



# Plant anatomy: history and future directions

## Charcoal anatomy of Brazilian species. III. Melastomataceae

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### Abstract

Charcoal anatomy descriptions are paramount for identifying unknown charcoal specimens in different contexts. They form an integral part of anthracological studies, which can provide crucial information for researchers of different expertise. This paper describes the charcoal anatomy of 21 species in two subfamilies (Melastomatoideae and Olisbeoideae) of Melastomataceae native to Brazil. From those, six species are here described for the first time. The results point to clear distinction between the anatomical types inside the two studied subfamilies along with a relative homogeneity in anatomical features inside Melastomatoideae. For the latter, small qualitative and quantitative differences were identified, but intrageneric and interspecific variability hamper reliable identification in generic or tribe level.

**Key words:** anthracology, archaeobotany, nature conservancy, palaeoecology.

### Resumo

Descrições da anatomia do carvão são indispensáveis para a identificação de fragmentos de carvão desconhecidos em diferentes contextos. Elas formam uma parte integral dos estudos antracológicos, e podem fornecer informações cruciais para pesquisadoras e pesquisadores de diversas especialidades. O presente artigo analisa a anatomia do carvão de 21 espécies de duas subfamílias (Melastomatoideae e Olisbeoideae) de Melastomataceae nativas do Brasil. Destas, seis espécies são descritas pela primeira vez. Os resultados apontam para uma distinção clara entre os tipos anatômicos dentro das duas subfamílias, além de uma relativa homogeneidade em características anatômicas dentro de Melastomatoideae. Para a última, pequenas diferenças qualitativas e quantitativas foram identificadas, mas a variabilidade intragenérica e interespecífica dificulta a identificação confiável a nível de gênero ou tribo.

**Palavras-chave:** antracologia, arqueobotânica, conservação da natureza, paleoecologia.

### Introduction

Charcoal, a key material for the study of past societies, is often well preserved in archaeological sites. A charcoal piece can be analyzed and identified even after thousands of years of deposition, allowing the reconstruction of the plant environment and providing multiple data regarding human use, such as technological and ritual practices, firewood economy, wood uses, and others (Figueiral & Mosbrugger 2000; Pearsall 2015; Scheel-Ybert 2020). Charcoal analysis is also important in paleoecological and modern contexts. For instance, it can be a key ally in the

effort of reducing illegal wood extraction from native biomes - which proceed from the possibility of recognizing the exploited species through their charcoal anatomy (e.g., Gonçalves & Scheel-Ybert 2012, 2016; Gonçalves *et al.* 2018). Studies of charcoal anatomy are also crucial for identifying unknown charcoals, whether archaeological, paleoecological or modern.

Anthracology is the science that identifies and interprets charcoal remains. Taxonomic identification is based on wood anatomy. This is possible due to the preservation of the anatomical structure of charred wood (Prior & Alvin 1983;

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Prior & Gasson 1993; Braadbaart & Poole 2008). Diagnostic anatomical features allow archaeological, pedological or extant unknown specimens to be identified to generic or even specific level (Scheel-Ybert 2020). This identification, however, depends on the availability of good reference material, such as comparative collections containing well identified modern specimens, but especially wood and charcoal anatomy publications (Scheel-Ybert 2016).

In the last decade, a large investment has been made in charcoal studies for the Brazilian flora. The comparison of wood and charcoal anatomy demonstrated that anatomical changes due to carbonization are of low magnitude and do not prevent charcoal identification (Leme *et al.* 2010; Gonçalves *et al.* 2012). Several charcoal anatomy descriptions aiming to assist anthracological studies and/or to contribute to controlling the use of illegal logged native wood as charcoal have been published since (Nisgoski *et al.* 2012; Gonçalves & Scheel-Ybert 2016; Muñiz *et al.* 2016; Carvalho *et al.* 2017; Pinto *et al.* 2017; Scheel-Ybert & Gonçalves 2017; Gonçalves *et al.* 2018; Souza-Pinto & Scheel-Ybert 2021). In order to contribute to this effort, this work is part of a series intended to assist anthracological and wood anatomy studies and to improve our knowledge of tropical species.

Melastomataceae is a large botanical family widely distributed in tropical and subtropical regions. It is composed of 173 genera and about 6,000 species. Although pantropically distributed, the family has a marked concentration of species in the New World where there are 3,741 species in 84 genera. From these, 11 genera and 1,453 species are endemic to Brazil (Ulloa Ulloa *et al.* 2022).

Melastomataceae's economic and medicinal importance nowadays is poorly known, as most of its uses refer to ornamental purposes. Among the few species more widely known as medicinal, several belong to the genus *Pleroma* s.l., used to ease pains in general (Cruz & Kaplan 2004). On the other hand, this family has high ecological relevance. It comprises many pioneer species, of great importance in Atlantic and Amazonian Forests and in several other Brazilian and tropical biomes as well. For this reason, they are largely used for ecological restoration (Albuquerque *et al.* 2013).

On account of its ecological and cultural importance, Melastomataceae charcoal is very frequently found in archaeological sites (*e.g.*,

Scheel-Ybert 2000; Bianchini *et al.* 2007; Beauclair *et al.* 2009; Bianchini & Scheel-Ybert 2012; Caromano *et al.* 2013; Scheel-Ybert *et al.* 2014, 2016; Bachelet & Scheel-Ybert 2017; Capucho & Scheel-Ybert 2019). However, it is rarely identified lower than family level, because of the great homogeneity of its wood anatomy (Détienne & Jacquet 1983; Scheel-Ybert 1998).

