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ECOLOGIC FEATURES OF WOOD ANATOMY OF *Casearia sylvestris* SW (SALICACEAE) IN THREE BRAZILIAN ECOSYSTEMS

Keywords:
Comparative wood anatomy
guaçatonga
Casearia sylvestris
Mata Atlântica
Cerrado

ABSTRACT: *Casearia sylvestris* SW (Salicaceae) is a highly adaptive perennial species that is found throughout Latin America and widely spread in Brazil. This work analyzed the ecological features of wood anatomy of *C. sylvestris* occurring in three ecosystem types: Cerrado, Gallery Forest (Northern of Minas Gerais) and Mata Atlântica (Southern of Minas Gerais). Qualitative features were similar among plants in the three ecosystems, differing only in the distribution of pith flecks and neighboring tyloses that were more frequent in Cerrado and Gallery Forest. The quantitative results showed significant differences for several parameters, as well as variation between individuals of vegetation types of Northern and Southern of Minas Gerais. The correlation matrix of variables including quantitative anatomical characteristics, soil characteristics, height and diameter of the plants showed that plants were grouped by ecosystem type. *Casearia sylvestris* might adopt different survival strategies regarding safety and efficiency of water transport by wood anatomy ecological adaptation. The adaptive anatomical features to drought were mostly an decrease of vessel frequency and an increase of ray width and frequency.

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CARACTERÍSTICAS ECOLÓGICAS DA ANATOMIA DA MADEIRA DE *Casearia Sylvestris* SW (SALICACEAE) EM TRÊS ECOSSISTEMAS BRASILEIROS

Palavras chave:
Anatomia comparada da madeira
Guaçatonga
Casearia sylvestris
Mata Atlântica
Cerrado

RESUMO: *Casearia sylvestris* SW é uma espécie perene altamente adaptável que é encontrada em toda a América Latina e amplamente disseminada no Brasil. Este trabalho analisou as características ecológicas da anatomia da madeira de *C. sylvestris* ocorrendo em três tipos de ecossistemas: Cerrado, Floresta da Galeria (Norte de Minas Gerais) e Mata Atlântica (Sul de Minas Gerais). As características qualitativas foram semelhantes entre as plantas nos três ecossistemas, diferindo apenas na distribuição de máculas e tiloses próximas a máculas que eram mais frequentes no Cerrado e na Floresta da Galeria. Os resultados quantitativos mostraram diferenças significativas para vários parâmetros, bem como variação entre indivíduos dos tipos de vegetação do Norte e do Sul de Minas Gerais. A matriz de correlação entre as variáveis, características anatômicas quantitativas, características do solo, altura e diâmetro das plantas, mostrou que as plantas foram agrupadas por tipo de ecossistema. *Casearia sylvestris* pode adotar diferentes estratégias de sobrevivência em relação à segurança e eficiência do transporte de água pela adaptação ecológica da anatomia da madeira. As características anatômicas adaptativas à seca foram principalmente uma diminuição da frequência do vaso e um aumento da largura e frequência dos raios.

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INTRODUCTION

Casearia sylvestris SW (Salicaceae) is a highly adaptive perennial species found throughout Latin America (LORENZI, 2008). In Brazil, it grows from 1 to 6 m in Southeastern and up to 30 m in the Southern (LORENZI, 2002). It is a widespread species in the southeastern region of Brazil, where it is known as “guaçatonga” or “erva-de-lagarto”, and it has been studied because of the pharmacological value of its bark and leaves (FERREIRA et al., 2011).

The broad distribution and ecological tolerance allow *C. sylvestris* a potential morphological, genetic and physiological variation. Additionally, it is an excellent species to study the structural diversity of xylem linked to the ecosystem characteristics (BAAS, 1986). Previous studies demonstrated that a significant component of xylem anatomical variability has an adaptive and functional explanation (DICKISON, 2000) and may be associated to plant growth environments, water availability and atmospheric changes (RIBEIRO; BARROS, 2006). Current researches also indicate that observed differences, when considering the diameter of xylem vessel among different environments, are primarily driven by plant length (diameter’s and trunk’s height). Those are strictly related to the weather conditions and indirectly lead to a relation between vessel sizes and climate (ANFODILLO et al. 2013; OLSON; ROSELL, 2013; LONGUI et al. 2014).

