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Wood anatomy of *Mollinedia glabra* (Spreng.) Perkins (Monimiaceae) in two Restinga Vegetation Formations at Rio das Ostras, RJ, Brazil

FERNANDA DA S. NOVAES[1], CÁTIA H. CALLADO[2], MARIA VERÔNICA L. PEREIRA-MOURA[1] and HELENA R.P. LIMA[1]

[1]Universidade Federal Rural do Rio de Janeiro, Instituto de Biologia, Departamento de Botânica
Rod. BR 465, km 7, Caixa Postal 74582, 23890-000 Seropédica, RJ, Brasil
[2]Universidade do Estado do Rio de Janeiro, Instituto de Biologia Roberto Alcântara Gomes
Departamento de Biologia Vegetal, Laboratório de Anatomia Vegetal
Rua São Francisco Xavier, 524-PHLC, 20550-013 Rio de Janeiro, RJ, Brasil

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ABSTRACT

This paper aimed to characterize the anatomical structure of the wood of specimens of *Mollinedia glabra* (Spren Perkins growing in two contiguous formations of restinga vegetation at Praia Virgem, in the municipality of Rio d Ostras, RJ. Both the Open Palmae (OPS) and the Sandy Strip Closed Shrub (SSCS) formations are found in coas regions that receive between 1,100 and 1,300 mm of rainfall per year. Sapwood samples were collected in bo formations. Typical anatomical features for this species include: solitary vessels, radial multiples or clusters elemen that are circular to angular in outline, 5-15 barred scalariform perforation plates, wood parenchyma scanty, septa fiber-tracheids, and wide multiseriate rays with prismatic crystals. Statistical analyses indicated a significant increa in the frequency of vessel elements and an increase in fiber-tracheid diameters in OPS individuals. These characteristi are considered structural adaptations to increased water needs caused by a greater exposure to sunlight. Continuo pruning may be responsible for the tyloses observed in OPS plants. The greater lengths and higher frequencies of t rays in SSCS trees may be due to the greater diameters of their branches. Our results suggest that *M. glabra* develo structural adaptations to the restinga micro-environmental variations during its development.

Key words: *Mollinedia glabra*, Monimiaceae, restinga, wood anatomy.

INTRODUCTION

Monimiaceae (*sensu stricto*) is a Pantropical family comprising 25 to 30 genera and about 200 species. Five genera are cited for Brazil: *Grazielanthus* Peixoto & Per.-Moura, *Hennecartia* Poisson; *Macropeplus* Perkins; *Macrotorus* Perkins, and *Mollinedia* Ruiz & Pav (Peixoto and Pereira-Moura 2008).

The genus *Mollinedia* has the largest number of described species and is typified by highly branched shrubs or small trees with erect trunks (Peixoto 1979)

of this taxon is hard, whitish, and easy to wo though it is little harvested commercially (Peixot 2001). These trees have medicinal uses (Leitão 1999) and some species are used in urban lands and to produces barrels and sieves in southern they also have an important role in reforestati in the maintenance of the local fauna (Peixoto 2001). *Mollinedia glabra* (Spreng.) Perkins is ered a threatened species in Brazil (Ibama 2008 small populations that occur only in coastal low The species occurs in two distinct vegetation for

Most studies concerning this genus in Brazil have focused on their taxonomic (Peixoto et al. 2001, 2002) or phytochemical (Leitão et al. 1999) nature, with only infrequent works concentrating on the anatomical or ecological aspects of this taxon (Barros et al. 1997, Callado et al. 1997). Anatomical studies of wood are considered to be very informative (Metcalfe 1989), mainly when correlated with evolutive and phylogenetic questions, as environmental factors are considered active in defining the structure of the secondary xylem (Aguilar-Rodríguez and Barajas-Morales 2005, Carlquist 2000). Although the first anatomical studies considering ecological aspects of plant populations were first performed in the 1970's (Baas 1973, Carlquist 1975), this type of investigation is still uncommon in the tropics – largely due to the great variety of species and environments found there. In general, researchers that use the anatomical characters of wood in studies of intra-specific variation in ecologically distinct environments have described modifications in the diameter, length, and frequency of the vessel elements, the thickness of the walls and the lengths of the fibers, and the height and width of the rays (Baas et al. 1983, Callado et al. 1997, Wheeler and Baas 1991, Marcati et al. 2001, León 2005, Ribeiro and Barros 2006).

The present work described and compared the wood anatomy of individuals of *M. glabra* growing in two contiguous vegetation formations under distinct illumination and disturbance regimes in restinga (shoreline) vegetation at Praia Virgem, municipality of Rio das Ostras, Rio de Janeiro, Brazil.

