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Wood anatomy of *Pleodendron costaricense* (Canellaceae) from Southern Pacific, Costa Rica

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ABSTRACT. *Pleodendron costaricense* N. Zamora, Hammel & R. Aguilar (Canellaceae) is an endemic species from the southern Pacific region of Costa Rica. It is rare and is considered to be a living fossil. The wood of *P. costaricense* has high density (0.92 Kg/cm^3, air dry) with little distinction between heartwood and sapwood. The growth rings are marked by tangential rows of fibers. Its porous are diffuse with moderately few, small, very long vessel elements and scalariform intervessel pitting. Vessels are solitaries with scalariform perforations having 20-40 bars. Rays are uniseriate and homocellular. *P. costariceme* shares many features with P. *macranthum* and *Canella winterana.*

RESUMEN. *Pleodendron costaricense* N. Zamora, Hammel & R. Aguilar (Canellaceae) es una especie endémica del Pacífico sur de Costa Rica, la cual es considerada de rara distribución. Presenta una alta densidad de madera seca al aire (0.92 Kg/cm^3), una marcación indistinta entre albura y duramen y los anillos de crecimiento se observan por banda de fibras al finalizar los anillos. La madera presenta porosidad difusa, los poros son de mediana frecuencia y con diámetro moderado. Los elementos vasculares muy largos, de radio uniseriado y homocelulares y puntuaciones inter-vasculares de tipo escalariforme. Esta característica es considerada como un rasgo anatómico primitivo. Vasos solitarios y placas de perforación escalariforme de 20-40 barras, las cuales son consideradas como estructuras nuevamente primitivas. *P. costaricense* presenta muchas similitudes con *P. macranthum* y *Canella winterana.*

KEY WORDS. *Pleodendron costaricense,* Canellaceae, wood anatomy, Costa Rica

The new species *Pleodendron costaricense* N. Zamora, Hammel & R. Aguilar (Canellaceae), discovered in southern Pacific of Costa Rica (Hammel & Zamora 2005), is related to the early angiosperms and is considered rare distribution (Gram & Jarzen 1969). Only three mature individuals are known, so its natural distribution seems to be very limited.

P. costaricense is the only species of the Canellaceae found in Central America. The family is comprised of 15 species from southern Florida, the West Indies, northeastern South America, southeastern Brazil, southeastern Africa and Madagascar (Tieghem 1899, Wilson 1966). Its only congener, *P. macranthum,* grows 2000 km to the northeast, in Puerto Rico. Like other members of the Canellaceae, P. *costaricense* is an aromatic tree. Its bark and leaves have glands that contain volatile compounds (Hollick & Berry 1924). Treyvaud *et al.* (2006) recently have demonstrated that its bark and leaves produce essential oils that are used for medical treatments. We present here a description of its wood that will help elucidate its relationships to other disjunct members of the Canellaceae.

MATERIAL AND METHODS

Only three mature trees of *P. costaricense* have been discovered; two grow in Parrita and the other one grows in the Peninsula de Osa. The material for this study, collected by the Instituto Nacional de Biodiversidad (INB) and the Missouri Botanical

Garden (MO) in 1998, came from one tree that was identified and described by Hammel & Zamora (2005) based on its leaves and fruit. The tree is about 15 m tall and is situated at the edge of the road to El Carmen, valle del río Palo Seco cantón de Parrita (9° 32' 00.17" N - 84° 16' 25.94" W.) The wood was cut from a branch approximately 15 cm in diameter. A botanical voucher was deposited at the INBio herbarium (as *R. Aguilar* 6007) and the wood sample was donated to the xylarium of the Instituto Tecnológico de Costa Rica (catalog number TECw00198.)

A 3 cm x 3 cm x 10 cm wood specimen was cut from the branch and was placed inside a conditioning chamber at 22°C and 65 percent relative humidity, corresponding to an equilibrium moisture content of 12%. Its air dry density at equilibrium was determined as its weight divided by its volume as determined by water displacement. Following the density determination, a 1 cm x 1 cm x 1 cm sectioning block was cut from the specimen, and additionalsmall sticks were cut for maceration using Franklin's method (Ruzin 1999). Fiber dimensions (length, lumen diameter and wall thickness) and vessel lengths were measured from the macerated wood. The sectioning block was softened by boiling in water, sectioned using a sliding microtone, stained in safranin, and mounted on glass slides with Canada balsam. Anatomical terms used in this paper follow the recommendations of the IAWA list of Microscopic for Hardwood Identification (IAWA Committee 1989).

RESULTS

Wood characteristics. Heartwood and sapwood not distinct from each other; white to pale yellow in color. Taste and smell indistinct. Texture medium. Air-dry density 0.92 g/cm^3.