The ecological anatomy of the secondary xylem contributes to the understanding of survival strategies used by species under different environmental conditions, namely concerning safety and efficiency of water transport (e.g. BAAS, 1973; CARLQUIST, 1985, 2001; BARAJAS-MORALES, 1985; TYREE; ZIMMERMANN, 2002; LUCHI, 2004; AGUILAR-RODRIGUEZ et al., 2006; ZANNE et al., 2006; NOVAES et al., 2010; JÚNIOR et al., 2011; SONSIN et al., 2012). Comparative studies have shown that environmental variations are in general reflected into the xylem anatomy, especially regarding cell dimensions such as vessel frequency and area, fibers length and wall thickness, rays width, and frequency. Such studies on ecological anatomy were first developed in the 1970’s with species from temperate regions (BAAS, 1973; CARLQUIST, 1975), but they are rare in the tropics despite the flora richness and the environmental diversity (MARCATI et al., 2001, NOVAES et al., 2010).

The aim of this study was to characterize the wood anatomy of *Casearia sylvestris* growing in three different ecosystems and relate the qualitative and quantitative functional characteristics with the environmental conditions. Therefore, the sampling was done in distinct ecosystems where *C. sylvestris* was present: Mata Atlântica, Gallery Forest and Cerrado in Minas Gerais, Brazil. The wood anatomical features were determined (e.g. cell types and biometry) and analyzed in association with tree biometry and soil and climatic data using multivariate and principal component analysis.

MATERIAL AND METHODS

The study was made with specimens collected in three different ecosystem types in Minas Gerais, Brazil: a remnant seasonal semi-deciduous montane forest of Mata Atlântica, located on the campus of the Federal University of Lavras, in the Southern of Minas Gerais (21°13’40”, S 44°57’50” W); a Gallery Riparian Forest and one area of Cerrado *sensu stricto*, both located at Fazenda Albino, Coração de Jesus, in the Northern of Minas Gerais (16°41’07” S, 44° 21’ 54” W).

The climate in Lavras is mesothermic with mild summers and dry winter (Cwb type, in Köppen classification) and in the sampling site in the Northern of Minas Gerais it has clear and distinct dry and rainy seasons (Aw type, in Köppen classification). The climatic diagram in Figure 1 shows that the Northern of Minas Gerais has a 3-month summer period without precipitation and overall higher temperature than the Southern.

The soil in the three sampling points was analyzed concerning texture, pH and content of silt, clay, sand, organic matter, Al+H, Ca, Mg, K and P (Table 1). For soil sampling, we used a primary soil sample, which was shared into sub-samples, and they were collected close to each tree specimen (nearly 20 cm depth). All samples

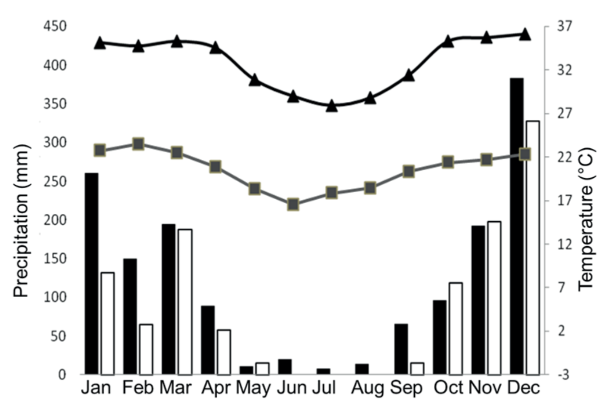

FIGURE 1 Climatic diagram in the study areas (Lavras and Coração de Jesus, respectively Southern and Northern Minas Gerais), showing the average values of monthly precipitation and average temperature in the period 2008-2012. Temperature Lavras (Line with square), temperature Coração de Jesus (Line with triangle), precipitation Lavras (Black bar), precipitation Coração de Jesus (White bar).

were forwarded to the Soil Analysis Laboratory of the Federal University of Lavras, and they were analyzed following the standard protocol of Embrapa (1997).

TABLE 1 Soil characteristics in the three locations of plant sampling.

