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Original Article

Wood anatomy of *Myrrhinium atropurpureum* Schott (Myrtaceae)

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Abstract: The Atlantic Forest biome, which predominates in southern Brazil, consists primarily of dense and mixed Ombrophilous Forests, where the Myrtaceae Juss. plays an important role. Due to the large number of species and the scarcity of taxonomic studies, the family is considered difficult to identify. Therefore, the present study aimed to analyze the wood of *Myrrhinium atropurpureum* Schott from São José dos Pinhais, Paraná. Histological sections and macerates were prepared from stem wood samples of three individuals and analyzed under a light microscope. *M. atropurpureum* has grayish bark and light-yellow wood, with no characteristic luster, odor, or taste, and is very resistant to cutting. The growth rings are distinct to the naked eye, formed by fibrous zones; the porosity is diffuse; the pores are circular to oval and mostly solitary, with an average diameter of 35.53 µm; and the vessel elements have an average length of 497.55 µm; the perforation plates are simple, and the intervessel pits are alternate, sometimes tending to be opposite, with an average diameter of 3.96 µm. The axial parenchyma is diffuse in aggregates, consisting of series 5-7 cells high, with the presence of prismatic crystals. The rays are heterogeneous and unstratified, mostly two cells wide, with an average height of 188.31 µm and an average width of 16.23 µm; the fibers are fibrotracheids, with an average height of 950.75 µm and an average wall thickness of 6.33 µm. The results are consistent with the basic characteristics of Myrtaceae wood and will help resolve outstanding taxonomic issues within the family.

Keywords: Wood anatomy, Mixed Ombrophilous Forest, murtilho.

Resumo: (Anatomia da madeira de *Myrrhinium atropurpureum* Schott (Myrtaceae)). O bioma Mata Atlântica, predominante no sul do Brasil, possui como principais formações as Florestas Ombrófilas Densa e Mista, onde Myrtaceae Juss. é família importante. Devido ao grande número de espécies e escassez de estudos taxonômicos, a família é considerada de difícil determinação. Por isso, o presente estudo objetivou analisar o lenho de *Myrrhinium atropurpureum* Schott de São José dos Pinhais/PR. Com amostras de lenho de caule de três plantas foram preparadas lâminas histológicas e macerados, analisados em microscopia de luz. *M. atropurpureum* apresenta casca acinzentada e lenho de cor amarelo claro, sem brilho, odor ou gosto característicos, e é muito resistente ao corte. As camadas de crescimento são distintas a olho nu, formadas por zonas fibrosas, a porosidade é difusa, os poros são circulares a ovais e solitários em maioria, diâmetro médio de 35,53 µm, com elementos de vaso de comprimento médio de 497,55 µm; as placas de perfuração são simples e as pontoações intervasculares são alternas às vezes tendendo à opostas, com 3,96 µm de diâmetro médio. O parênquima axial é difuso-em-agregados, série de 5-7 células de altura, com presença de cristais prismáticos. Os raios são heterogêneos e não estratificados, com duas células de largura em maioria, média de 188,31 µm de altura e 16,23 µm de largura; as fibras são fibrotraqueídes, com média de 950,75 µm de altura e espessura média da parede de 6,33 µm. O resultado corrobora com as características básicas para o lenho de Myrtaceae e contribuirá com esclarecimentos taxonômicos pendentes na família.

Palavras-chave: Anatomia da madeira, Floresta Ombrófila Mista, murtilho.

Introduction

The Atlantic Forest is composed of a variety of vegetation formations and is the fourth biome on the planet with the highest number of endemic plant and animal species (Fundação SOS Mata Atlântica, 2023). Approximately only 12% of its original coverage remains, and it is classified as one of the priority conservation hotspots (Myers et al., 2000; Saout et al., 2013). Human activity has led to the fragmentation of these forests, causing environmental damage such as reproductive and genetic isolation, susceptibility to pest attacks, and climate variations (Zaú, 1998; Lopes, 2004; Seoane et al., 2010). In southern Brazil, the Atlantic Forest is the predominant biome, and in the state of Paraná, it covers a forest area of 23,136.13 km², representing 11.8% of the original forest cover (Fundação SOS Mata Atlântica, 2023), where only 1% of the mixed rainforest remains, out of the 37% that originally covered the state (Dias & Mikich, 2006).