MATERIALS AND METHODS

The studied plant material was collected in an area of restinga vegetation at Praia Virgem, municipality of Rio das Ostras, Rio de Janeiro, Brazil (22°31′S × 41°56′W). This coastal restinga area occupies about 20 ha on a narrow strip of sand, circa 1 km long, along the coast (H. Braga, unpublished data). Two distinct vegetation formations were identified there (Menezes et al. 2005): Open Palmae Shrub (OPS) and Sandy Strip Closed Shrub (SSCS), corresponding to the edge and to humid, with only a small water deficit during the year (FIDERJ 1978). The two vegetation formations are separated by circa 200 m and differ mainly concerning the amount of sunlight that they receive, their exposure to the on-shore winds, and in terms of anthropogenic disturbances, the OPS suffering from frequent pruning.

Samples from three individuals of *Mollinedia glabra* were obtained in the vegetation formations (Table I). As this species is normally branched near the base, samples of the SSCS individuals were collected from the most developed branches at breast height (1.30 m above ground level), and from the middle of straight branches of individuals at the OPS site (Table I). The wood samples, as suggested by Coradin and Muñiz (1991), were obtained from the sapwood region, as the heartwood was rather small. Reproductive material was housed at the Herbarium RBR of the Botany Department of the UFRRJ under the number 401054.

TABLE I

List of individuals sampled in both sites, collection sites, dendrometrics data and record from the wood collection of Instituto de Pesquisas Jardim Botânico Rio de Janeiro (OPS – Open Palmae Shrub; SSCS – Sandy Strip Closed Shrub Growing; H = plant height (m), CSH = circumference at sampling height (cm); RBw = record of the wood; SLI = record of the slides).

Inds	collection sites	H (m)	CSH (cm)	RBw	SLI
1	OPS	0.6	7.6	8563	2250
2	OPS	1.0	7.5	8564	2251
3	OPS	1.8	7.8	8424	2146
4	SSCS	2.5	8.1*	8425	2147
5	SSCS	3.0	7.8*	8566	2253
6	SSCS	3.5	8.0*	8565	2252

(*) Samples collected at 1.30 m above ground level.

The wood samples from each of the studied individuals were sectioned along their transversal and longitudinal planes, at an average thickness of 15μm. The histological sections were cleared, stained, dehydrated and mounted as permanent slides. The stain that was used was a mixture of 1% astra blue and safranin (Bur-

Fig. 1 – a. Aspect of the Open Palmae Shrub (OPS), individuals of *Mollinedia glabra* (arrows). b. Aspect of the Shrub
Vegetation (SSCS).

registration numbers indicated in Table I. The wood fragments were boiled in 50% nitric acid to dissociate the cellular elements (modified from Occhioni 1948). The descriptions, counts, and measurements of the cellular elements followed the norms of the IAWA Committee (1989) and Coradin and Muñiz (1991). The numbers of measurements per analyzed individual were: 10, for frequency and diameter of the vessels elements; 20, for the ray frequencies; and 25, for other parameters (Table II).

Quantitative data were obtained by measurements

were first tested for normality using the Lilliefo
(Lilliefors 1967) at an alfa significance level o
The data for all of the analyzed parameters were
mined to have normal distributions. The Studen
was then used to compare the two means of the in
dent data, at an alfa significance level of 0.05, by
the XLStat version 7.5 software package (Table I

In order to compare environmental effects o
tomical characters associated with water transpo
nerability, and mesomorphy indices were applied a
ing to Carlquist (1975).

TABLE II
Mean and Standard Deviation of wood anatomical features of *Mollinedia glabra* in both plant formations (OPS = Open Palmae Shrub, SSCS = Sandy Strip Closed Shrub).

