Acta Botanica Brasilica 28(3): 484-488. 2014.
doi: 10.1590/0102-33062014abb2952

Short Communication

Structure of the secondary xylem of *Aniba* Aubl. species from the Brazilian Amazon

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Received: December 21, 2012. Accepted: January 14, 2014

ABSTRACT
The aim of this study was to characterize the wood of *Aniba* species from the Brazilian Amazon, on the basis of specimens in the wood collection of the Herbarium of the Museu Paraense Emílio Goeldi, in the city of Belém, Brazil. The species were found to present a homogeneous structure in the secondary xylem, as defined by the location of oil cells; the presence of tyloses and crystals; and singularities of the radial and axial parenchyma.

Key words: Anatomy of wood, identification of wood, Lauraceae

The genus *Aniba* is represented by 26 species that are of great importance for the production of essential oils. For instance, the species *Aniba rosaeodora* Ducke, known in Brazil as *pau-rosa* (Brazilian rosewood), was intensively harvested for commercial purposes in the 1990s for the extraction of linalool, which is used by the perfume industry (Marques 2001). Trees and shrubs of the *Aniba* genus are difficult to identify in the forest. The identification is mainly based on floral aspects and the morphology of the organs (Quinet 2005). Data regarding the intrinsic aspects of the structure of the secondary xylem of *Aniba* species are scarce and contradictory (Richert 1981, 1987; León & Pernia 2000).

The identification of *Aniba* species is fundamental, because the active principles that constitute the oils can differ, quantitatively and qualitatively, among species, which can negatively affect their end use in the case of incorrect identification. Although crucial in this context, the number of studies that contribute to such identification is not proportional to the great species diversity within the genus. The aim of the present work was to characterize the wood of 13 *Aniba* species that occur in the Brazilian Amazon. To that end, we evaluated specimens available in the Walter Alberto Egler wood collection of the Herbarium of the Museu Paraense Emílio Goeldi (code, MG), located in the city of Belém, in the state of Pará, Brazil. Our objective was to contribute to the identification of *Aniba* species and to augment the database of the Virtual Xylotheque of Amazonian Wood. The study was based on the material available in the collection, together with the corresponding botanical material on deposit at the herbarium, for the following species: *Aniba affinis* (Meisn.) Mez; *A. canellila* (Kunth) Mez; *A. citrifolia* (Nees) Mez; *A. cylindriflora* Kosterm.; *A. fragrans* Ducke; *A. gigantifolia* O. C. Schmidt; *A. guianensis* Aubl.; *A. hostmanniana* (Nees) Mez; *A. megaphylla* Mez; *A. parviflora* (Meisn.) Mez; *A. puchury-minor* (Mart.) Mez; *A. riparia* (Nees) Mez and *A. rosaeodora* Ducke. The descriptions followed the guidelines established by the International Association of Wood Anatomists (IAWA Committee 1989).

The species studied presented distinct growth layers delimited by the thickening of fiber cell walls in cross sections of latewood. We found that *A. hostmanniana* was ring porous (Fig. 1A), whereas the remaining species were all diffuse porous, with solitary, circular pores in an undefined arrangement. In *A. canellila*, *A. citrifolia* and *A. puchury-minor*, some of the tyloses were sclerotic. The vessel elements presented simple perforation plates and alternate intervessel pits, except in *A. hostmanniana*, which had scalariform intervessel pits (Fig. 1B). For rays,