Among the most important plant families in the Ombrophilous Forests is Myrtaceae Juss., with 140 genera and 6,000 species distributed across subtropical and pantropical regions (Judd et al., 2009; Souza & Lorenzi, 2019; POWO, 2026; Flora e Funga do Brasil, 2026), with 29 genera and 1,223 species in Brazil, of which four genera and 814 species are endemic (Flora e Funga do Brasil, 2026). It comprises two subfamilies (Lucas et al., 2019): Psiloxyloideae, restricted to Madagascar and comprising two tribes and two genera: *Psiloxylon* (tribe Psiloxyleae) and *Heteropyxis* (tribe Heteropyxideae), with species characterized primarily by plants with alternate leaves and dry fruits; and Myrtoideae, the most diverse subfamily, which represents the traditional circumscription of Myrtaceae and comprises 15 tribes, of which Eucalypteae, Myrteae, and Syzygieae are the most species-rich (Flora e Funga do Brasil, 2026). Myrtoideae has a Neotropical distribution, with species characterized by opposite or whorled leaves and fleshy fruits; these species are widely distributed and exhibit great diversity in the Ombrophilous Forests of the Atlantic Forest (Souza & Lorenzi, 2019). In Brazil, there are 29 genera and 1,223 species, of which four genera and 814 species are endemic (Flora e Funga do Brasil, 2026), many of which have considerable economic value (timber) and nutritional value (fruits and honey), making it one of the families with the largest number of economically important species in the country (Kniess, 2016). They are always woody plants, mostly trees, shrubs or subshrubs; all share a high degree of morphological similarity and are generally considered difficult to identify taxonomically due to the large number of species and the scarcity of taxonomic studies (Barroso, 1984; Sobral, 2003; Souza & Lorenzi, 2019).

Myrrhinium belongs to the subfamily Myrtoideae, tribe Myrteae, subtribe Pimentinae O.Berg. (Lucas et al., 2019), which also includes the genera *Acca, Amomyrtella, Campomanesia, Curitiba, Feijoa, Legrandia, Pimenta, Psidium*, and *Mosiera* (The Neotropical Myrtaceae Working Group et al., 2024). It is a monospecific genus, morphologically very distinct from the other genera in Myrtaceae (Lima, 2026). It is typically South American, and due to its distribution in Brazil, Uruguay, Argentina, and Colombia, it was initially described as comprising seven species (Landrum, 1986). Following studies by Landrum (1986), the existence of a single species, *Myrrhinium atropurpureum* Schott, was confirmed. Commonly known as “carrapato”, “carrapatinho”, “pau-ferro” or “murtilho”, it is characterized as a small tree, generally found in riparian areas, with opposite leaves lacking stipules and distinctive flowers featuring fleshy pink or reddish petals and long red stamens (Fig. 1A–B) (Milani et al., 2015; Landrum, 1986; Lima, 2026).

Studies on the leaf anatomy of *Myrrhinium atropurpureum* in Argentina were conducted by Roitman et al. (1997). However, the only recorded studies on stem wood anatomy are those by Santos & Marchiori (2011b), though they lack a more in-depth discussion or a comparison with closely related genera, which was outside the scope of the authors’ work.

Given the ecological importance of Myrtaceae species to the Brazilian flora and to forest communities in southern Brazil, the lack of more detailed studies on the anatomy of the stem wood of *Myrrhinium atropurpureum* and on how the use of these data in phylogenetic studies can help elucidate the species’ biogeographic and phylogenetic history, justifies the conduct of this study, through the analysis and description of the anatomical, qualitative, and quantitative characteristics of its wood, in comparison with other genera of the family.