The wood anatomy of Melastomataceae is as yet incompletely known, largely because the family is composed mostly by shrubs, while its few trees are not economically valuable (Metcalf & Chalke 1950; Van Vliet 1981). Better taxonomic identifications depend on improving the knowledge on its charcoal anatomy. For that, it is key to investigate its anatomical features, in order to increase the knowledge on the wood and charcoal anatomy and verify the reliability of genera and species-level identifications. In doing so, this study aims to contribute not only to Anthracology, but also to Wood Anatomy and to other charcoal-related researches, such as Paleocology, Paleobotany, Wood Anatomy, Forensics, Forest Sciences, and others.

## Material and Methods

In this paper, we follow the classification of Melastomataceae as given in Penneys *et al.* (2022), divided in three subfamilies, Melastomatoideae, Olisbeoideae and Kibessioideae (since this subfamily has no occurrence in Brazil, it was not mentioned in this paper), with Melastomatoideae comprising 21 tribes. Genera classification inside each tribe was regarded as put by Ulloa Ulloa *et al.* (2022), Michelangeli *et al.* (2022), Stone (2022), Veranso-Libalah *et al.* (2022).

Twenty-nine charcoal samples of 21 species from 2 subfamilies of Melastomataceae native to Brazil were described. The samples were deposited in the charcoal collection of the *Laboratório de Arqueobotânica e Paisagem* (RAWA), *Museu Nacional*, Federal University of Rio de Janeiro, that was unfortunately almost entirely lost on the fire that struck the institution in September, 2018. They are the following:

Subfamily Melastomatoideae: Tribe Pyramieae: *Huberia glazioviana* Cogn.; *H. ovalifolia* DC.; *H. semiserrata* DC.; Tribe Merianieae: *Meriania excelsa* (Gardner) Cogn.; *M. robusta* Cogn.; Tribe Miconieae: *Miconia albicans* (Sw.) Triana.; *M. breviflora* (Cogn.) R. Goldenb.; *M. cinnamomifolia* (DC.) Naudin.; *M. dasytricha* (A. Gray) R. Goldenb.; *M. minutiflora*

(Bonpl.) DC.; *M. mirabilis* (Aubl.) L.O. Williams.; *M. sellowiana* Naudin.; *M. stenostachya* DC.; *M. tristis* Spring.; *Miconia* sp. [formerly in *Leandra* sp.]; Tribe Melastomateae: *Pleroma arboreum* (Gardner.) Cogn.; *P. estrellense* (Raddi) P.J.F. Guim. & Michelang.; *P. granulosum* (Desr.) D. Don.; *P. stenocarpum* (Schrank et Mart. ex DC.) Triana.

Subfamily Olisbeoideae: *Mouriri chamissoana* Cogn.; *Mouriri* sp.

The wood samples were obtained through donations from institutional wood collections, where they were already taxonomically identified by specialists: *Instituto de Pesquisas Tecnológicas do Estado de São Paulo* (BCTw), *Instituto de Botânica de São Paulo* (SPw), *Instituto de Pesquisas Jardim Botânico do Rio de Janeiro* (RBw), and *Instituto Florestal de São Paulo* (SPSFw). Samples were wrapped in aluminum foil and carbonized in a muffle furnace at 400 °C during 40 minutes (Scheel-Ybert 2004).

Charcoal samples were manually split according to the three fundamental wood sections: transversal, longitudinal tangential, and longitudinal radial. They were then examined under a reflected light brightfield/darkfield Zeiss AxioScope.A1 microscope. Descriptions followed the procedures and terminology recommended by the International Association of Wood Anatomists (IAWA Committee 1989), except for intervessel pits size, for which the internal horizontal diameter of pits apertures was measured (Scheel-Ybert & Gonçalves 2017).

Quantitative data were obtained using an ocular micrometer. They were based on 25 measurements of tangential vessel diameter and 10 measurements for the other parameters. Results are presented as arithmetic means and range (minimum and maximum values). The measurement of characters with diagnostic and identification value was prioritized. For this reason, some characters that are frequently considered in wood anatomy studies were not taken into account here, such as ray height and width (in  $\mu\text{m}$ ), vessel element length, and fibres pitting. Fibres pitting, although important for wood identification, is of small value for charcoal identification, because the homogenization of cell walls during carbonization often prevents the identification of bordered pits (Scheel-Ybert & Gonçalves 2017). The codes alongside the charcoal characteristics in the anatomical descriptions correspond to their IAWA Feature Number (IAWA Committee

1989). Photographs were obtained using the ZEN Microscopy Software with extended focus tool. A representative plate of each taxonomic group is given along their descriptions in the results section.

Taxonomic classification was revised according to the Brazilian Flora [Flora e Funga do Brasil 2022 (continuously updated)] and the Melastomataceae.Net (2007-2024) databases. Data regarding vernacular names, geographical distribution, ecological data, and uses were obtained from the specialized literature and from the List of Species of the Brazilian Flora [Flora e Funga do Brasil 2022 (continuously updated)]. They are presented in Table S1 (available on supplementary material <<https://doi.org/10.6084/m9.figshare.25818352>>).

## Results

All genera, in both subfamilies, present medium mean vessels diameter (all species between 50 and 100  $\mu\text{m}$  or very close to it) and few to moderately numerous vessels (7 to 40 vessels/ $\text{mm}^2$ ), with few species presenting a higher vessel frequency (up to 100 vessels/ $\text{mm}^2$ ) (Tab. S2, available on supplementary material <<https://doi.org/10.6084/m9.figshare.25818352>>). While *Mouriri* (Olisbeoideae) presents only non-septate fibres, Melastomatoideae exhibit great intrageneric variation, some species presenting only septate fibres, others only non-septate fibres, and others still presenting both types in the same specimens. Mineral inclusions are very common in *Mouriri* (Olisbeoideae) and generally absent in Melastomatoideae, except for one individual of *Miconia cinnamomifolia* that exhibited raphides in ray cells.