Mollinedia glabra		OPS Deviation	Standard Deviation	SSCS	Standard
Growth rings		distinct		indistinct	
Porous		difuse		difuse	
Vessels frequency (mm^2)		78.5	± 20.4	57.7	± 18.7
Vessels lenght (μm)		818.5	± 76.4	843.3	± 52.7
Vessels diameter (μm)		38.6	± 8.0	36.3	± 5.1
Vessels wall thickness (μm)		3.7	± 0.2	3.7	± 0.6
Number of bars of scalariform	Perforation plates	5-15	± 0.2	7-14	± 1.1
Vessels	Radial multiples	2-5		2-4	
	Clusters	2-6		2-8	
Intervessel pitting	Scalariform (μm)	15.2	± 2.4	13.9	± 2.0
	Opposite (μm)	6.5	± 1.1	6.4	± 0.5
Vessel-ray pitting	Scalariform (μm)	15.4	± 7.1	15.7	± 2.7
	Opposite (μm)	8.6	± 3.5	7.2	± 0.7
Fibers-tracheids lenght (μm)		1544.1	± 195.2	1118.3	± 705.7
Fibers-tracheids diameter (μm)		28.6	± 2.9	24.9	± 3.2
Fibers-tracheids lumina (μm)		14.3	± 1.6	11.8	± 1.2
Fibers-tracheids wall thickeness (μm)		7.2	± 0.7	6.5	± 1.3
Fibers-tracheids pits (μm)		4.3	± 1.2	3.8	± 0.85
Gelatinous fibers		present		present	
Rays frequency (linear mm)		3.0	± 0.6	3.4	± 0.1
Rays lenght (μm)		677.4	± 112.4	746.5	± 156.3
Rays width (μm)		80.6	± 10.8	80.9	± 3.3
Rays width (number of cells)		2-8	± 0.2	2-6	± 0.5
Sheath cells		present		present	
Prismatic crystals		present		present	
Indice of Vulnerability		0.5		0.6	
Indice of Mesomorphy		401.0		522.7	

RESULTS AND DISCUSSION

In general, the examined qualitative characters were constant among all studied individuals of *M. glabra* from the two restinga formations (Table II), and were consistent with previously published data for the family Monimiaceae, subfamily Mollinedioideae, and the genus *Mollinedia* (Thorne 1974 *apud* Metcalfe 1987, Barros et al. 1997, Callado et al. 1997). This species demon-

ration plates with few bars (5-15), scalariform to opposite intervessel pitting and vessel-rays pitting predominantly scalariform; fiber-tracheids septate, ranging from thin to thick; axial parenchyma extremely rare; multiseriate rays wide (uniseriate rare), heterocellular, composed of procumbent cells in the central region and marginal rows of up right and square cells, with the presence of aggregated and fused rays, sheath cells and prismatic crystals (Figs. 2-4).

TABLE III
Student *t* test results for parameters analyzed in both plant formations (α = 0,05).

Variables	*t* (observed)	p
VESSELS		
Frequency mm^2	4.39	<0.0001*
Lenght	0.37	0.7126
Diameter	1.63	0.1051
Wall thickeness	–0.12	0.8997
FIBERS-TRACHEIDS		
Lenght	0.46	0.6452
Diameter	4.29	<0.0001*
Lumina	3.87	0.0001*
Wall thickeness	1.65	0.1008
RADIAL PARENCHYMA		
Lenght	–2.52	0.0124*
Width	–0.05	0.9577
Number of cells	–0.92	0.3570
Frequency linear mm	–2.26	0.0250*

Values marked with (*) are statistically significant (P<0.05).

growth rings. In the studied specimens of *M. glabra*, the degrees of distinction of these rings ranged between the two different formations (Table II), with distinct layers marked by the thick-walled and radially flattened latewood fibers among individuals from the OPS (Fig. 2a).

The formation of growth rings in tropical species is usually associated with seasonal factors such as droughts, flooding, changes in the photoperiod, phenology, endogenous factors, or in response to stochastic factors such as insect attacks or diseases, the loss of branches, or other injuries (Worbes 1989, 1999, Alves and Angyalossy-Alfonso 2000, Callado et al. 2001, 2004). In the OPS area, the individuals of *M. glabra* experience frequent cutting and form latewood, laying down growth rings that probably represent responses to these injuries when they cease their radial growth due to the energetic investments required to form new branches. Another important characteristic of the individuals growing in the OPS is the presence of tyloses with sclerified walls (Fig. 3b). This characteristic can likewise be considered a response to anthropogenic disturbances in this formation. Tyloses are observed

considered the capacity to form sclerified tilos
taxonomic characteristic.

Among the examined quantitative characte
the two restinga formations only demonstrated
cant differences in terms of the frequency of t
sel elements, the diameter of the lumen of the
tracheids, and the length and the frequency of t
(Table III). Numerous authors have noted that
growing in dry environments usually demonstr
creased frequencies of vessels with small diamet
sociating conductive efficiency with conductive
(Carlquist 1977, Baas et al. 1983). The individ
M. glabra examined in the OPS area demonst
greater frequency of vessel elements than the
ported in SSCS individuals (Table II). In spite
variation in their frequency, no significant statisti
ferences were observed in terms of the diame
these elements (Tables II and III). Similar resu
the variation of the frequency and diameter of
elements were found for the wood of *Xilopia*
tica (Lam.) Mart. growing in cerrado (savanna
and in plantations of *Pinus elliottii* Engelm (L
al. 2005).