Soil characteristics	Mata Atlântica	Gallery Forest	Cerrado
Silt (%)	25	46	30
Clay (%)	45	35	29
Sand (%)	30	19	41
Texture	Clay	Moderate sandy	Sandy
pH ($CaCl_2$)	4.8	5.9	4.2
Al+H (mmolc· kg^{-1})	3.62	2.32	7.04
Ca (mmolc·kg^{-1})	1.8	4.6	0.8
Mg (mmolc·kg^{-1})	0.7	1.5	0.5
K (mmolc·kg^{-1})	128	260	134
OM (g·kg^{-1})	3.99	6.92	4.6
P (mg·kg^{-1})	1.42	2.3	2.3

Three trees were randomly selected and measured for total height and diameter at breast height (1.3 m above ground). Botanical samples were taken from the selected trees in the three ecosystem types and treated following standard procedures and deposited in the Montes Claros Herbarium of the State University of Montes Claros, Brazil (Table 2).

TABLE 2 Biometry of the sampled trees (H = height, DBH = diameter at breast height) and Voucher (registration number in the Herbário Montes Claros of the State University of Montes Claros).

Ecosystem	Sample	H (m)	DBH (cm)	Voucher
Mata Atlântica	7	4.6	7.512	4363
	8	4.3	6.970	4363
	9	4.6	8.562	4363
Gallery forest	4	7.4	8.594	4364
	5	7.8	6.684	4364
	6	7.7	9.230	4364
Cerrado	1	2.3	3.023	4364
	2	1.7	3.246	4364
	3	1.9	3.787	4364

The samples were taken from a stem cross-sectional disc in two radial positions, respectively near the pith and the bark. The descriptions, scoring and the measurements of the cellular elements (30 repetitions per tree) followed the IAWA List of Microscopic Features for Hardwood Identification (IAWA COMMITTEE, 1989). The samples were softened (CORADIN; & MUÑIZ, 1991) and transverse, radial and tangential sections (16–20 μm thickness) were cut with a sliding microtome Spencer 860 or Leica SM 2000R. The sections were washed, dehydrated and stained with a 1% safranin aqueous solution (BUKATSCH, 1972) and assembled in permanent slides.

The following measurements were made: vessel diameter, length and vessel frequency; rays height, width and rays frequency. Fibers length, width and wall thickness were measured on dissociated material; only complete fibers were measured and fiber width and lumen were determined at mid-length. Cell dissociation was made by maceration of the samples in a 1:1 acetic acid and hydrogen peroxide solution following Berlyn & Miksche (1976). Microscopic observations and data acquisition were made using an optical microscope Ken-A Vision *TT-1010*, coupled to a digital camera and the Wincel – PRO software was used for wood anatomy analysis.

The data was analyzed by analysis of variance (ANOVA) for comparison of the quantitative anatomical values for the three environments and using the Tukey test at 5% probability level. Normality of data was evaluated using the Kolmogorov-Smimov test (ZAR, 1996). The average values of each sample were applied in multivariate cluster analysis. All statistical processing used Statistica v12 software. Principal component analysis (PCA) was used to rank specimens, anatomical features, soil characteristics, plant biometry and to show the factors with higher variance (LUDWIG; REYNOLDS, 1988), using PCORD for Windows v4.14 (MCCUNE; MEFFORD, 1999).

RESULTS

Anatomical descriptions

Wood anatomy of *Casearia sylvestris* did not show variation between the three ecosystem types except for the distribution of pith fleck (Figure 2B) and tyloses in the neighborhood of pith flecks (Figure 3D), which were found to be present in most of the Cerrado and Gallery Forest specimens.

Growth rings: distinct by the wall thickening of fibers in the latewood (Figure 2A-C). Vessels: diffuse-porous; 20 vessels/mm^2; The porosity was diffuse with solitary vessels (72.6%) or radial multiple with 2-8 elements; circular to oval outline; mean length 696.79 μm; mean tangential diameter 42.61 μm; simple perforation plates (Figure 3G); appendices on both ends; alternate, circular intervessel pits with distinct borders; vessel-ray pits similar to intervessel pits; tyloses present and organic inclusions deposited in the vessels (Figure 3D). Fibers: mean length 977.76 μm; mean diameter 22.57 μm; lumen 0.12 μm; thin- to thick-walled. Axial Parenchyma: rare and the paratracheal parenchyma was scarce. Rays: mean 17/mm; uniseriate and multiseriate, heterogeneous with procumbent cells with marginal square or upright with a random distribution (Figure 3A-C); mean width 31.40 μm and with 2 to 5 cells of width; mean height 701.19 μm; fused rays present (Figure 2D-F); prismatic crystals were present (Figure 3F).