Wood anatomical descriptions for each genus follow. The species were ordered according to their taxonomic classification. A synthesis of the main anatomical features of the studied species are presented in Table S2 (available on supplementary material <<https://doi.org/10.6084/m9.figshare.25818352>>). A dichotomous key was also constructed.

Family: **Melastomataceae** Juss.

Subfamily: **Melastomatoideae** Ser. ex DC.

Tribe: **Pyramieae** Naudin.

**Huberia** DC.

Fig. 1

Growth ring boundaries: Indistinct or absent (2). Vessels: Wood diffuse-porous (5); random arrangement; solitary (48.8%) and multiple



(51.2%). Tangential diameter 91(70–130)  $\mu\text{m}$ , but 60(50–80)  $\mu\text{m}$  in *H. glazioviana*; 26(12–49) vessels/ $\text{mm}^2$ . Solitary vessel outline circular to oval. Simple perforation plates (13). Intervessel pits alternate (22); vestured; aperture diameter 14.5(10–20)  $\mu\text{m}$ , but 8(6–10)  $\mu\text{m}$  in *H. semiserrata*. Vessel-ray pits larger than intervessel pits (borders much reduced to apparently simple); rounded (31); horizontal and vertical (32). Tyloses absent in *H. ovalifolia*, rare in *H. glazioviana* and common in *H. semiserrata*. Fibres: Septate (65); very thin-walled (68) to thin-to-thick-walled (69); faint parenchyma-like fibre bands alternating with ordinary fibres (67). Axial Parenchyma: Parenchyma scanty paratracheal (78). 1–3 cells per parenchyma strand. Rays: Exclusively uniseriate (96); 20(15–25) rays/ $\text{mm}$ ; all ray cells upright and/or square (105).

**Material studied:** *Huberia glazioviana* Cogn.: RIO DE JANEIRO, Macaé de Cima (RBw 7296, RAwa 1159). *Huberia ovalifolia* DC.: RIO DE JANEIRO, Gávea Pequena (RBw 3235, RAwa 1160). *Huberia semiserrata* DC. (Fig. 1a–c). SÃO PAULO, Parque do Estado (BCTw 644, RAwa 1161).

Tribe: **Merianieae** Triana.

#### *Meriania* Sw.

Fig. 2

Growth ring boundaries: Indistinct or absent (2). Vessels: Wood diffuse-porous (5); random arrangement; solitary (56.4%) and multiple (43.6%). Tangential diameter 61(40–80)  $\mu\text{m}$ ; 44.5(34–69) vessels/ $\text{mm}^2$ . Solitary vessel outline circular to oval. Simple perforation plates (13).

Intervessel pits alternate (22); vestured; aperture diameter 7(6–10)  $\mu\text{m}$ . Vessel-ray pits larger than intervessel pits (borders much reduced to apparently simple); rounded (31); horizontal and vertical (32). Tyloses absent in *M. excelsa* and rare in *M. robusta*. Fibres: Septate (65) and non-septate (66) in *M. excelsa*, or exclusively non-septate (66) in *M. robusta*; very thin-walled (68); faint parenchyma-like fibre bands alternating with ordinary fibres (67). Axial Parenchyma: Scanty paratracheal (78); 2–4 cells per parenchyma strand. Rays: Exclusively uniseriate (96) [*M. robusta*] or 1–3-seriate (97) [*M. excelsa*]; 10(6–13) rays/ $\text{mm}$ ; all ray cells upright and/or square (105).

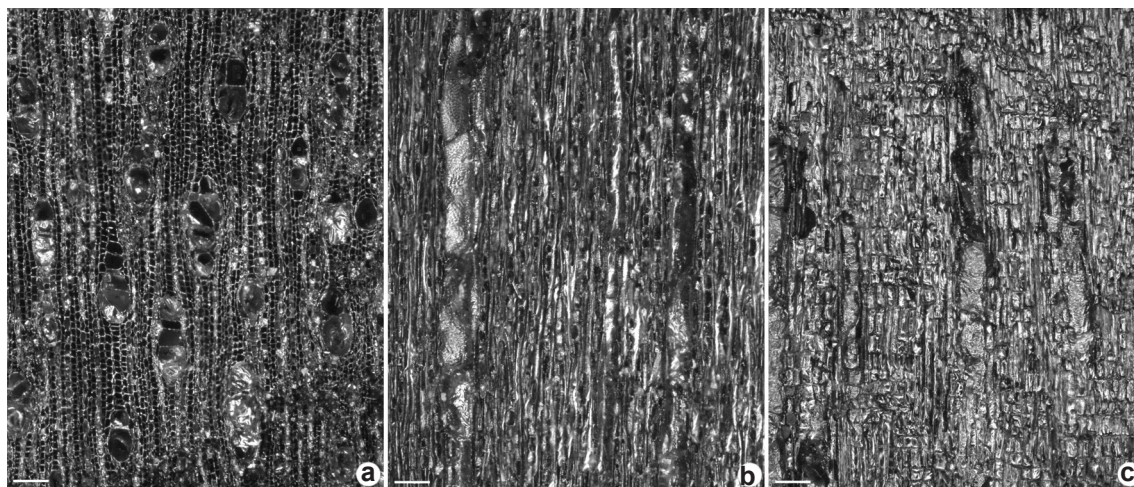
**Material studied:** *Meriania excelsa* (Gardner) Cogn. (Fig. 2a–c): RIO DE JANEIRO, Parque Nacional da Serra dos Órgãos (RBw 2180, RAwa 1167). *Meriania robusta* Cogn.: RIO DE JANEIRO, Macaé de Cima (RBw 7275, RAwa 1168).