The higher frequency of vessel elements
ated with fiber-tracheids that have increased dia
and lumens can be considered a structural adapta
lated to the water requirements of plants growing
OPS site, due to the greater exposure of these pl
direct sunlight. The fiber-tracheids in *M. glabra* a
tate (Fig. 3c, d), which is a characteristic typical
genus *Mollinedia* (Metcalfe 1987). Esau (2000
tioned that, in taxa where axial parenchyma is ext
rare, as in the studied species, the septate fibers
sponsible for the transport and storage of photosy
products.

Although statistical tests did not demonstra
nificant differences in the lengths of the vessel el
between the two restinga formations, they did
smaller in individuals from the OPS. This charact
together with the smaller numbers of bars on the
ration plates of the vessel elements (Fig. 2c, Ta
represents adaptations to drier environments (V

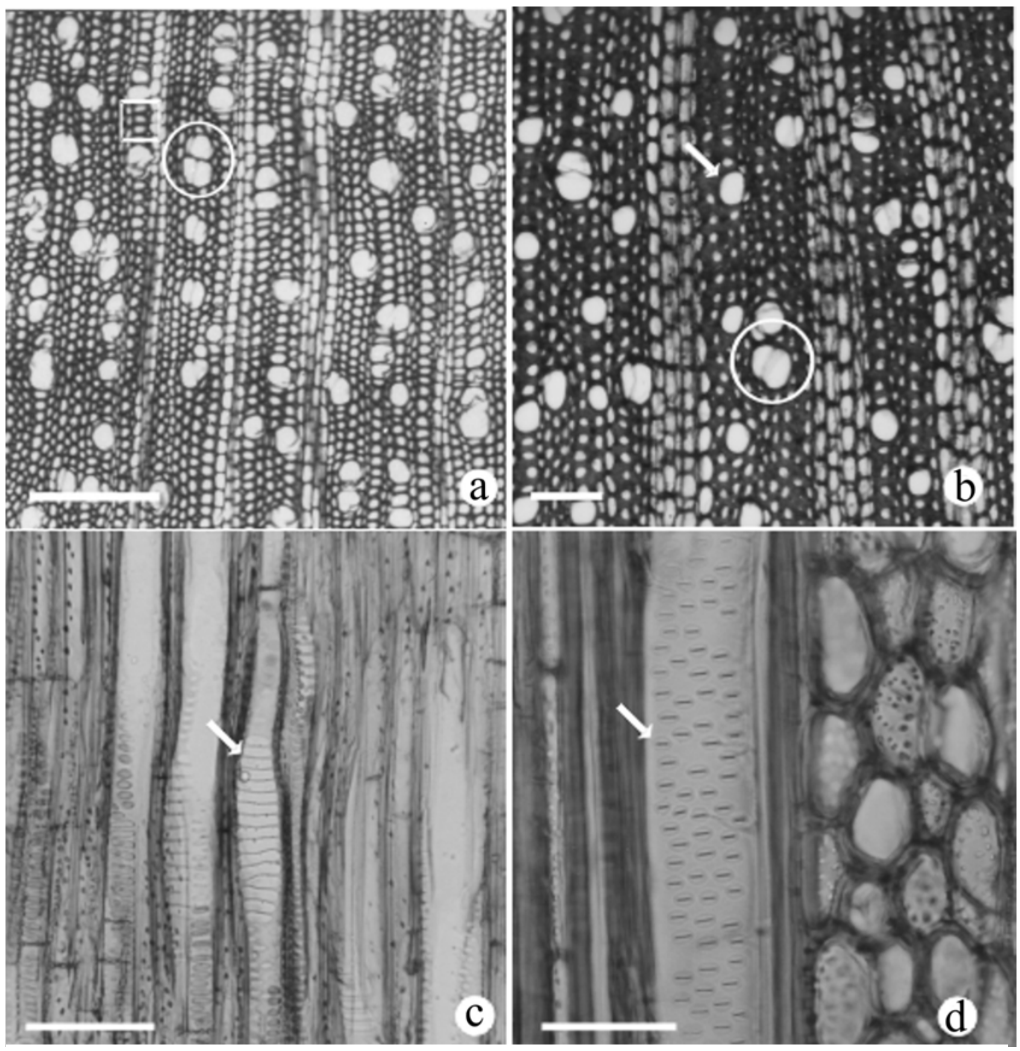

Fig. 2 – Cross and longitudinal sections of the branches of *Mollinedia glabra*. a. Growth rings distinct (square), difuse-porous, vessels clusters (circle) and solitary of OPS (CS). b. Growth rings indistinct or absent, difuse-porous, vessels paired (circle) and solitary (arrow) of SSCS (CS). c. Scalariform plates (arrow) of OPS (RLS). d. Intervessel opposite (arrow) of OPS (TLS). Bar = 200μm (a); 100μm (b, c); 50μm (d).