Material and Methods

The study was conducted using samples of *Myrrhinium atropurpureum* collected at the locations shown in Fig. 2, in the municipality of São José dos Pinhais, Paraná state, within the Atlantic Forest biome, in a mixed rainforest formation (IBGE, 2012).

The region’s climate is classified as Cfb (Temperate Humid climate), according to the Köppen-Geiger classification (Ayoade, 2007). The average temperature in the hottest month is below 22°C, and in the coldest month, below 18°C; there is no dry season, summer are mild, with severe and frequent frosts in the winter (Ayoade, 2007).

To collect the wood samples, a field expedition was conducted in April 2023. In the areas where the species occurs, three individuals were randomly selected, choosing those with straight, intact trunks free of scars. Due to the small trunk diameter, it was decided to collect samples from branches, preferably lower ones with a larger diameter, using a handsaw. A voucher specimen is housed in the JOI Herbarium collection (accession 19,674), and a wood sample is deposited in the JOIw collection (accession 1,120).



Figure 1: *Myrrhinium atropurpureum* A: Leaves. B: Flowers. C: Detail of the bark and wood of a branch. Source: Primary.

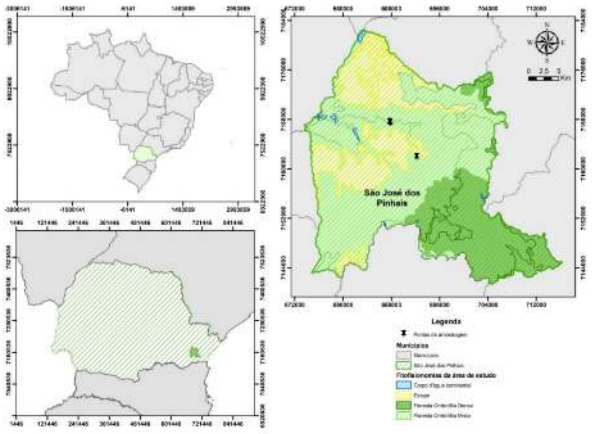


Figure 2: Study area and collection sites. Source: Primary.

A block measuring approximately 2 × 2 × 2 cm, with the transverse, longitudinal, tangential, and radial surfaces oriented correctly, was prepared from each wood sample. For macroscopic analysis, the transverse surface was polished to observe porosity and pore arrangement under a 10x magnifying lens. For microscopic analysis, the blocks were softened by boiling in water and glycerine for 60 hours (Ferreirinha, 1958), until they were soft enough to be cut on a sliding microtome (ZEISS) using a type C tungsten blade, yielding transverse, tangential longitudinal, and radial longitudinal sections with a thickness of 20 to 30 µm, for analysis of the following characteristics: diameter, length, and frequency of vessels; length, lumen diameter, and wall thickness of the fiber; height, width, and frequency of rays; and height and width of intervessel pits.

Histological slides were prepared according to the method described by Kraus and Arduin (1997); the sections were clarified with sodium hypochlorite (5%), washed in distilled water, stained with an aqueous "safrablau" solution (blue astra and safranin 1:1), dehydrated in a series of increasing ethanol concentrations (30%, 50%, 70%, 80%, 90%, 95%, and 100%), passed through n-butyl acetate, and mounted with synthetic resin on permanent slides.

Portions of the material were dissociated using a modified version of Franklin's (1945) protocol, in which wood chips were submerged in a solution of glacial acetic acid and hydrogen peroxide (1:1) in an incubator at 60°C for 48 hours or until complete maceration. The material was then thoroughly washed in distilled water, stained with an aqueous safranin solution, and mounted with glycerine on semipermanent slides (Franklin, 1945).

The analyses were performed using a light microscope (ZEISS AXIO IMAGER A2), the images were captured with a Zeiss AxioCam ICc 3 camera attached to the microscope. The description of the anatomical characteristics followed the guidelines proposed by the IAWA Committee (1989). For each observed anatomical charac-

teristic, 30 measurements were taken using the Dino Capture 2.0 software. To describe the quantitative characteristics of the wood, descriptive statistics were performed on the obtained data using Microsoft Excel 2019, and the values are presented in the format minimum (mean) maximum.