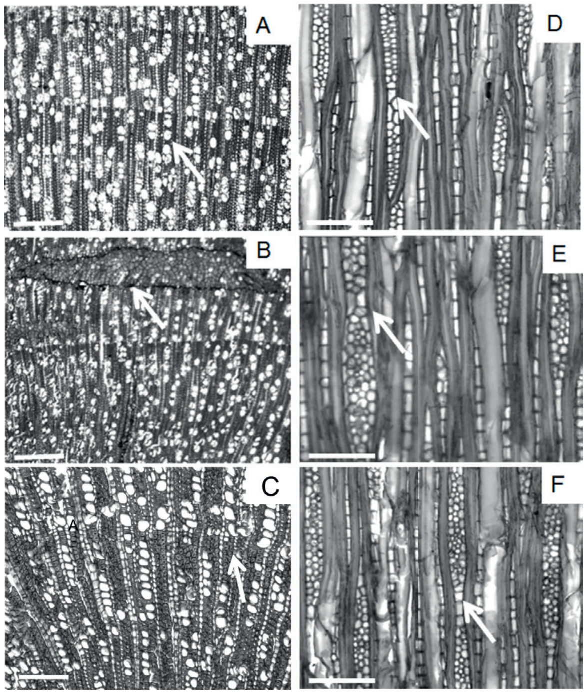

FIGURE 2 Transverse and tangential sections of *Casearia sylvestris*. (A,D) Mata Atlântica, (B,E) Gallery Forest and (C,F) Cerrado. Transverse sections showing the growth ring given by the radial flattening of fibers (A-C, arrow), pith fleck (B, arrow). Tangential sections showing fusioned rays (D-F,arrow). Scale bar = 300 μm (A, B, C); 150 μm (D, E, F).

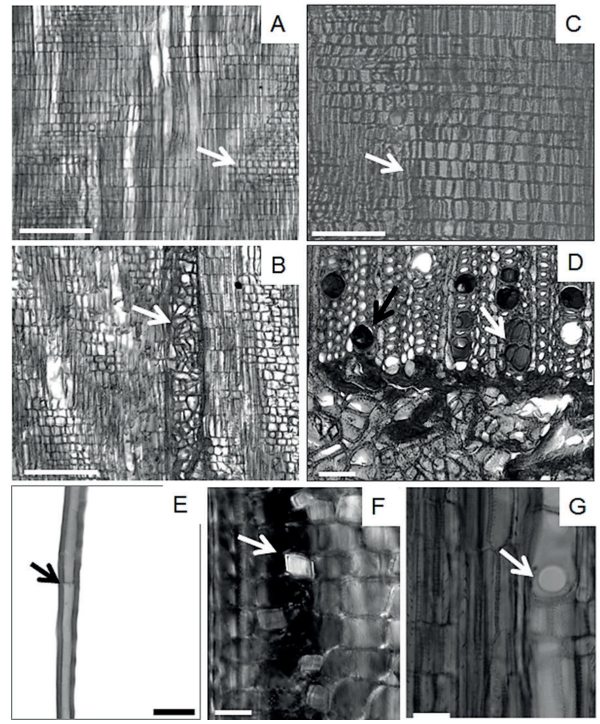

FIGURE 3 Radial and transverse sections, and dissociated cell of *Casearia sylvestris* from Mata Atlântica. (A,F), Gallery Forest (C,D,E) and Cerrado (B,G). Radial sections show procumbent cells with marginal square and upright randomly distributed (A-C, arrows) and pith fleck (B, arrow), prismatic crystals (F, arrow), simple perforation plates (G arrow). Transversal section showing tyloses near to a pith fleck (D, white arrow) and organic inclusions deposited in the vessels (D, black arrow). Dissociated cell showing a sept (E, arrow). Scale bar = 150 μm (A, B, C); 50 μm (D, E, F,G).

Cellular biometry

Table 3 summarizes the results obtained for the measurement of cell dimensions and frequency. Significant differences were found in vessel frequency with more presence of them in the Mata Atlântica in comparison with Cerrado and Gallery Forest (Table 3). The vessel element length and diameter did not differ significantly between the three ecosystem types although the values were higher in Mata Atlântica (Table 3).