noted for *M. glabra* (5-15 bars) when compared to other species of *Mollinedia* growing in Dense Montane Ombrophilous Forests (and having from 20 to more than 40 bars) (Barros et al. 1997, Callado et al. 1997).

In spite of the placement of individuals of the two formations within the mesomorphic range (indices

are less mesomorphic and more vulnerable to xylem hydraulic conductivity in OPS individuals (Table II). Previous analyses undertaken with the species *Mollinedia gilgiana* Perkins, *M. marliae* A. Peixoto *et* V. Pereira, and *M. salicifolia* Perkins in Serra de Macaé de Cima (Callado et al. 1997) all demonstrated greater

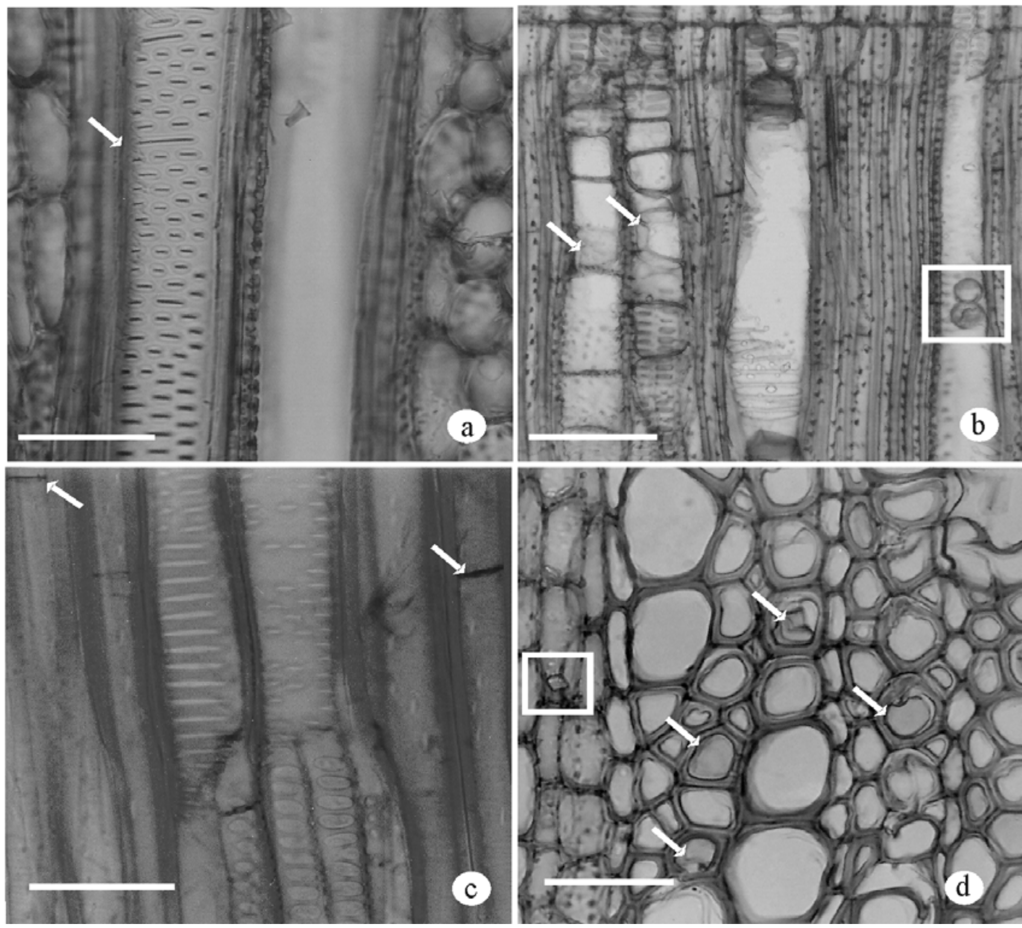

Fig. 3 – *Mollinedia glabra* wood. a. Details of intervessel pits scalariform to opposite (arrow) of OPS (TLS) b. Tyloses lightly sclerosed (arrows) and common tyloses (square) of OPS (RLS). c. Fiber-tracheids septate (arrows of OPS (TLS). d. Fiber-tracheids (arrows) and presence of prismatic crystal (square) SSCS (CS). Bar = 50μm (a, d) 100μm (b, c).