Tribe: **Miconieae** DC.

#### *Miconia* Ruiz & Pav.

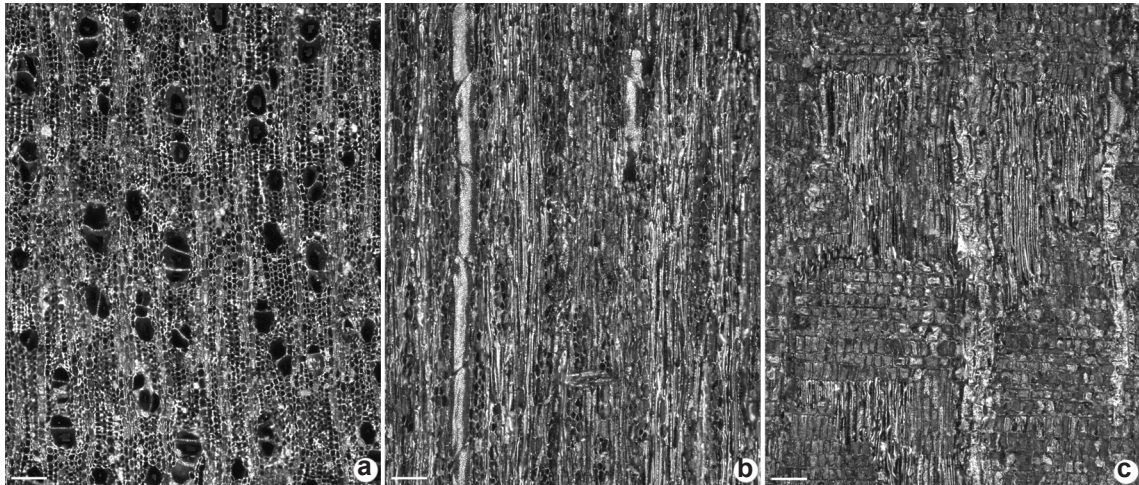
Fig. 3

Growth ring boundaries: Indistinct or absent, or sometimes boundaries marked by weakly distinguished early and thick-walled latewood fibres [RAwa 1173; RAwa 1174]. Vessels: Wood diffuse-porous (5); random arrangement; solitary (51.5%) and multiple (48.5%). Tangential diameter 77.5(50–130)  $\mu\text{m}$ , or 51(30–80)  $\mu\text{m}$  [*M. albicans*, *M. breviflora*, *M. dasytricha* and *M. stenostachya*] and 91(70–100)  $\mu\text{m}$  [*Miconia* sp.]; 16(11–20) to 94.6(75–139) vessels/ $\text{mm}^2$ . Solitary vessel outline



**Figure 1** – a–c. *Huberia semiserrata* (BCTw 644, RAwa 1161) – a. transverse section; b. tangential section; c. radial section. Bars = 100  $\mu\text{m}$ .

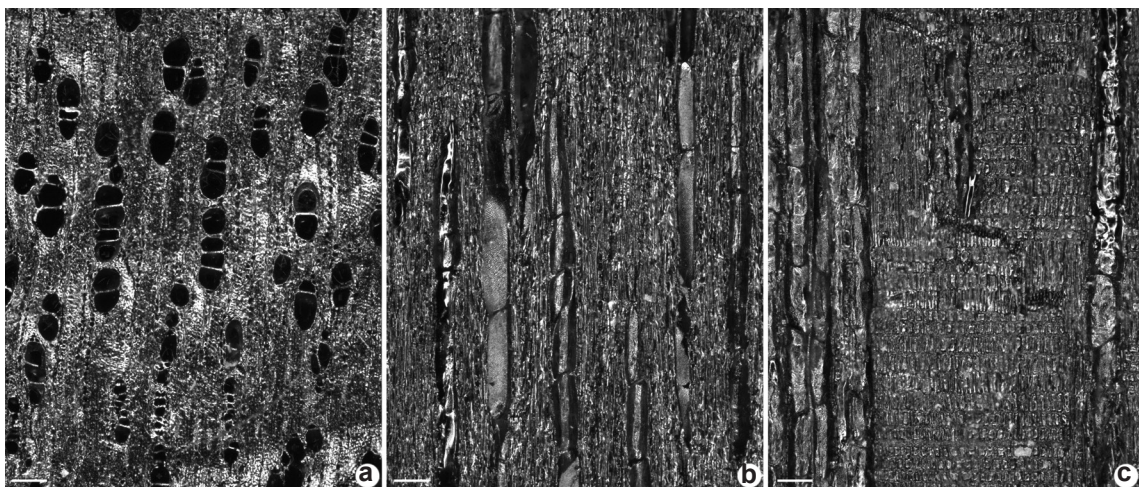




**Figure 2** – a-c. *Meriania excelsa* (RBw 2180, RAwa 1167) – a. transverse section; b. tangential section; c. radial section. Bars = 100  $\mu$ m.

circular to oval. Simple perforation plates (13). Intervessel pits alternate (22); vestured; aperture diameter 2.6(2–6)  $\mu$ m or 4(3–5)  $\mu$ m in *Miconia* sp., 7(5–8) in *M. dasytricha*, 7(6–10)  $\mu$ m in *M. mirabilis*, and 7.4(6–10) in *M. robusta*. Vessel-ray pits similar to intervessel pits in size and shape throughout the ray cell (30) [*M. albicans*, *M. cinnamomifolia*, *M. minutiflora*, *M. sellowiana* and *M. stenostachya*] or larger than intervessel pits (borders much reduced to apparently simple); rounded (31); horizontal and vertical (32) [*M. breviflora*, *M. dasytricha*, *M. mirabilis* and