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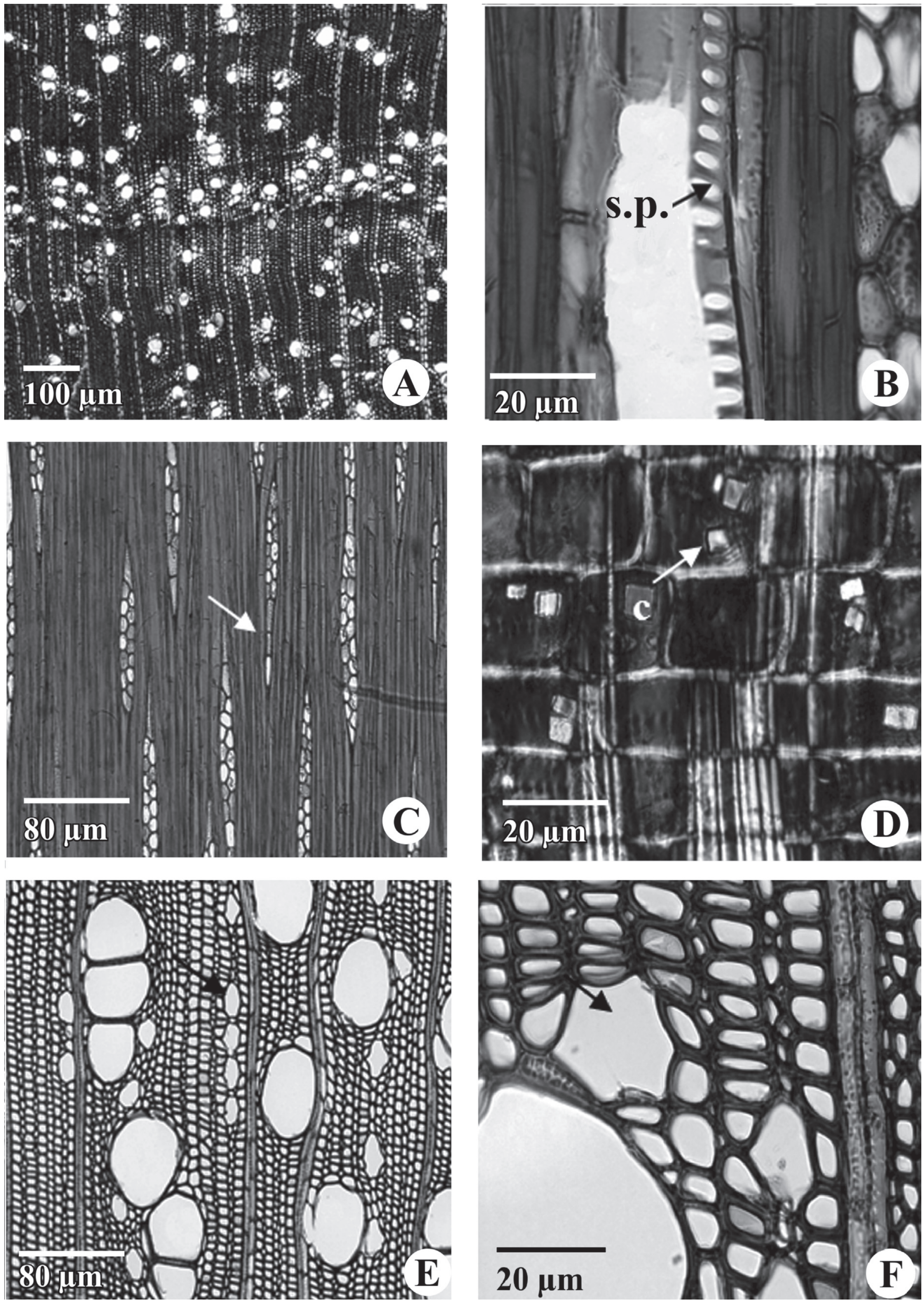

Figure 1. (A) Semi-porous rings - *Aniba hostmanniana* (Nees) Mez; (B) Scalariform intervessel pits (s.p., arrow) - *A. hostmanniana*; (C) Three rows of upright or square marginal cells (arrow) - *A. riparia* (Nees) Mez; (D) Prismatic crystals (c., arrow) - *A. cylindriflora* Kosterm.; (E & F) Oil cells (arrows) associated with the fibers and axial parenchyma, respectively - *A. rosaeodora* Ducke.

the following characteristics were observed: ray-vessel pits with reduced angular areolae. Septate fibers were found. In *A. affinis*, *A. canellila*, *A. gigantifolia*, *A. guianensis* and *A. puchury-minor* the axial parenchyma was sparse paratracheal-vasicentric or sparse vasicentric, whereas it was consistently paratracheal-vasicentric in *A. citrifolia*, *A. megaphylla*, *A. parviflora* and *A. rosaeodora*. In *A. cylindriflora* and *A. fragrans*, the axial parenchyma was vasicentric, occasionally presenting lines simulating the border lines. We observed a very short paratracheal lozenge-aliform axial parenchyma in *A. hostmanniana* and *A. riparia*. Body ray cells were procumbent, with one to three rows of upright or square marginal cells (Fig. 1C), biseriate. Fused rays were observed in *A. puchury-minor*. Prismatic crystals were seen on the procumbent ray cells of *A. affinis*, *A. cylindriflora*, *A. gigantifolia*, *A. parviflora* and *A. riparia* (Fig. 1D). Oil cells were observed in all of the species studied. However, the location differed among species, oil cells being located on the ray, the fibers (Fig. 1E) or the axial parenchyma (Fig. 1F), as did the frequency. The quantitative characteristics of each species are described in Table 1.