The increase in the frequency and length of the rays among the species studied here may be associated with the increasing diameters of the branches among individuals in the SSCS site (Fig. 4). The greater height of the rays has been interpreted as being important for the efficiency of radial transport between the pith and the bark (Catesson 1990, Yáñez-Espinoza et al. 2001).

The results obtained in the present study demonstrated phenotypic variations in the wood of the species being studied, and pointed towards adaptations to micro-environmental variations during the development

terial and argue for the existence of a single pop of *M. glabra* in both vegetation formations.

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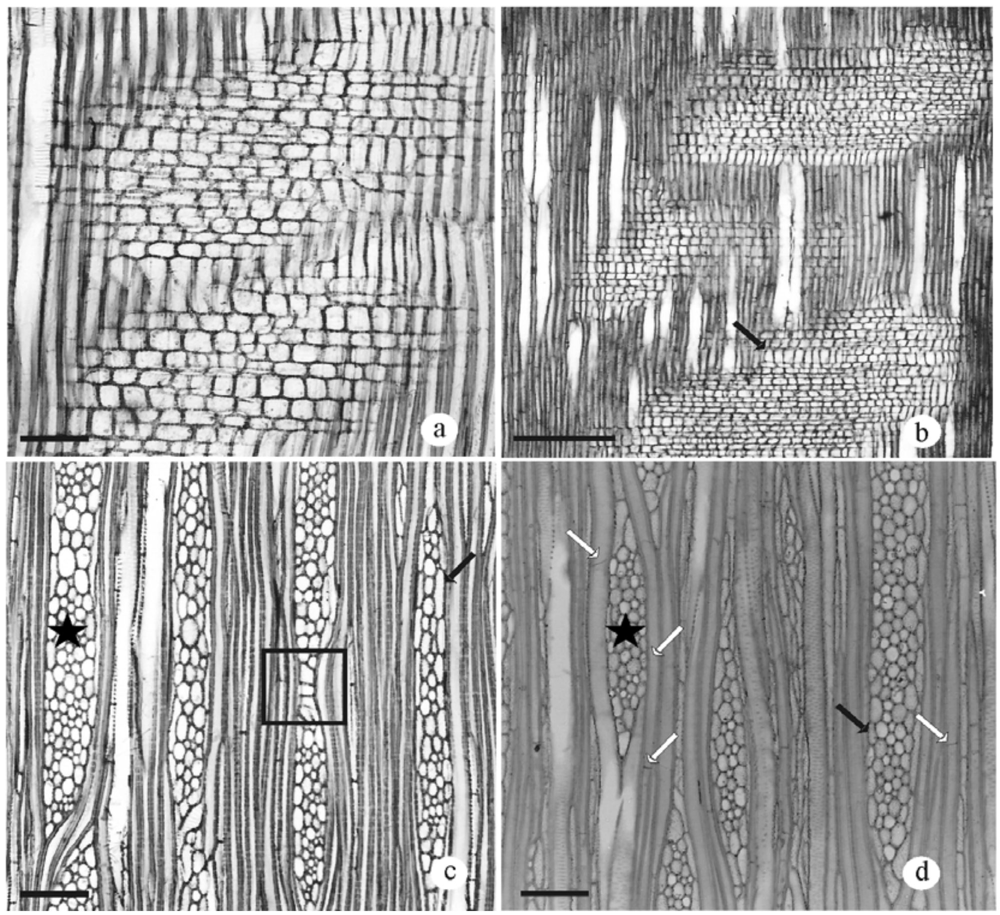

Fig. 4 – Longitudinal sections of branches of *Mollinedia glabra*. a. Upright cells, square and procumbent of OPS (RLS). b. Upright cells (arrow), square and procumbent of SSCS (RLS). c. Multisseriate rays (⋆), fusioned (square), sheath cells (arrow) of OPS (TLS). d. Multisseriate rays (⋆), sheath cells (black arrow); fiber-tracheids septate (white arrows) of SSCS (TLS). Bar = 100μm (a; c; d), 400μm (b).