Results and Discussion

Myrrhinium atropurpureum has grayish bark and light-yellow wood (Fig. 1C), with no characteristic luster, odor, or taste, and is very resistant to cutting. Landrum (1986) observed a different pattern in his studies of Myrtaceae, describing the bark as gray to dark reddish-brown.

The growth rings are distinct to the naked eye, formed by fibrous zones; the porosity is diffuse, with mostly solitary pores, circular to oval in shape, visible only under a 10x magnifying lens (Fig. 3A).

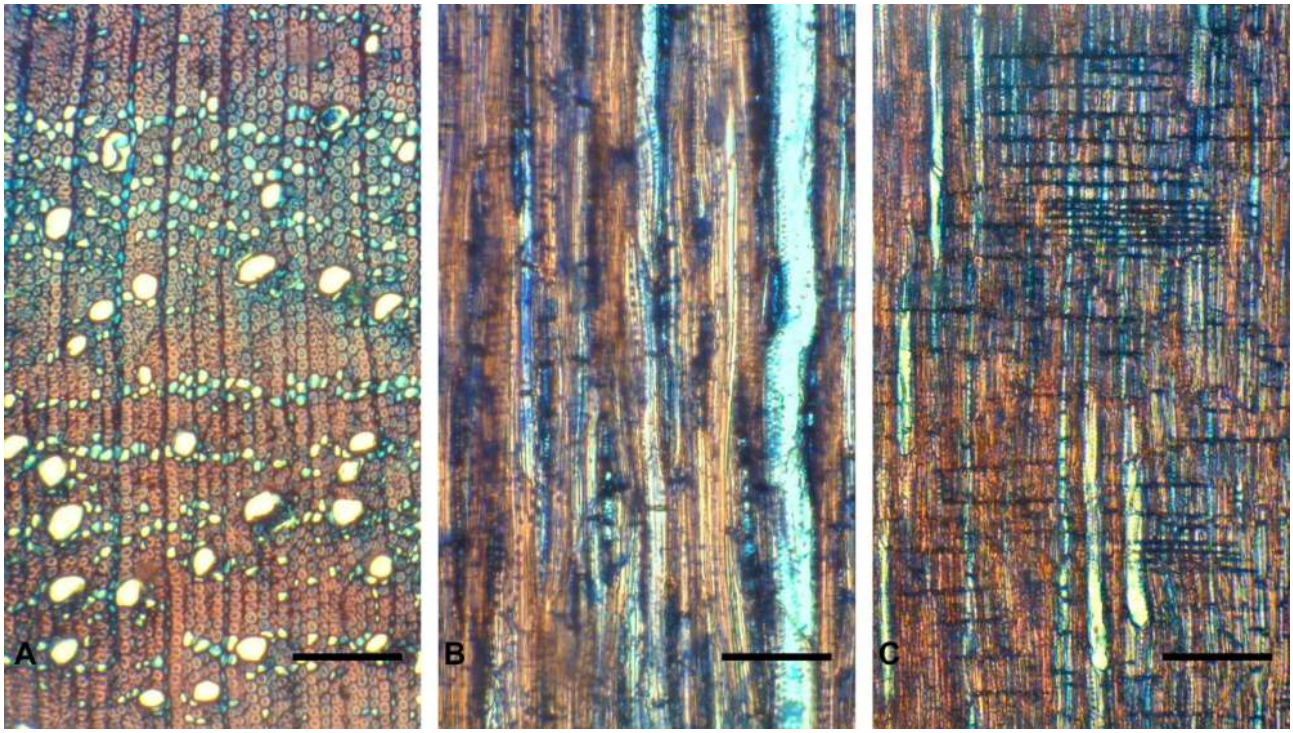


Figure 3: Wood of *Myrrhinium atropurpureum*. A: Cross section. B: Tangential longitudinal section. C: Radial longitudinal section. Scale: A–C: 200 µm.