It was observed rays significantly wider and more frequent in the Gallery Forest and Cerrado than in Mata Atlântica (Table 3). The height of rays also significantly differed between the three ecosystem types, with the highest values found in Mata Atlântica and Gallery Forest (Table 3).

Fibers dimensions did not significantly differ between the three ecosystem types, however larger fibers were found in the Gallery Forest and Mata Atlântica (Table 3).

The cluster analysis regarding the anatomical parameters ordered the samples in two groups (Figure 4): one group includes the plants from Mata Atlântica (Southern Minas Gerais) and the other groups the plants from the Gallery Forest and Cerrado (Northern Minas Gerais). The adaptive anatomical characteristics were the vessel frequency (lower in the drought-prone region) the ray frequency and ray width (higher in the drought-prone region) and ray height (lower) (Table 3).

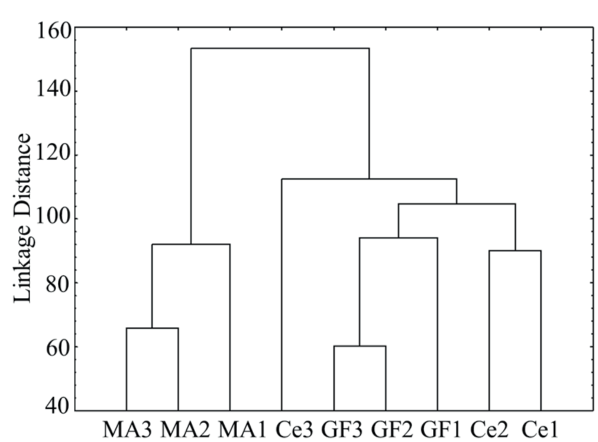

FIGURE 4 Dendrogram obtained from the cluster analysis showing similarities of plants based on anatomical parameters. Plants MA1-MA3: Mata Atlântica, GF1-GF3: Gallery Forest, Ce1-Ce3: Cerrado.

TABLE 3 Variance analysis (ANOVA) and Tukey test of the cellular characteristics of the *Casearia sylvestris* trees sampled in the three ecosystems (Mata Atlântica, Gallery Forest and Cerrado). Average- standard deviation (n = 30).

Variables	Mata Atlântica	Gallery Forest	Cerrado
Vessel frequency (no·mm^{-2})	24.95 ± 1.16 b	16,98 ± 1.85 a	17.48 ± 2.56 a
Vessel length (μm)	708.92 ± 77.94 a	698.59 ± 35.23 a	682.87 ± 97.37 a
Vessel diameter (μm)	45.10 ± 7.57 a	42.23 ± 1.78 a	40.51 ± 3.35 a
Ray height (μm)	863.36 ± 25.75 c	634.24 ± 35.56 b	605.97 ± 90.24 a
Ray width (μm)	25,26 ± 0.07 a	35.23 ± 5.23 b	33.72 ± 1.09 b
Ray height (n° of cells)	31.52 ± 0.85 c	28.3 ± 1.43 b	23.94 ± 1.53 a
Ray width (n° of cells)	3.09 ± 1.28 a	2.37 ± 0.23 a	2.16 ± 0.16 a
Ray frequency (linear mm)	14.95 ± 2.47 a	18.89 ± 1.93 b	17.97 ± 0.54 b
Fibers lumen diameter (μm)	0.13 ± 0.05 a	0.14 ± 0.05 a	0.11 ± 0.07 a
Fibers cell wall thickness (μm)	0.17 ± 0.01 a	0.18 ± 0.01 a	0.16 ± 0.03 a
Fibers length (μm)	981.73± 67.69 a	987.63 ± 40.15 a	963.92 ± 93.08 a

The PCA shows that three components explain 72.8% of the total variance, with the plants showing little variation within each ecosystem type (Figure 5). The first component explains 38.7% of the total variance and influenced by the vessel frequency, ray height (μm and number of cells) width (μm) and frequency. The second component explains 18.6% of the variance and influenced by vessel element length and fiber length; and the third component explains 15.5% of the total variance and including vessel diameter, ray width (number of cells) and fibers' lumen diameter (Table 4).