RESUMO

Este trabalho objetiva caracterizar a estrutura anatômica do lenho de *Mollinedia glabra*, ocorrente em duas formações vegetais contíguas na restinga da Praia Virgem, município de Rio das Ostras, RJ. Essas formações Arbustiva Aberta de Palmae (AAP) e Arbustiva Fechada do Cordão Arenoso (AFCA) estão sobre cordão arenoso e recebem precipitações anuais de 1.100-1.300 mm. Foram obtidas amostras do lenho das duas formações. São características anatômicas gerais da espécie: elementos de vasos solitários, em arranjos radiais ou prismáticos. A análise estatística evidenciou aumento significativo na frequência dos elementos de vasos e aumento no diâmetro das fibrotraqueídes nos indivíduos de AAP. Essas características são consideradas adaptações estruturais ao aumento da necessidade de água causada por maior exposição à luz solar. A realização de podas frequentes pode ter relação com a formação de tilos nesses indivíduos. O aumento significativo no comprimento e frequência de raios podem representar uma resposta ao maior diâmetro dos indivíduos em AFCA. Os resultados obtidos sugerem que *M. glabra* desenvolve adaptações estruturais às variações micro-ambientais da

REFERENCES

AGUILAR-RODRÍGUEZ S AND BARAJAS-MORALES J. 2005. Anatomía de la madera de especies arbóreas de un bosque mesófilo montaña: un enfoque ecológico-evolutivo. Bol Soc Bot Mex 77: 51–58.

ALVES ES AND ANGYALOSSY-ALFONSO V. 2000. Ecological trends in the anatomy of some Brazilian species. I: Growthrings and vessels. IAWA Journ 21: 3–30.

BAAS P. 1973. The wood anatomy of *Ilex* (Aqüifoliaceae) and its ecological and filogenetic. Significance. Blumea 21: 193–25.

BAAS P, WERKER E AND FAHN A. 1983. Some ecological trends in vessel characters. IAWA Bull 4: 141–159.

BARROS CF, CALLADO CH, COSTA CG, PUGIALLI HRL, CUNHA M AND MARQUETE O. 1997. In: BARROS CF AND CALLADO CH (Orgs), Madeiras da Mata Atlântica-Anatomia do lenho de espécies ocorrentes nos remanescentes florestais do estado do Rio de Janeiro – Brasil, Rio de Janeiro: JBRJ 1: 62–69.

BURGUER LM AND RICHTER HG. 1991. Anatomia da Madeira. São Paulo: Ed Nobel, 154 p.

CALLADO CH, PUGIALLI HRL, COSTA CG, CUNHA M, MARQUETE O AND BARROS CF. 1997. Anatomia do lenho de espécies da Mata Atlântica: Interpretação ecológica e indicações para aproveitamento. In: LIMA HC AND GUEDES-BRUNI RR (Eds), Serra de Macaé de Cima: Diversidade Florística e Conservação em Mata Atlântica, Rio de Janeiro: JBRJ, p. 251–273.

CALLADO CH, SILVA NETO SJ, SCARANO FR AND COSTA CG. 2001. Periodicity of growth rings in some flood-prone trees of the Atlantic Rain Forest in Rio de Janeiro, Brazil. Trees – Structure and Function 15: 492–497.

CALLADO CH, SILVA NETO SJ DA, SCARANO FR AND COSTA CG. 2004. Radial growth dynamics of *Tabebuia umbellata* (Sond.) Sandwith (Bignoniaceae), a floodtolerant tree from the Atlantic Forest swamps in Brazil. IAWA J 25: 175–183.

CARLQUIST S. 1975. Ecological strategies of xylem evolutions. Berkeley: University of California Press, 259 p.

CARLQUIST S. 1977. Ecological factors in wood evolution: a floristic approach. Amer J Bot 64: 887–896.

CARLQUIST S. 2000. Wood and stem anatomy of *Sarcobatus* (Caryophyllales): systematic and ecological implica-

CATESSON AM. 1990. Cambial cytology and bioch
In: IQBAL M (Ed), The vascular cambium. Lond
search Studies Press, p. 63–112.

CORADIN VTR AND MUÑIZ GMB. 1991. Normas
cedimento em estudos de anatomia da madeira: I.
permae. II Gimnospermae. L.P.F. 5: 1–19.

DENARDI L AND MARCHIORI JNC. 2005. Anaton
lógica da madeira de *Blepharocalyx salicifolius*
Berg. Cienc Florest 15: 119–127.

DICKISON WC. 2000. Integrative Plant Anatomy.
Academic Press, 533 p.

ESAU K. 2000. Anatomia das plantas com sement
Paulo: Edgard Blucher.