The *Aniba* species studied here presented very similar anatomies, which can be characterized by the location of oil cells; the obstruction of vessels by tyloses; the peculiarities of radial and axial parenchyma; and the presence of crystals. Our findings are in accordance with the available literature for species of this genus, including some from the Venezuelan Amazon (Loureiro 1976; Richter 1981, 1987; Silva *et al.* 1992; León & Pernia 2000; Silva 2001; Wheeler *et al.* 2006; Parra 2009; Sakala *et al.* 2010), in which taxonomic importance is placed on characteristics such as the location of oil cells; the presence of septate fibers, tyloses and crystals; the type of axial parenchyma; the types of perforation plates; and the types of intervessel pits. Divergences in the scalariform intervessel pit observed in *A. hostmanniana* might be related to the evolution of the species.

Table 1. Biometric data related to selected species of the genus *Aniba* Aubl.

	Vessel elements			Fibers			Rays		
Species	Diameter (μm)	Length (μm)	Frequency (mm^2)	Length (μm)	Cell wall thickness (μm)	Cell lumen width (μm)	Length (mm)	Width (n. of cells)	Frequency (mm linear)
Aniba affinis (Meisn.) Mez.									
Maximum	171.24	748.96	10.00	1512.81	5.74	3.87	0.860	2.00	11.00
Minimum	67.56	413.74	2.00	872.56	2.00	1.00	0.250	1.00	2.00
Mean	112.14	548.64	4.54	1221.94	3.67	1.61	0.531	1.98	5.68
Coefficient of variation (%)	19.91	15.93	41.32	14.40	22.47	43.49	0.029	7.14	32.30
Standard deviation	22.32	87.41	1.88	175.90	0.82	0.70	0.153	0.14	1.83
n = 50									
Aniba canellila (Kunth) Mez									
Maximum	147.36	525.49	11.00	1165.62	6.26	9.76	0.490	3.00	12.00
Minimum	49.16	277.41	2.00	539.07	2.37	1.07	0.190	1.00	5.00
Mean	98.39	387.09	5.84	845.11	4.15	5.65	0.301	2.16	8.18
Coefficient of variation (%)	20.69	18.18	34.13	19.43	20.68	41.38	0.024	19.53	23.26
Standard deviation	20.36	70.39	1.99	164.22	0.86	2.34	0.073	0.42	1.90
Aniba citrifolia (Nees) Mez									
Maximum	169.07	618.49	15.00	1352.60	5.73	8.96	0.720	3.00	9.00
Minimum	73.73	240.75	4.00	671.17	2.14	1.00	0.225	1.00	2.00
Mean	113.54	418.04	8.86	1041.31	3.95	3.82	0.413	2.14	5.68
Coefficient of variation (%)	19.87	20.04	25.60	16.95	21.50	78.72	0.022	21.13	29.21
Standard deviation	22.56	83.76	2.27	176.46	0.85	3.01	0.091	0.45	1.66
Aniba cylindriflora Kosterm.									
Maximum	187.21	703.33	9.00	1294.33	7.70	9.00	0.405	3.00	10.00
Minimum	71.71	304.44	2.00	634.09	3.75	1.02	0.121	1.00	4.00
Mean	118.22	447.43	4.78	1042.46	5.34	3.29	0.259	2.30	6.10
Coefficient of variation (%)	18.62	20.42	37.16	14.64	18.03	94.65	0.028	25.23	25.28
Standard deviation	22.02	91.37	1.78	152.65	0.96	3.11	0.073	0.58	1.54

Continues.

Table 1. Continuation.