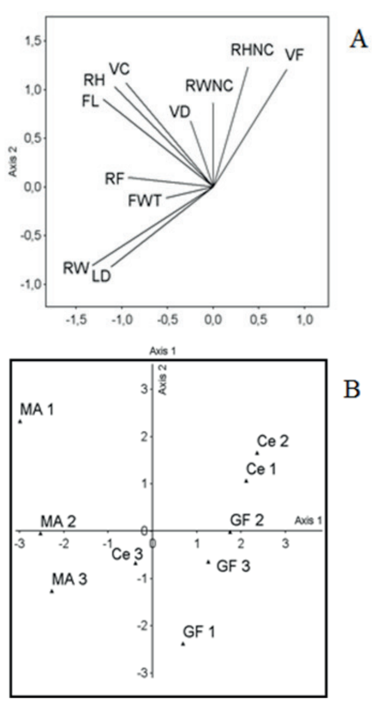

FIGURE 5 Projection of the specimens on the plane of the two main factors resulting from principal component analysis: VF, vessel frequency/mm2; VD, vessel diameter; VC, vessel element length; RW, ray width (μm); RWNC, ray width (number of cells); RH, ray height (μm); RHNC, ray height (number of cells); RF, ray frequency/mm2; LD, fibers lumen diameter; FL, fibers length; FWT, fibers cell wall thickness; MA1, MA2 e MA3, plants of Mata Atlântica; GF1, GF2 e GF3, plants of Gallery Forest; Ce1,Ce2 e Ce3, plants of Cerrado.

TABLE 4 High value data of principal component analysis.

Variables	Factor 1	Factor 2	Factor 3
Vessel frequency (no/mm2)	-0.9138*	-0.1336	-0.3144
Vessel length (μm)	-0.3380	0.9051*	0.1669
Vessel diameter (μm)	-0.4491	-0.0518	0.6820*
Ray height (μm)	-0.9590*	-0.0373	0.0198
Ray width (μm)	0.8422*	0.0925	0.1963
Ray height (n° of cells)	-0.8125*	-0.0111	0.1073
Ray width (n° of cells)	-0.4826	0.1107	-0.6336*
Ray frequency (linear mm)	0.6608*	0.5396	-0.2594
Fibers lumen diameter (μm)	-0.0667	0.0189	0.7300*
Fibers cell wall thickness (μm)	-0.2425	-0.0263	0.2502
Fibers length (μm)	-0.2873	0.9416*	0.0307

*Features that contributed most for axes 1, 2 and 3.

If considering additionally soil characteristics and plant biometry, the plants were better discriminated by the ecosystem types. In fact, if considering wood anatomical parameters, soil properties and plant height and diameter, the PCA shows that three components explain 82.9% of the total variance, with the plants showing little variation within each ecosystem type (Figure 6). The first component explains 39.4% of the total variance and is influenced by the ray frequency, pH, base content, organic matter, Al+H, silt, sand, iron and the plant height. The second component explains 29.0% of the variance and is influenced by the vessel frequency, ray width (μm), ray height (number of cells), fibers cell wall thickness and lumen diameter, clay, P, and plant diameter. The third component explains 14.5% of the total variance and includes vessel element length and diameter, ray height (μm) and fiber length (Table 5).