FIDERJ. 1978. Indicadores climatológicos do estado
de Janeiro. Governadoria do estado do Rio de
Secretaria de Planejamento e Coordenação Gera
PLAN), Fundação Instituto de Desenvolvimento
mico e Social do Rio de Janeiro (FIDERJ). Siste
Informação para o Planejamento Estadual (SIPE)

IBAMA (INSTITUTO BRASILEIRO DO MEIO AMBI
DOS RECURSOS NATURAIS RENOVÁVEIS). 20
trução Normativa, setembro, (www.ibama.gov.b
legislacao.php?id_arq=42), (acesso em 15/01/200

IAWA COMMITTEE. 1989. List of microscopic feat
hardwood identification. IAWA Bull 10: 219–332

LEITÃO GG, SIMAS NK, SOARES SSV, BRITO
CLAROS BMG, BRITO TBM AND MONAC
1999. Chemistry and pharmacology of Mominia
special focus on *Siparuna* and *Mollinedia*. J Eth
macol 65: 87–102.

LEÓN HWJ. 2005. Anatomía ecológica del xilema
dario de um bosque seco tropical de Venezuela. A
Venez 28: 257–274.

LILLIEFORS H. 1967. On the Kolmogorov-Smirnov
normality with mean and variance unknown. J Ar
tistical Assoc 62: 399–402.

LUCHI AE, SILVA LC AND MORAES MA. 2005.
mia comparada do lenho de *Xylopia aromatica*
Mart. em áreas de cerrado e de plantação de *Pinus*
Engelm. Revista Brasil Bot 28: 809–820.

MARCATI CR, ANGYALOSSY-ALFONSO V AND
TATI L. 2001. Anatomia comparada do lenho de
fera langsdorffii Desf. (Leguminosae-Caesalpin
de floresta e cerradão. Revista Brasil Bot 3: 311

(Eds), História Natural da Marambaia, Seropédica: Edur, p. 67–120.

METCALFE CR. 1987. Anatomy of the Dicotyledons. Oxford: Clarendon. Press, 297 p.

METCALFE CR. 1989. Anatomy, Phylogeny and Taxonomy. In: METCALFE CR AND CHALK L (Eds), Anatomy of the Dicotyledons. Wood Structure and Conclusion of the General Introduction, Oxford: University Press, p. 108–125.

OCCHIONI P. 1948. Histologia e Anatomia dos órgãos vegetais (raiz, caule, folha e fruto). Contribuição do estudo da família Canellaceae. Arq Jard Bot 8: 3–96.

PEIXOTO L, SANTOS IS AND PEREIRA-MOURA MVL. 2002. Monimiaceae. In: WANDERLEY MGL, SHEPHERD GJ AND GIULIETTI AM (Coords), Flora fanerogâmica do estado de São Paulo, São Paulo: Fapesp/ Editora HUCITEC 2: 189–207.

PEIXOTO L AND PEREIRA-MOURA MVL. 2008. A new genus of Monimiaceae from the Atlantic Coastal Forest in Southeastern Brazil. Kew Bull 63: 137–141.

PEIXOTO LA. 1979. Contribuição ao conhecimento da seção *Exppendiculatae* Perkins do gênero *Mollinedia* Ruiz *et* Pavon (*Mollinedia*, Monimoideae, Monimiaceae). Rodriguésia 31: 135–222.

PEIXOTO LA, REITZ R AND GUIMARÃES FE. 2001. Monimiáceas. Flora Ilustrada Catarinense. Parte 1, 63 p.

RIBEIRO MLR DA C AND BARROS CF. 2006. Variação intraspecífica do lenho de *Pseudopiptadenia contorta* (DC.). Lewis GP and Lima MP (Leguminosae-Mimosoideae) de populações ocorrentes em dois remanescentes de Floresta Atlântica. Acta Bot Bras 20: 839–844.

WHEELER EA AND BAAS P. 1991. A survey of the fossil record for dicotyledonous wood and its significance for evolutionary and ecological wood anatomy. IAWA Bull 12: 275–332.

WORBES M. 1989. Growth rings, increment and age of trees in inundation forests, savannas and a mountain forest in the neotropics. IAWA Bull 10: 109–122.

WORBES M. 1999. Annual growth rings, rainfall-dependent growth and long-term growth patterns of tropical trees from the Caparo Forest Reserve in Venezuela. J Ecol 87: 391–403.

YÁÑEZ-ESPINOSA L, TERRAZAS T AND LÓPEZ-MATA L. 2001. Effects of flooding on wood and bark anatomy of four species in a mangrove forest community. Trees 15: 91–97.