in the here presented case, the circumstances have to be regarded as somewhat unusual.

In 1999, an archeological excavation was carried out in the church of St. Laurentius in Zeholfing (District Dingolfing-Landau, Bavaria, Germany). During the detailed examination of an approximately 900 year-old ancient foundation, consisting of boulders and calcareous tufa blocks, a piece of silicified wood was discovered. Preliminary studies revealed that the internal anatomy was well-preserved. As a result, a more detailed examination appeared to be of interest for both archeologists and paleontologists. For the archeologists, it was interesting to resolve from where the builders of the church floor collected their material. The taxonomical identification of the specimen and paleoecological information contained in the wood were of interest for paleontology.

2. Material and methods

The village of Zeholfing is located in Lower Bavaria, aside the river Isar, some 120 km ENE of Munich (Fig. 1). In 1999, the Diocesal Architectural Office at Passau initiated the restoration of the Zeholfing church, which included the removal of several floor layers down to a depth of approximately 90 cm. In order to save the archeological information contained in the ground inside the church an archeological excavation accompanied the restoration. The archeological results of the excavation were both astonishing and of great significance. More than 150 grave sites of different epochs were discovered, and interesting artefacts unearthed (see Eibl 2001 for detailed information).

In the apse area, an ancient 11th century foundation was discovered that was constructed of limestone boulders, each

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of which 30 cm and more in diameter, and calcareous tufa square stones; among these rocks was a segment of a fossilized stem. This stem segment is preserved as a silicified cellular permineralization.

A first set of thin sections was produced by Dr. J. Gregor (Olching), and the wood was tentatively assigned to the genus *Cedreloxylon* Selmeier, 1987 by Prof. H. Gottwald (Hamburg). Later, a second set of sections was produced in order to more fully examine the specimen. A diamond saw was used to cut thick sections (wafers) of transverse, longitudinal tangential, and radial surfaces. Thin sections were prepared using a Logitech LP 50 grinding machine. The anatomical details were analyzed by transmitted light microscopy (cf. Hass & Rowe 1999). The description of the fossil generally follows the list of microscopic features for hardwood identification as recommended by the IAWA Committee (1989). Images were taken with a Zeiss Ultraphot analog camera.

Figure 1: Geographical position: The village of Zeholfing is located in Lower Bavaria, ~120 km ENE of Munich.

3. Systematic paleontology

Order Rutales
Family Meliaceae

Genus *Cedreloxylon* Selmeier, 1987

Cedreloxylon cristalliferum Selmeier, 1987
Figs 2, 3

Age and horizon: ?Miocene; discovered in a 11th century church foundation.

Material: Silicified wood sample; measurements: l = 39 cm, w = 10 cm, Ø = 28 cm. Three slides with thin sections; area of cross section = 4.7 x 3.2 cm.

The hand specimen and thin sections are deposited in the paleobotanical collection of the Bayerische Staatssammlung für Paläontologie und Geologie in Munich (Germany) under accession numbers BSPG 2002 XIII 225a–d.

Description: Secondary xylem of dicotyledoneous wood, bark and pith missing. Preservation of wood structure in cross section fairly good; tangentially compressed; longitudinal sections only locally with recognizable wood structure.

Growth rings pronounced, large wood pores visible by the naked eye in thick sections of transversely, tangentially, as well as radially cut surfaces. Zone of up to 5–6 layers of large springwood pores at the growth ring boundaries; porous zones form conspicuous straight stripers in the radially cut surface; growth ring boundaries also characterized by 2–3 rows of radially flattened latewood fibres and profound differences in vessel diameter between late- and earlywood of subsequent rings; width of the 9 growth rings 2.5–6.7 (mean 4.8) mm.