*M. tristis*]. Tyloses absent in *M. albicans*, *M. breviflora*, *M. cinnamomifolia*, *M. dasytricha*, *M. sellowiana*, *M. stenostachya*, *M. tristis* and *Miconia* sp., rare in *M. cinnamomifolia* (SPw 1139), *M. minutiflora*, *M. mirabilis*, and common in *M. cinnamomifolia* (BCTw 16253). Fibres: Septate (65) and non-septate (66), or exclusively septate (65) in *M. mirabilis* and *M. stenostachya*; very thin-walled (68) or thin-to-thick-walled (69); faint parenchyma-like fibre bands alternating with ordinary fibres (67). Axial Parenchyma: Scanty paratracheal (78); 1-6 cells per parenchyma strand.



**Figure 3** – a-c. *Miconia stenostachya* (BCTw 6366, RAwa 1184) – a. transverse section; b. tangential section; c. radial section. Bars = 100  $\mu$ m.



Rays: Exclusively uniseriate (96), and rarely 2-seriate [*M. sellowiana*]; 14(8–28) rays/mm [6(4–10) rays/mm in *M. albicans*]; all ray cells upright and/or square (105). Rare procumbent cells in *M. minutiflora*, *M. sellowiana*, and *M. tristis*. Mineral inclusions: Rare raphides crystals on the rays (149) in *M. cinnamomifolia* (RAwa 1171).

**Material studied:** *Miconia albicans* (Sw.) Triana.: SÃO PAULO, Itirapina (SPw 200, RAwa 1169). *Miconia breviflora* (Cogn.) R. Goldenb.: RIO DE JANEIRO, Macaé de Cima (RBw 7253, RAwa 1162). *Miconia cinnamomifolia* (DC.) Naudin.: SÃO PAULO, Serra da Cantareira (SPSFw 1667, RAwa 1174); SÃO PAULO (RBw 1705, RAwa 1173); SÃO PAULO, Jardim Botânico (SPw 1139, RAwa 1175). MINAS GERAIS, Universidade Federal de Viçosa (BCTw 16253, RAwa 1171). *Miconia dasytricha* (A. Gray) R. Goldenb.: SÃO PAULO, Ilha Bela (BCTw 19139, RAwa 1163). *Miconia minutiflora* (Bonpl.) DC.: PARÁ, Belém (SPSFw 836, RAwa 1180). *Miconia mirabilis* (Aubl.) L.O. Williams.: RIO DE JANEIRO, Mesa do Imperador (RBw 1248, RAwa 1179). *Miconia sellowiana* Naudin.: SÃO PAULO, Parque do Estado (BCTw 633, RAwa 1181). *Miconia stenostachya* DC. (Fig. 3a-c): PARÁ, Belém (BCTw 6366, RAwa 1184). *Miconia tristis* Spring.: RIO DE JANEIRO, Parque Nacional da Serra dos Órgãos (RBw 2188, RAwa 1187). *Miconia* sp. [*Leandra* sp.] SÃO PAULO, Chapada (BCTw 647, RAwa 1164).

Tribe: **Melastomateae** Bartl.

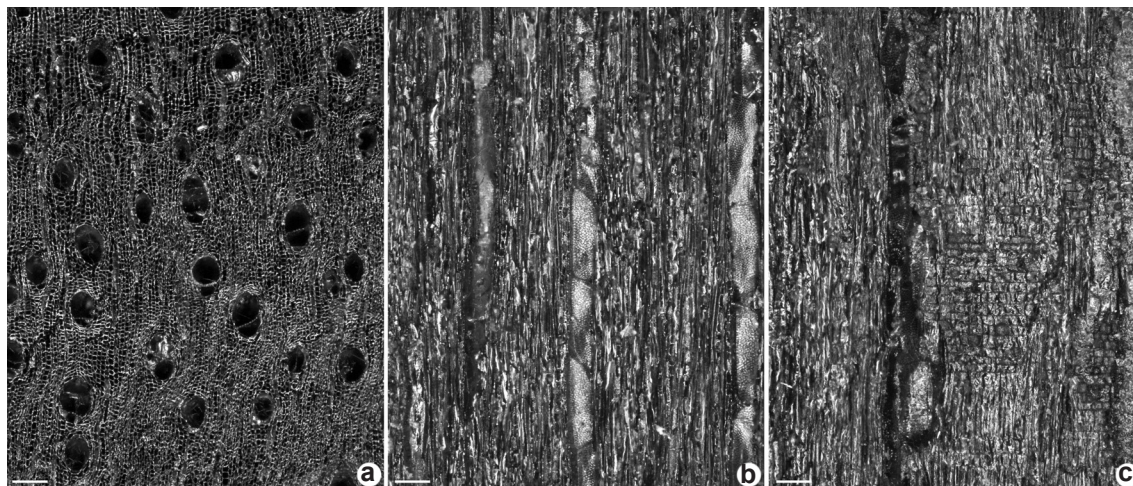
*Pleroma* D. Don.