Wood anatomy. Growth rings distinct, delineated by tangential rows of fibers (Fig. 1). Wood diffuse-porous. Vessels exclusively solitary (>90%), oval to round in cross-section, with a slight tendency to form diagonal or radial lines (Fig. 1). Vessel frequency 13 (12-15) pores/mm^2; average tangential diameter 90 (70–110) µm; average length 940 (590 - 1260) µm. Perforation plates scalariform with 20 - 40 bars (Fig. 2) and reticulate (Fig. 3). Tyloses, gums or other deposits not observed in heartwood vessels. Intervessel pits bordered, round, and opposite (Fig. 4); mean diameter 5.0 (2.7–9.1) µm; not vestured. Vessel-ray pits with distinct borders, similar to intervessel pits in size and shape (Fig. 5) Fibers non-septate, with distinctly bordered pits common on both radial and tangential walls. Fibers 1.05 (0.72-1.28) mm long, 17.1 (13.0-24.4) µm in diameter. Fiber wall thickness 4.51 (3.09-5.87) µm; fiber lumen diameter 8.03 (3.85-15.26) µm. Axial parenchyma apotraqueal scanty, diffuse and diffuse-in-aggregates, unilateral paratracheal, scanty vasicentric and aliform with long wings (Fig. 6). Parenchyma strands with eight or more cells, without crystals. Prismatic crystals present in body and marginal cells of rays (Fig. 7). Rays composed entirely of procumbent cells; uniseriate (rarely biseriate) (Figs. 8 and 9); 16.1 (13.2–20.6) µm in width; 12 (4-25) cells, 270 (100-520) µm high; 11.4 (9.6–13.0) rays per mm.

DISCUSION

Wilson (1960) found that the anatomy of young stems or branches of the Canellaceae is not very different from that of mature stems. Therefore our description of *P. costaricense* branch wood probably applies to mature stem wood as well. Some of the characters, such as diffuse porosity, are related to latitude; some, such as vessel number and diameter are related to habitat; and others are related to degree of specialization. Of those related to specialization, long vessel elements and multiple perforations are found in primitive taxa whereas rays uniseriate and homogeneous are found in advanced taxa (Carlquist 2001).

Wilson (1960) description of *P. macranthum* and our description of *P. costaricense,* are similar. In both cases the wood is diffuse porous, with pores exclusively solitary and diagonally or radially aligned, perforations are scalariform with many bars, the intervessel pits are small to medium, and ray-vessel pits are similar to intervessel pits, the fibers are non-septate with thin to thick cell walls and distinctly bordered pits on both radial and tangential walls, paratracheal and apotraqueal axial parenchyma are present with more than eight cells per parenchyma strand and lacking crystals and rays are 4-12 per mm, almost exclusively uniseriate, and composed of procumbent cells.

Somewoodanatomical differencescanbeused to separate *P. costaricense* from *P. macranthum.* Vessels in dendritic pattern and scalariform perforation plates with 10-20 bars, observed in *P. macranthum,* do not occur in *P. costaricense.* Vessels are less frequent in *P. costaricense* than in *P. macranthum.* The most conspicuous differences between the two species were in the axial parenchyma which is absent or diffuse in *P. macranthum* from Puerto Rico, but unilaterally paratracheal, scanty vasicentric and aliform in *P. costaricense*(Fig. 6). The axial parenchyma suggests that the species growing in Costa Rica might be considered with some specialization, but the presence of multiple perforation suggests the contrary.

Cinnamosma madagascariensis (Madagascar), *Cinnamodendron axillare* and *Canella stuhlmannii* (southeastern Brazil), *Warburgia ugandensis* and *W. stuhimannii* (Africa), and *Canella winterana* (south Florida, West Indies, Mexico, and Honduras) are similar to *P. costaricense* in the presence of prismatic crystals found in ray cells (Wheeler et al. 2006, Metcalfe 1987, Wilson 1960,1965, Rebollar & Quintanar 2000). Wilson (1960) described the wood of a species of *Cinnamosma* as having vasicentric, aliform and confluent axial parenchyma; these features are similar to those found in *P. costaricense.* Of the American species of Canellaceae, *P. macranthum* from Puerto Rico and *Canella winterana* are geographically and anatomically closest to *P. costaricense.*