Species	Vessel elements			Fibers			Rays		
	Diameter	Length	Frequency	Length	Cell wall thickness	Cell lumen width	Length	Width	Frequency
	(µm)	(µm)	(mm^2)	(µm)	(µm)	(µm)	(mm)	(n. of cells)	(mm linear)
Aniba fragrans Ducke									
Maximum	169.02	694.69	9.00	1731.48	6.25	9.03	0.945	4.00	9.00
Minimum	72.16	303.47	1.00	741.51	2.00	1.05	0.265	2.00	2.00
Mean	119.94	467.95	3.92	1194.37	4.11	5.06	0.518	2.52	4.28
Coefficient of variation (%)	18.50	20.96	41.18	16.70	25.25	45.30	0.030	23.01	35.34
Standard deviation	22.19	98.06	1.61	199.48	1.04	2.29	0.156	0.58	1.51
Aniba gigantifolia O. C. Schmidt									
Maximum	174.45	711.55	8.00	1726.11	8.97	9.84	0.904	2.00	10.00
Minimum	84.08	191.69	1.00	590.20	2.00	1.00	0.300	1.00	4.00
Mean	132.04	543.39	3.16	1346.78	6.07	4.92	0.578	1.84	6.98
Coefficient of variation (%)	19.01	19.52	42.58	17.26	23.40	63.60	0.030	20.13	17.48
Standard deviation	25.10	106.06	1.35	232.48	1.42	3.13	0.172	0.37	1.22
Aniba guianensis Aubl.									
Maximum	182.28	727.39	23.00	1621.59	6.26	9.76	0.621	3.00	9.00
Minimum	71.27	326.02	1.00	860.84	2.37	1.07	0.249	2.00	4.00
Mean	135.82	498.96	5.64	1329.59	4.15	5.65	0.402	2.10	6.16
Coefficient of variation (%)	20.27	19.06	65.34	16.01	20.68	41.38	0.025	14.43	24.84
Standard deviation	27.53	95.09	3.69	212.85	0.86	2.34	0.100	0.30	1.53
Aniba hostmanniana (Nees) Mez									
Maximum	127.07	708.81	11.00	1643.05	8.69	9.97	0.761	2.00	9.00
Minimum	52.85	322.00	2.00	580.13	3.33	1.00	0.213	1.00	3.00
Mean	85.20	498.15	5.12	1168.53	5.58	5.78	0.428	1.70	5.72
Coefficient of variation (%)	20.38	18.71	34.99	21.03	23.61	44.34	0.029	27.23	26.44
Standard deviation	17.37	93.22	1.79	245.74	1.32	2.56	0.124	0.46	1.51
Aniba megaphylla Mez									
Maximum	143.74	617.13	13.00	1.424.07	6.24	9.70	0.713	4.00	9.00
Minimum	61.48	298.25	2.00	678.74	2.41	1.00	0.198	1.00	2.00
Mean	103.75	423.34	5.60	1.019.96	3.98	3.80	0.370	2.64	4.36
Coefficient of variation (%)	18.25	18.26	36.79	15.02	23.32	83.74	0.029	27.34	35.82
Standard deviation	18.94	77.32	2.06	153.16	0.93	3.18	0.108	0.72	1.56
Aniba parviflora (Meisn.) Mez									
Maximum	155.16	656.29	24.00	1.367.76	8.10	9.98	0.548	3.00	8.00
Minimum	67.70	277.93	4.00	536.68	3.07	3.03	0.175	1.00	1.00
Mean	103.18	471.42	9.90	989.23	4.84	6.56	0.357	2.02	4.52
Coefficient of variation (%)	19.26	19.36	43.54	18.03	23.69	26.10	0.025	32.39	34.40
Standard deviation	19.87	91.25	4.31	178.38	1.15	1.71	0.090	0.65	1.55
Aniba puchury-minor (Mart.) Mez									
Maximum	218.77	667.48	6.00	1741.42	8.83	9.82	0.847	3.00	11.00
Minimum	110.68	302.65	1.00	561.29	2.53	1.18	0.176	2.00	4.00
Mean	163.77	430.87	2.62	1086.67	5.31	5.20	0.328	2.02	7.52
Coefficient of variation (%)	16.82	18.97	44.22	23.04	25.74	48.01	0.035	7.00	22.83
Standard deviation	27.55	81.72	1.16	250.37	1.37	2.50	0.114	0.14	1.72

Continues.

Table 1. Continuation.

Species	Vessel elements Diameter (μm)	Length (μm)	Frequency (mm²)	Fibers Length (μm)	Cell wall thickness (μm)	Cell lumen width (μm)	Rays Length (mm)	Width (n. of cells)	Frequency (mm linear)
Aniba riparia (Nees) Mez									
Maximum	175.22	681.13	10.00	1826.61	6.63	9.55	0.554	3.00	10.00
Minimum	68.36	310.07	2.00	833.44	2.22	1.10	0.153	1.00	4.00
Mean	119.45	506.73	4.16	1297.66	4.22	4.17	0.346	2.00	6.46
Coefficient of variation (%)	19.92	19.06	45.65	16.52	24.55	60.71	0.026	10.10	23.03
Standard deviation	23.79	96.57	1.90	214.41	1.04	2.53	0.090	0.20	1.49
Aniba rosaeodora Ducke									
Maximum	162.93	591.15	10.00	1050.83	5.62	9.95	0.675	3.00	8.00
Minimum	81.46	242.95	3.00	106.76	1.80	4.03	0.221	1.00	3.00
Mean	113.85	420.70	5.86	840.66	3.55	7.34	0.392	2.08	4.16
Coefficient of variation (%)	19.68	19.32	29.66	17.91	25.49	24.37	0.030	27.20	30.85
Standard deviation	22.41	81.26	1.74	150.55	0.90	1.79	0.116	0.57	1.28

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