Fig. 4

Growth ring boundaries: Indistinct or absent (2). Vessels: Wood diffuse-porous (5);

random arrangement; solitary (38%) and multiple (62%) (64.4% solitary and 35.6% multiple in *P. granulatum* and *P. estrellense*). Tangential diameter 92(50–150)  $\mu\text{m}$ , 15.5(8–32) vessels/ $\text{mm}^2$ . Solitary vessel outline circular to oval. Simple perforation plates (13). Intervessel pits alternate (22); vestured; aperture diameter 6(4–10)  $\mu\text{m}$ . Vessel-ray pits larger than intervessel pits (borders much reduced to apparently simple); rounded (31). Tyloses absent in *P. granulatum* and *P. stenocarpum*, and common in *P. arboreum* and *P. estrellense*. Fibres: Septate (65) and non-septate (66), or exclusively septate (65) in *P. estrellense* and exclusively non-septate in *P. granulatum* (66); very thin-walled (68) or thin-to-thick-walled (69); conspicuous parenchyma-like fibre bands alternating with ordinary fibres (67). Axial Parenchyma: Scanty paratracheal (78); 1–4 cells per parenchyma strand. Rays: Exclusively uniseriate [*P. granulatum*], or 1(–2)-seriate [*P. arboreum*], 1–2(–3)-seriate [*P. estrellense*] and 1–3(–4)-seriate [*P. stenocarpum*]; 11(7–19) rays/mm; upright, square and procumbent cells mixed throughout the ray (109).

**Material studied:** *Pleroma arboreum* Gardner. (Fig. 4a-c): RIO DE JANEIRO, Parque Nacional da Serra dos Órgãos (RBw 2169, RAwa 1195). *Pleroma estrellense* (Raddi) P.J.F. Guim. & Michelang.: RIO DE JANEIRO, Parque Nacional Itatiaia (RBw 2256, RAwa 1197); RIO DE JANEIRO, Pico Itatiaia (BCTw 6065, RAwa 1196). *Pleroma granulatum* (Desr.) D. Don.: SÃO PAULO, Serra da Cantareira (BCTw 637, RAwa 1198). *Pleroma stenocarpum* (Schrank et Mart. ex DC.) Triana.: MINAS GERAIS, Serra do Cipó (SPw 713, RAwa 1201).



**Figure 4** – a-c. *Pleroma arboreum* (RBw 2169, RAwa 1195) – a. transverse section; b. tangential section; c. radial section. Bars = 100  $\mu\text{m}$ .

Subfamily: **Olisbeoideae** Burnett.

**Mouriri** Aubl.

Fig. 5

Growth ring boundaries: Indistinct or absent (2). Vessels: Wood diffuse-porous (5); random arrangement; exclusively solitary or solitary (77.5%) and multiple (22.5%) in RAwa 1190, RAwa 1191 and RAwa 1192. Tangential diameter 81.5(50–110)  $\mu\text{m}$ . 19.8(10–34) vessels/ $\text{mm}^2$ . Solitary vessel outline circular to oval. Simple perforation plates (13). Intervessel pits alternate (22); vestured; aperture diameter 7.5(4–10)  $\mu\text{m}$ . Vessel-ray pits similar to intervessel pits in size and shape throughout the ray cell (30). Tyloses absent, and rare in *M. chamissoana* (BCTw 645). Fibres: Non-septate (66); very thick-walled (70).

Axial Parenchyma: Paratracheal vasicentric (79); aliform (80) and confluent (83). Rays: Exclusively uniseriate; 17.5(10–24) rays/ $\text{mm}$ ; all cells upright and/or square (105). Mineral inclusions: Presence of prismatic (136); styloids and/or elongate (151) crystals on the included phloem in *M. chamissoana* and on the vessels in *Mouriri* sp; crystal sand (153) in ray cells in the latter. Cambial variants: Included phloem; diffuse (134).

**Material studied:** *Mouriri chamissoana* Cogn. (Fig. 5a-c): SÃO PAULO, Jardim Botânico (SPw 1138, RAwa 1193); SÃO PAULO, Serra da Cantareira (SPSFw 2564, RAwa 1192); SÃO PAULO, Parque do Estado (BCTw 646, RAwa 1191); SÃO PAULO, Chapada (BCTw 645, RAwa 1190); MARANHÃO (BCTw 17369, RAwa 1189). *Mouriri* sp. Aubl.: RIO DE JANEIRO, Ilha Grande (BCTw 6837, RAwa 1194).