Vessels variable in size, wood ring-porous; outline of the large vessels usually blurred by tangential deformation; commonly abrupt transition to the latewood of the same growth ring; earlywood vessels solitary and in radial multiples of 2(–3); vessels form a well-defined zone with 3–5 layers; diameter of solitary vessels tangential : radial (186–207) : (269–331) µm, diameter of radial multiples of two, tangential : radial (204–262) : (415–517) µm, multiple vessels with three pores tangential 220 µm, radial 524 µm; latewood vessels solitary, e.g., tangential 70 µm, radial 110 µm, radial multiples (2–6) common, formation of small vessel clusters locally observable; tangential diameter of latewood pores 48–89 µm, radial 124–180 µm; perforations exclusively simple; nearly horizontal to oblique; springwood vessel elements mean 388 (138–483) µm, vessels truncate or abruptly tailed on one or two ends, thin-walled; intervessel pits crowded, alternate, polygonal in outline with included slit-like horizontal apertures, 6–7 µm; vessel-ray pits presumably similar in size and shape to intervessel pits but not clearly recognizable, helical thickenings absent, many vessels plugged with reddish-brown gum deposits, dumb-bell-shaped deposits often occlude the perforations in tangential view; tyloses absent. Fibres non-septate, 3–15 radial rows between two rays, relatively thick-walled, polygonal or quadratic in cross section, ~14 µm in diameter; pits not recognizable. Axial parenchyma scanty paratracheal, terminal and diffuse, 1–2-cell-wide sheats around the vessels common, larger parenchyma between the early springwood vessels, diameter of parenchyma cells in transverse section ~21 µm, vertically 35–71 µm, radially 35–49 µm, vertically up to 70 µm.

Rays of two sizes occur: 1) uniseriate rays, rare, composed of quadratic to upright cells, 4–10 cells high; 2) multiseriate rays, weakly heterocellular, commonly 2–3 cells wide, e.g., height 7–33 (186–759 µm) cells, some rays with short uniseriate rows of marginal cells, total ray height up to 700 µm, uniseriate rays, e.g., 4 cells (140 µm), or total heigth of 25 cells with 10 cells uniseriate; multiseriate rays composed of procumbent, square-like and upright cells; procumbent ray cells vertically 27 µm, marginal ray cells 34–56 µm. Solitary rhomboid crystals in