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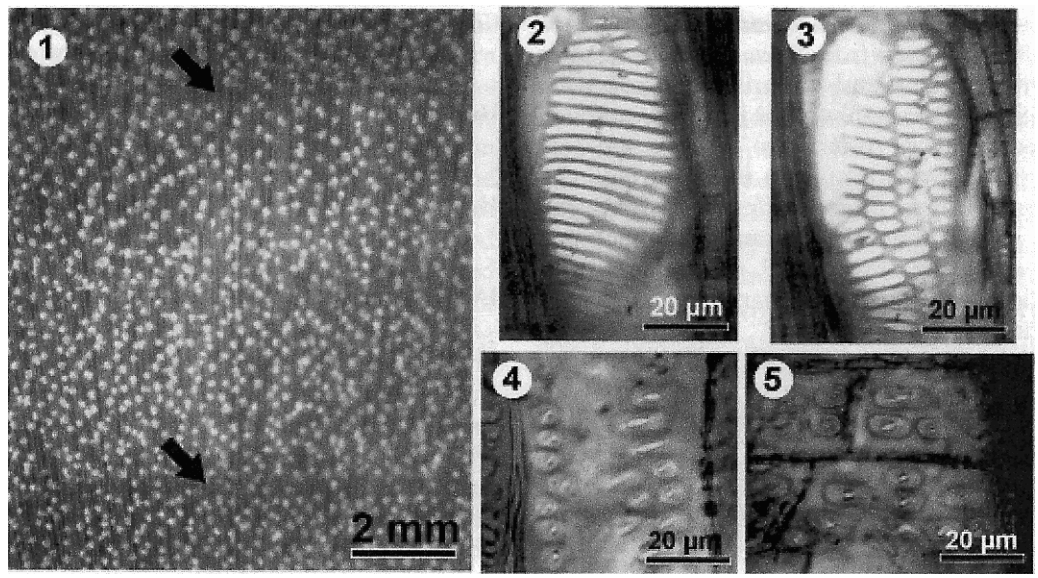
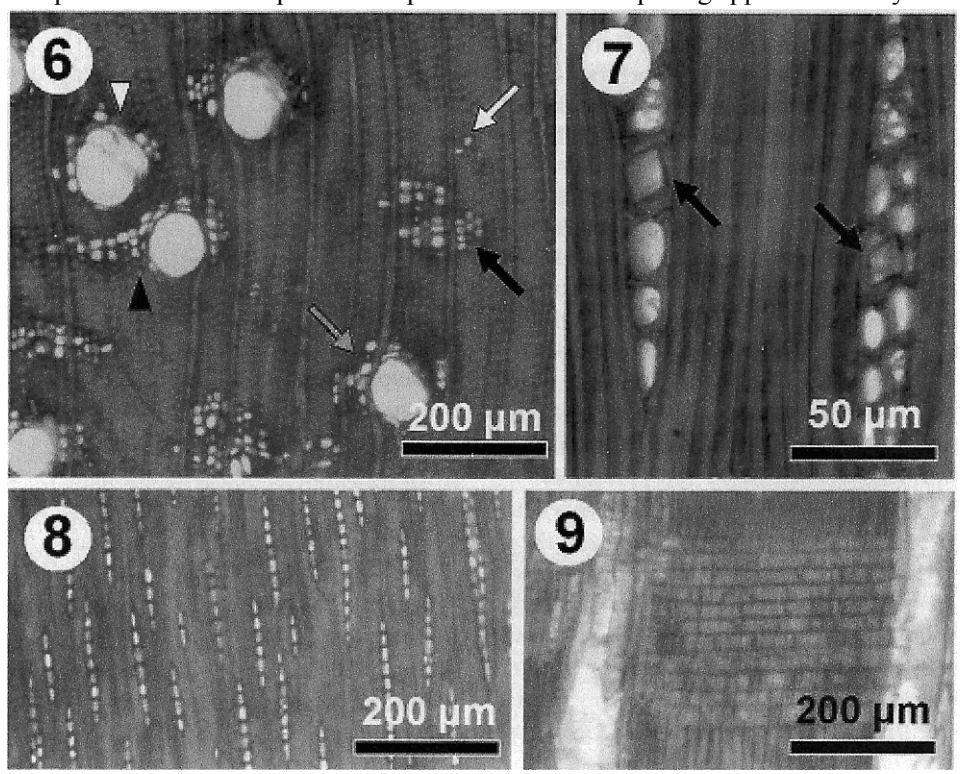


Figures 1-5. -1: Growth rings (indicated by arrows); vessels in diagonal or radial pattern. - 2 Scalariform perforation plate. -3: Reticulate perforation plate. -4: Intervessel pitting opposite. -5: Ray-vessel pits.



Figures 6-9. -6: Vessels mostly solitary; axial parenchyma diffuse (white arrow), diffuse-in-aggregates (black arrow), unilateral paratracheal (black arrowhead), scanty vasicentric (white arrowhead)and winged-aliform(gray arrow). -7: Prismaticcrystalspresentinraycells. -8: uniseriaterays. -9:raycomposed of procumbent cells only.