### Key to the analyzed Melastomataceae charcoal anatomy samples

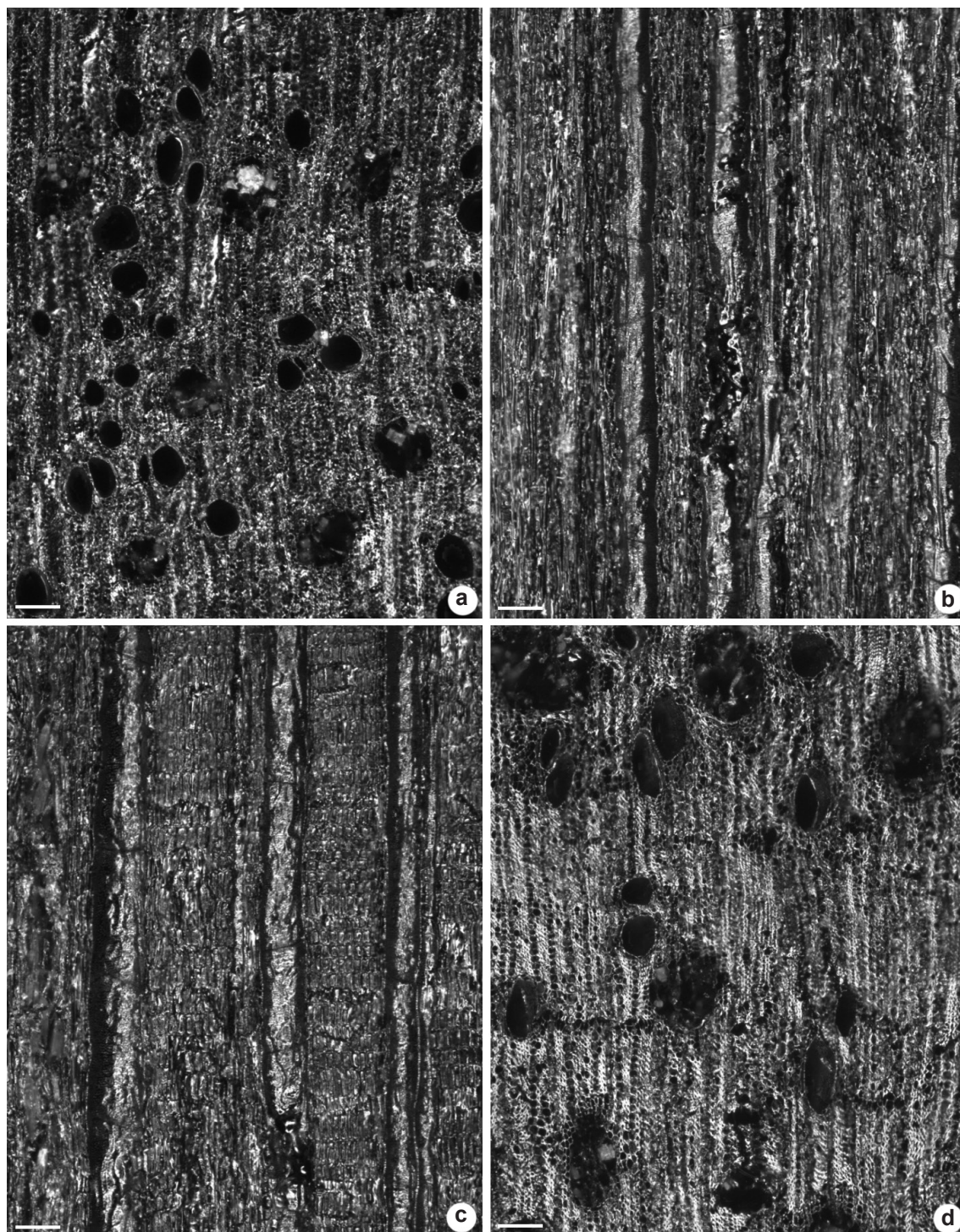
1. Presence of included phloem; axial parenchyma vasicentric or aliform ..... *Mouriri*
- 1'. Absence of included phloem; axial parenchyma scanty paratracheal or very rare ..... 2
2. Vessel-ray pits similar to intervessel pits in size and shape ..... *Miconia cinnamomifolia*, *M. minutiflora*, *M. sellowiana*, *M. stenostachya*
- 2'. Vessel-ray pits larger than intervessel pits ..... 3
3. Conspicuous parenchyma-like fibre bands alternating with ordinary fibres ..... *Pleroma*
- 3'. Faint or inconspicuous parenchyma-like fibre bands alternating with ordinary fibres .....  
*Meriania*, *Huberia*, *Miconia breviflora*, *M. dasytricha*, *M. mirabilis*, *M. tristes*, *Miconia* sp.

### Discussion

Circumscription of the Melastomataceae family has been kept relatively steadily over the years; the main controversies relate to the status of Olisbeoideae (previously Memecyloideae Meisn.), as a subfamily of Melastomataceae or as an autonomous family (Goldenberg *et al.* 2012; Stone 2022). Indeed, several authors argued for the separation between the Olisbeoideae subfamily (as Memecylaceae DC) and other clades such as Melastomataceae Juss. (Van Vliet 1981; Van Vliet *et al.* 1981; Ter Welle & Koek-Noorman 1981; Renner 1993), on the basis of wood anatomy features, especially regarding the presence of included phloem and fibre-tracheids in the first. Others agree that both are related groups which can be considered either as distinct families or in a single family (Conti *et al.* 1996; Clausen & Renner 2001; Goldenberg *et al.* 2012). Phylogenetic data corroborates the positioning of Olisbeoideae in Melastomataceae, since DNA and anatomical data suggest a close relationship between this subfamily and Kibessioideae (Penneys *et al.* 2022).

Wood and charcoal anatomy, however, are clearly distinguishable between the two studied subfamilies, Olisbeoideae (*Mouriri*) and Melastomatoideae [for which we analyzed species from the tribes Pyramieae (*Huberia*), Merianieae (*Meriania*), Miconieae (*Miconia*), and Melastomateae (*Pleroma*)]. *Mouriri* stands out for presenting included phloem and axial parenchyma vasicentric or aliform, while the other genera characteristically present axial parenchyma absent or scanty paratracheal and parenchyma-like fibre bands alternating with ordinary fibres. These bands seem to be more conspicuous in Melastomateae (*Pleroma*), when compared to the other genera. Inside Melastomatoideae, some *Miconia* species can be distinguished by the presence of vessel-ray pits similar to intervessel pits in size and shape, which contrasts to the larger vessel-ray pits typical from the other genera. Merianieae, Miconieae, and Melastomateae species can also be distinguished by small differences in rays seriation (either uniseriate or weakly multiseriate) and composition (rays composed either by upright and square cells





**Figure 5** – a-d. *Mouriri chamissoana* – a-c. (SPw 1138, RAwa 1193) – a. transverse section; b. tangential section; c. radial section; d. transverse section. Bars = 100  $\mu$ m.



only or by upright, square and procumbent cells mixed throughout the ray). However, none of these characters are consistent inside each genera or tribe, not being useful to separate the groups at taxonomic level.