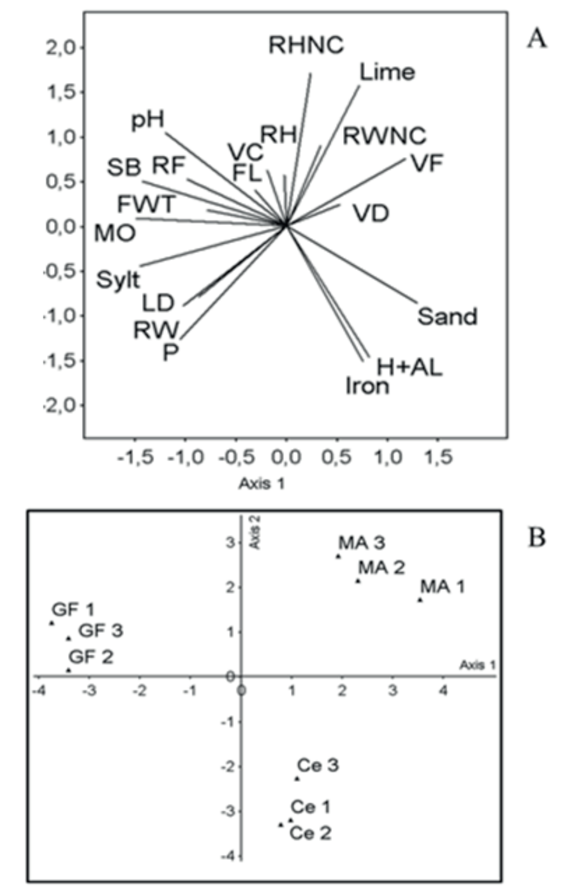

FIGURE 6 Projection of the specimens on the plane of the two main factors resulting from principal component analysis: VF, vessel frequency/mm2; VD, vessel diameter; VC, vessel element length; RW, ray width (μm); RWNC, ray width (number of cells); RH, ray height (μm); RHNC, ray height (number of cells); RF, ray frequency/mm2; LD, fibers lumen diameter; FL, fibers length; FWT, fibers cell wall thickness; MO, organic matter; SB, total base; H+AL, hydrogen+ aluminium; P, phosphorous; pH, Fe, iron; sand, silt, clay, D, plant diameter; H, plant height; MA1, MA2 e MA3, plants of Mata Atlântica; GF1, GF2 e GF3, plants of Gallery Forest; Ce1,Ce2 e Ce3, plants of Cerrado.

DISCUSSION

Wood anatomy of *Casearia sylvestris* confirms the general structure described by Ceccantini (1996), SONSIN et al. (2014) and agrees with the description of *C. obliqua* Spreng. made by Teixeira (1983) and as well as the description of the family Salicaceae, for the growth layers distinct, demarcated by the radial flattening of the fibers and also by the presence of vessel elements with simple perforation plates (DENARDI et al., 2008; WAGNER et al., 2009).

TABLE 5 High value data of principal component analysis.

Variable	Factor 1	Factor 2	Factor 3
Vessel frequency (no·mm^{-2})	0.5706	0.6741*	0.0216
Vessel length (μm)	-0.2009	0.2316	0.8040*
Vessel diameter (μm)	0.3006	0.2089	0.5136*
Ray height (μm)	-0.0833	0.2415	0.9349*
Ray width (μm)	-0.4291	-0.7315*	0.4733
Ray height (n° of cells)	-0.1949	0.9371*	-0.0165
Ray width (n° of cells)	0.0313	0.0541	0.2037
Ray frequency (linear mm)	-0.7003*	0.0323	0.2866
Fibers lumen diameter (μm)	-0.3647	-0.6316*	0.3679
Fibers cell wall thickness (μm)	-0.5047	-10.390*	0.0490
Fibers length (μm)	-0.2298	0.0870	0.9080*
pH (KCl)	-0.9525*	0.2542	-0.1145
Total base	-0.9857*	-0.0776	-0.1133
Organic matter	-0.9412*	-0.3085	-0.1046
Clay	0.1297	0.9787*	0.0002
Sand	0.9761*	-0.1448	0.1156
Hydrogen + Aluminium	0.7767*	-0.6029	0.0994
Silt	-0.8065*	-0.5766	-0.0849
Phosphorous	-0.3963	-0.9067*	-0.0323
Fe	0.8038*	-0.5667	0.1020
Plant height	-0.9212*	0.3289	-0.1325
Plant diameter	-0.6477	0.7365*	-0.0618

*Features that contributed most for axes 1, 2 and 3.

The presence of simple perforation plates is reported by Wheeler and Baas (1991) as features that allow an efficient water transport required by the high transpiration rates in the hot and dry environments. Additionally, the presence of septate fibers may be functionally associated with water and reserves storage (ESAU, 2000), once they are responsible for the transport and storage of photoassimilates in plants with very rare axial parenchyma, as following the case of *C. sylvestris*.

A higher occurrence of pith flecks and tyloses was found in the wood from plants in Cerrado and Gallery Forest. A similar event was reported in *C. sylvestris* plants in the State of São Paulo, where larger and more frequent pith flecks were found in the Cerrado than in mesophile forest (CECCANTINI, 1996). Pith flecks are formed in response to biotic or abiotic damage to the cambium that induces a disorganized formation of parenchymatous cells (IAWA 1964; CARLQUIST, 1988). Water deficits may cause pith flecks formation (CECCANTINI, 1996). In the Northern of Minas Gerais there are severe drought periods that may explain the pith fleck formation in the wood of Cerrado and Gallery Forest ecosystems. The fact that pith flecks were found preferentially near the latewood i.e. during the drought period supports this assumption.