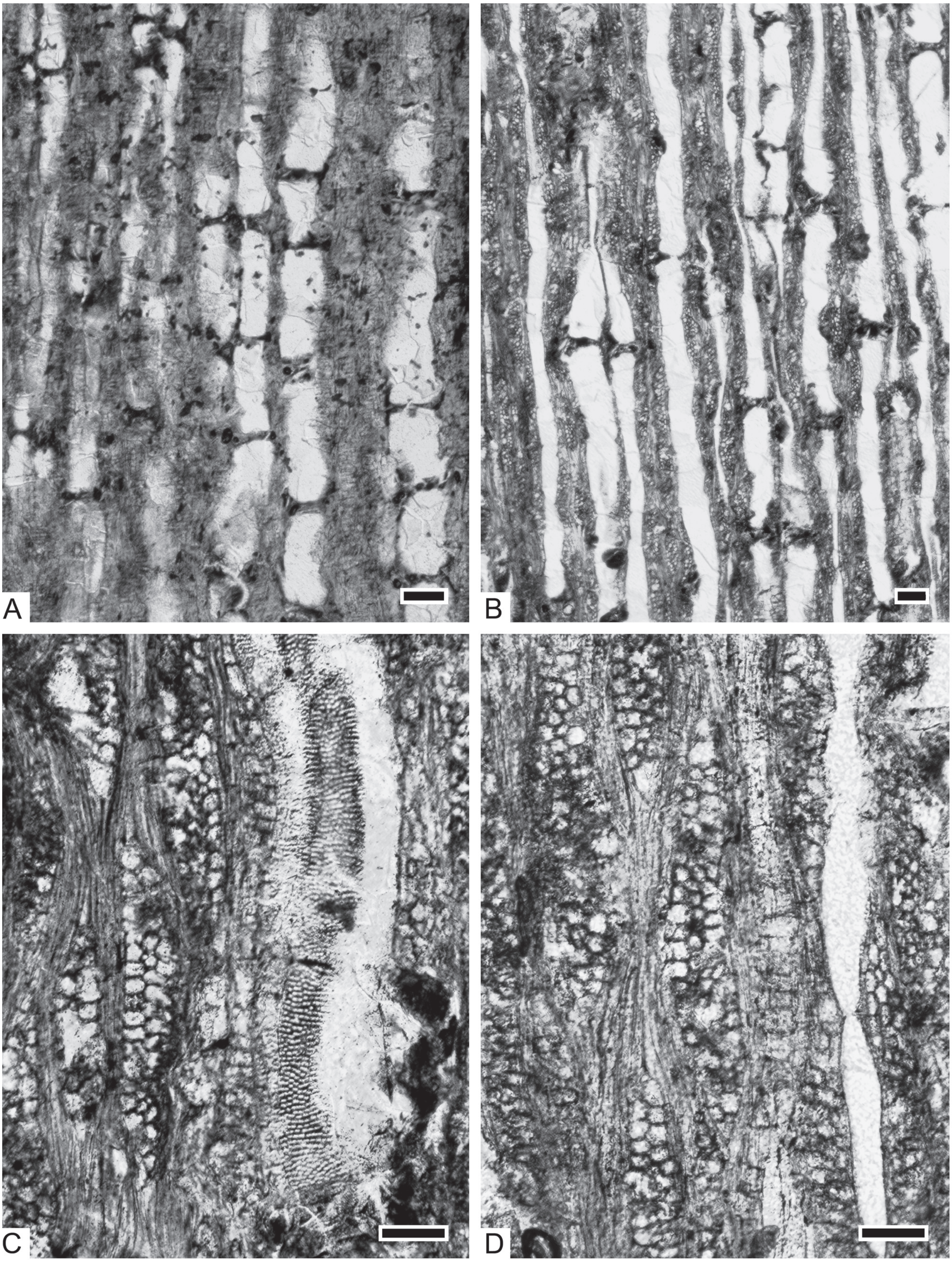

Figure 2: Thin sections of *Cedreloxylon cristalliferum* SELMEIER, 1987
(**A**) Longitudinal radial section; vessel perforations simple, dumb-bell-shaped deposits common. BSPG XIII 225 c. Scale bar = 20 µm; x 35. (**B**) Longitudinal tangential section; wood tangentially compressed prior to silification, vessel lumina distorted. BSPG XIII 225 d. Scale bar = 20 µm; x 25. (**C**) Longitudinal tangential section; intervessel pits crowded, alternate and minute, diameter ~ 4-5 µm. BSPG XIII 225 d. Scale bar = 10 µm; x 115. (**D**) Longitudinal tangential section; ray width 3 to 4 cells, weakly heterocellular, remains of rhomboid crystals sometimes preserved in marginal cells. BSPG XIII 225 d. Scale bar = 10 µm; x 115.

Table 1: Fossil record of *Cedreloxylon cristalliferum* and *Cedreloxylon* sp. in the North Alpine Foreland.

Locality	**Number of specimens**	**References**
Zeholfing Church	1	this paper
Southern Franconian Alb	19	Gottwald 2002, 2004; Selmeier 2003, 2004
Ortenburg gravel	1	Gottwald 1997
Molasse Basin (Germany, Austria)	26	Selmeier 1987, 2003

marginal ray cells; (6–)8–10(–12) rays per mm tangential.

Comparisons: The affinities of the fossil wood specimen were determined by consulting the wood-anatomical descriptions of Metcalfe & Chalk (1950), Brazier & Franklin (1961), Carlquist (2001), Gottwald (1997, 2002, 2004), IAWA Committee (1989), Panshin (1979), Pearson & Brown (1932), Purkayastha (1996), and Wheeler (1991).

The anatomical details of this type of wood have previously been analyzed by Selmeier (1987, 2003, 2004). The species *Cedreloxylon cristalliferum* Selmeier is common in the northern Alpine Molasse, and known to date based on 47 specimens (Tab. 1). The genus *Cedreloxylon* is most closely related to extant species in the genera *Cedrela* P. Br. and *Toona* (Endl.) Roemer.

4. Discussion

4.1 Origin and age

The here described specimen of *Cedreloxylon cristalliferum* was discovered from the church of St. Laurentius in Zeholfing (District Dingolfing-Landau, Bavaria, Germany). Zeholfing is a village situated in the "Tertiary hills" to the right side of the river Isar, approximately 35–40 m above the river valley (Fig. 1). The church is more than 1000 years old. After several phases of construction using wood and later calcareous tufa for the foundation and walls, a foundation composed of rocks was laid in the 11th century in the apse area of the church (Eibl 2001). The Building material consists in part of massive limestone boulders that come from the Northern Calcareous Alps and have been transported to Zeholfing glacially and/or fluvially. Several blocks are >30 cm in diameter. The by far greater part of the foundation, however, consists of calcareous tufa square stones, up to 100 cm long, that originate from carbonate-rich springs along the river Isar. Among these blocks the wood specimen was discovered.

The church builders did obviously not notice the nature of the wood specimen. Of course, paleontology was not in the people's mind during the 11th century, but unlike other fossil remains such as gryphaeids or belemnites, which were recognized as something out of the ordinary and explained mythologically, fossil wood was not regarded as unusual. Moreover, the silicified stem segment was welcome as building material, especially in an area where stones of considerable size are scarce.