All of the descriptions presented on this paper agree, in general lines, to previous wood anatomy studies available in the literature (Metcalfe & Chalk 1950; Koek-Noorman *et al.* 1979; Van Vliet *et al.* 1981; Ter Welle & Koek-Noorman 1981; Détienné & Jacquet 1983; Barros & Callado 1997 *apud* Insidewood 2004-onwards; Bosio *et al.* 2010; Scheel-Ybert & Gonçalves 2017). They also agree to specific wood descriptions of *Huberia glazioviana* (Barros & Callado 1997 *apud* Insidewood 2004-onwards), *H. semiserrata* (Ter Welle & Koek-Noorman 1981), *Miconia* sp. (named as *Leandra* in Ter Welle & Koek-Noorman 1981), *Meriania robusta* (Barros & Callado 1997 *apud* Insidewood 2004-onwards), *Miconia albicans* (Sonsin *et al.* 2014), *M. breviflora* (Barros & Callado 1997 *apud* Insidewood 2004-onwards), *M. minutiflora* (Ter Welle & Koek-Noorman 1981), *M. mirabilis* (Silva *et al.* 2015), *M. sellowiana* (Marcon & Costa 2000; Bosio *et al.* 2010), *Pleroma arboreum* (Ter Welle & Koek-Noorman 1981), *Pleroma estrellense* (Barros *et al.* 2001 *apud* Insidewood 2004-onwards).

Some small description divergences, however, occurred for some species. This is not unusual, and may happen for a series of reasons, including ecological differences and the conditions of growth of each individual. We present below some of the discrepancies found between our descriptions and the available literature.

Previous studies on *Miconia cinnamomifolia* described rays as 1–3-seriate (Barros & Callado 1997 *apud* Insidewood 2004-onwards), uniseriate and uniseriate with biseriate portions (Marcon & Costa 2000) or uniseriate (Scheel-Ybert & Gonçalves 2017). The present description agrees with the last.

Previous descriptions of *Pleroma stenocarpum* identified axial parenchyma diffuse (Sonsin *et al.* 2012, 2014), while the samples analysed here presented scanty paratracheal parenchyma.

Prior studies on *Mouriri* sp. described some variation on axial parenchyma. Ter Welle & Koek-Noorman (1981) attested a variation of diffuse apotracheal, scanty paratracheal, aliform, aliform-confluent and tangential/wavy bands parenchyma, on samples comprising *M. acutiflora* Naudin., *M. chamissoana*, *M. crassifolia* Sagot. and *M. vernicosa* Naudin. Van Vliet *et al.* (1981) classified vasicentric and aliform confluent parenchyma for *Mouriri* sp.;

and León (2012) attested, for *M. barinensis* (Morley) Morley, apotracheal, diffuse-in-aggregates, scanty paratracheal, vasicentric and aliform parenchyma. As for descriptions available on Insidewood (2004-onwards), scanty paratracheal and winged-aliform are recorded for *Mouriri* sp. Our results agree with Van Vliet *et al.* (1981) and with general descriptions for the genera.

Six out of the twenty-one analyzed species are having its wood and charcoal anatomical description presented for the first time, to the best of our knowledge. They are: *Huberia ovalifolia*, *Meriania excelsa*, *Miconia dasytricha*, *Miconia stenostachya*, *Miconia tristis*, *Pleroma granulolum*. As for charcoal anatomy, two species had published descriptions: *Miconia cinnamomifolia* (DC.) Naudin. (Carvalho *et al.* 2017; Scheel-Ybert & Gonçalves 2017) and *Mouriri chamissoana* Cogn. (Ter Welle & Koek-Noorman 1981; Scheel-Ybert & Gonçalves 2017). For the other nineteen species analyzed, charcoal anatomy descriptions are being presented for the first time.

Charcoal reference collections are paramount for identifying unknown charcoal specimens in different contexts and form an integral part of anthracological studies, which can provide crucial information for researchers of different expertise (Scheel-Ybert 2016). Likewise, charcoal anatomy descriptions and photographs are also of great value to assist in the identification of unknown ancient or modern charcoal samples. The high diversity of tropical woods adds to the difficulties of charcoal identification, highlighting the value of constituting comparative collections of modern charcoal and creating databases of anatomical descriptions.

In this paper, we contributed to this effort by describing the charcoal anatomy of 21 Melastomataceae species. Wood and charcoal anatomy of Brazilian Melastomataceae are, in general, very homogeneous, especially inside Melastomatoideae subfamily, hindering the distinction of genera and species. The present research evidenced a few diagnostic features that may help in better identifications, but further work on the description of more specimens is still needed.

This work corroborated previous studies pointing to diagnostic features in *Mouriri* (Olisbeoideae) such as the presence of included phloem and axial parenchyma vasicentric or aliform. In Melastomatoideae we demonstrate the consistency of traits such as heterogeneous rays, axial parenchyma absent or scanty paratracheal,

and parenchyma-like fibre bands alternating with ordinary fibres. Some *Miconia* species stand out by the presence of vessel-ray pits similar to intervessel pits in size and shape, while *Pleroma* can be distinguished by the conspicuousness of parenchyma-like fibre bands. Although small differences related to rays seriation and composition might help distinguishing different species in this subfamily, intergeneric and intraspecific variability hamper reliable identification in generic or even in tribe level.

The effort to analyze and characterize inframiliar taxonomic groups is particularly important in cases such as the one presented here, where the family is of certain homogeneity on its traits and requires a focused study. This research may indicate possible means of taxonomic distinction. Not only does it contribute to a better knowledge of our native flora, but also leads to increased accuracy in charcoal identification. This is of chief concern to the work of anthracologists and to all those who, for multiple reasons, search to identify wood specimens, be it in archaeological, palaeoecological, environmental, forensics, or any other context.

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### Data availability statement

In accordance with Open Science communication practices, the authors inform that all data are available within the manuscript.

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