Tyloses result from various causes such as frost, flooding, infections, injury or natural senescence (CHATTAWAY, 1949; DAVISON and TAY 1985; PARAMESWARAN et al. 1985; DUTE et al., 1999; AGRIOS, 2005). In a study with grapevines, Sun et al. (2007) reported that the presence of tyloses in the vascular elements was stimulated by the production of the phytohormone ethylene. For the present study, a possible explanation for a greater presence of tyloses in the specimens from the North of Minas Gerais may be related to the water deficit in the most intense periods of drought, common in that region, which can stimulate greater production of ethylene or even increase its concentration in the woody tissue.

The highest frequency of vessels was observed in Mata Atlântica in comparison with Cerrado and Gallery Forest, differs from previous works (BAAS, 1973; BARAJAS-MORALES, 1985; SONSIN et al., 2012) reporting a lower vessel frequency in wet environments and a higher frequency in dry conditions. However, Luchi (2004) observed higher vessel frequency and diameter in *Croton urucurana* Baill plants growing in more wet soils.

Although none statistically significant difference has been observed for vessel element length and diameter, higher values were observed for these characteristics in Mata Atlântica. Baas et al. (1983), Carlquist (1985) and Zimmermann (1983) observed that the longer and wider vessels, the higher is its conducting efficiency but they are more vulnerable to embolism, which may cause significant loss to the hydraulic system of the plant. On the other hand, smaller vessels are strategic since they are less prone to embolism once gas bubbles dissolve better due to their smaller dimensions (ZIMMERMANN and BROWN, 1971; ZIMMERMANN 1983; TYREE and ZIMMERMANN, 2002). That is likely to occur in the wood of Gallery Forests and Cerrado, where shorter vessel elements were also found. Short vessel elements give higher mechanical resistance, which has been described by Carlquist (1975) as an adaptation to xeric environments, for example.

Rays were significantly wider and more frequent in the Gallery Forest and Cerrado, Metcalf and Chalk (1989) explained the higher production of parenchyma with the upper nutrient storage capacity to help overcome difficult periods like the long drought that is observed in the Northern of Minas Gerais. Outer and Veenendaal (1976) also found wider rays in savanna species and Luchi (2004) in plants of *Croton urucurana* growing with less water availability. The presence of higher rays found in the woods from the Gallery Forest may be associated with the large stem diameters of those plants to ensure more efficient radial transport between (YÁÑEZ-ESPINOZA et al., 2001).

The presence of fibers with larger lumen, wall thickness and length in the trees *C. sylvestris* which occurs in the Gallery Forest and Mata Atlântica may be related to the higher tree height and nutrient supply in these systems. In fact, an allometric relation between plant height and fibers length was observed in *Buddleja cordata* Humb. Bonpl. & Kunth in Mexico (AGUILAR-RODRIGUEZ et al., 2006) and *Copaifera langsdorffii* Desf. in the Cerrado of Southern Brazil (JÚNIOR et al., 2011). The influence of nutrients in fibers dimensions was reported for *Xylopia aromatica* (Lam.) for plants in areas with higher calcium and magnesium contents (Luchi et al. 2005), as it is the case in Mata Atlântica and Gallery Forest in comparison to Cerrado (Table 1).

The cluster analysis showed the differences between the regions of origin of the plants (Northern or Southern of Minas Gerais) were most influential to the segregation of individuals analyzed than differences between ecosystems. This result points out that it is the presence of long lasting droughts that characterizes the climate in this region that conditions the wood anatomy. Principal Component Analysis (PCA) showed that *C. sylvestris* individuals were separated by vegetation types because they present quantitative anatomical, soil and dendrimetric differences.

CONCLUSIONS

Wood anatomy of *Casearia sylvestris* showed significant functional differences in relation with the environment namely regarding regional differences in water availability. The differences in drought occurrence between Northern and Southern of Minas Gerais influenced the adaptive ecological functionality of wood anatomy that overcomes differences in ecosystem type e.g. Cerrado and Gallery Forest.

The results showed that *Casearia sylvestris* might adopt different survival strategies regarding safety and efficiency of water transport by wood anatomy ecological adaptation. The adaptive anatomical features to drought were mostly an decrease of vessel frequency and an increase of ray width and frequency.

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