There exist several different geological strata in the area that may yield silicified wood. To the right side of the river Isar, the Obere Süsswasser-Molasse (OSM), Early- to Middle-Miocene in age, stretches southward towards the Alps. It consists predominantly of continental clastics of various grain sizes. Most of the silicified wood specimens from the Lower Bavarian molasse, as well as from the neighbouring area of Zeholfing (Selmeier 1983, 1985, 2000), have been discovered in sediments of similar age and consistency (Böhme et al. in press). Moreover, reworked wood specimens often occur in the Pleistocene or Holocene fluvial terraces (Unger 1983) of the Isar river (own observations) where the other massive limestone boulders must have been collected. Although the specimen from Zeholfing cannot be specifically assigned to an exact locality, it is likely Miocene in age since most of the other 46 *Cedreloxylon* specimens recorded to date are well-dated (Böhme et al. in press).

4.2 Ecology and climate

The extant genus *Cedrela*, consisting of 8 species, is native to the tropical and subtropical regions of the Caribbean and South America. Today, however, these trees are cultivated throughout the entire tropical belt. The extant members of the genus *Toona*, which closely resembles *Cedrela* in wood anatomy, also prefer tropical climates and are of Old World origin. They are growing in moist regions and thrive in habitats of up to 2500 m above the sea level (Purkayastha 1996). The temporal and ecological distribution of *Cedreloxylon cristalliferum* in different forest types during the Miocene in southern Germany (Böhme et al. in press) suggests a relatively generalistic mode of life, especially with regard to precipitation.

Extant *Cedrela* trees can reach a stem diameter of up to 3 m, while growing up to a height of 60 meters. Based on the growth ring curvature of the 9 ring arcs recognizable from the fossil from Zeholfing (Fig. 3 A), this specimen belonged to a large stem of >1 m in diameter.

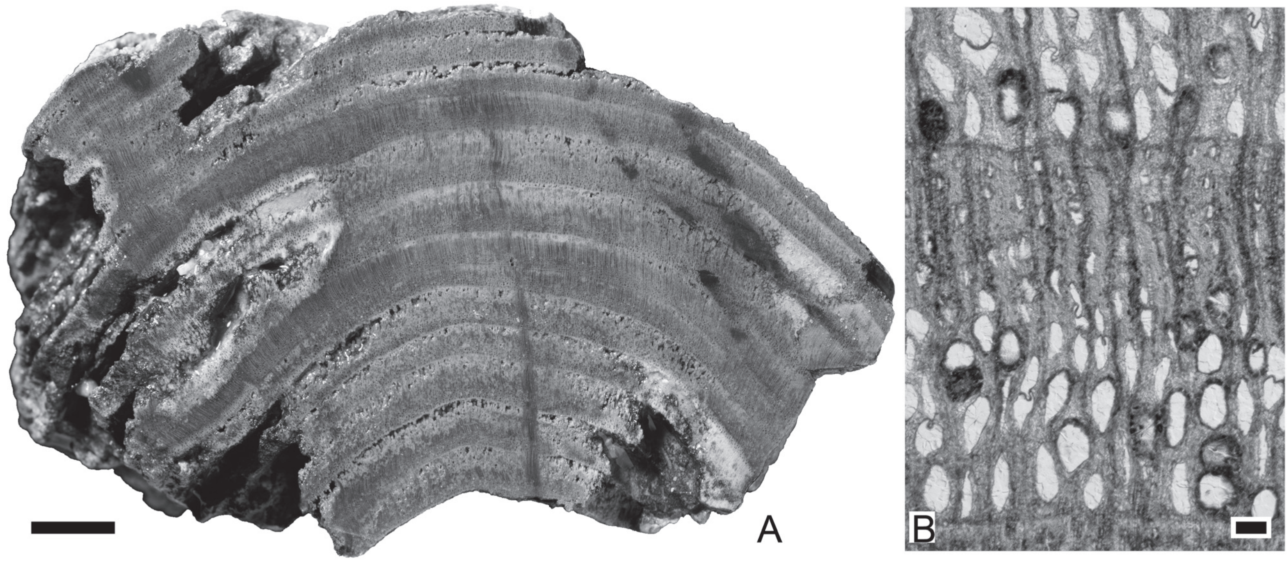

Figure 3: Sections of *Cedreloxylon cristalliferum* SELMEIER, 1987
(**A**) Cross section of the complete specimen. The weak curvature of growth rings is visible. BSPG XIII 225 a. Scale bar = 1 cm.
(**B**) Cross section; wood ring-porous, growth ring boundaries distinct, vessel lumina partly filled with dark deposits. BSPG XIII 225 b. Scale bar = 20 µm; x 30.

Acknowledgments

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