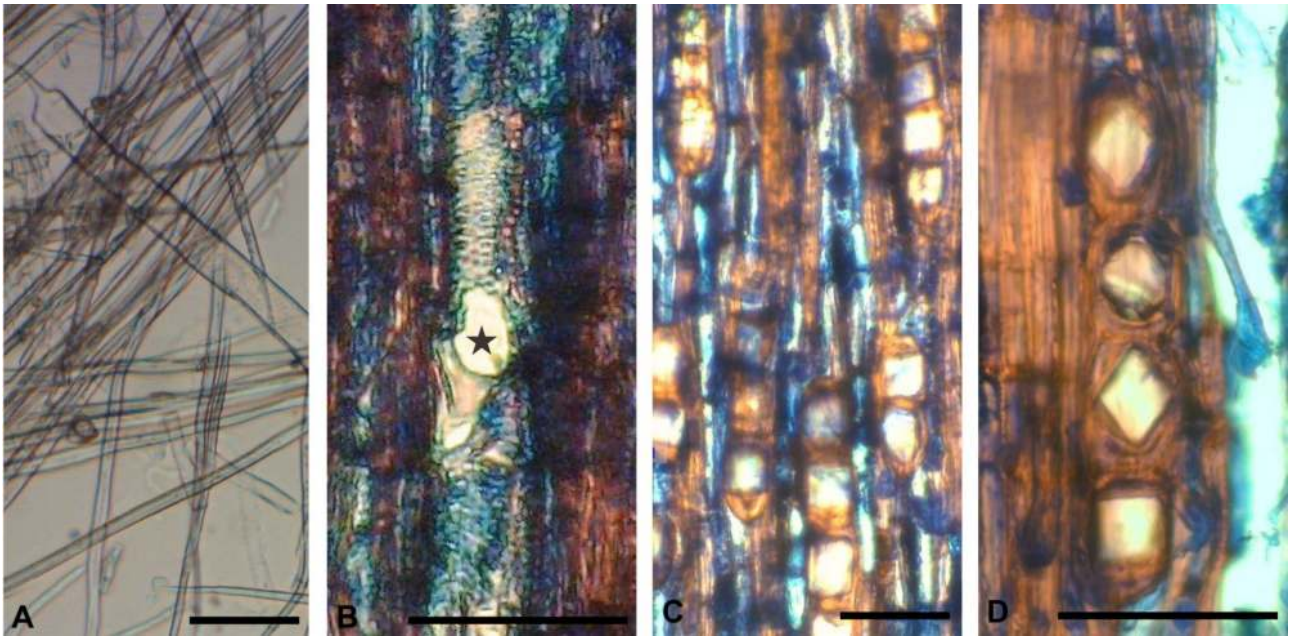


Figure 4: Details of the wood of *Myrrhinium atropurpureum*. A: Vessel element and fibrotracheids. B: Simple perforation plate (star). C–D: Crystalline series in the axial parenchyma. Scale: A and C: 200 µm; B and D: 100 µm.

The vessels of *M. atropurpureum* have a very small diameter, averaging 35.53 µm; they are predominantly solitary and lack a defined arrangement (Fig. 3A). In terms of length, the vessels range from medium to long, with an average of 497.55 µm, and generally have short appendages at both ends (Fig. 4A). The perforation plates are simple (Fig. 4B) and slightly inclined relative to the wall, and the intervessel pits are alternate, sometimes tending to be opposite (Fig. 4B), relatively small, with an average height of 3.06 µm and an average width of 3.96 µm. Vessel density is moderate to low, with an average of 48 vessels/mm². No tyloses or spiral thickening were observed in the vessels.

The axial parenchyma occurs diffusely in aggregates forming irregular lines (Fig. 3A), in series 5–7 cells long, and contains numerous prismatic crystals (Fig. 4C–D), with series of up to 10 crystals in subdivided cells.

The fibers are fibrotracheids (Fig. 4A) with an average length of 950.75 µm. The walls are thick, with an average thickness of 6.33 µm and an average lumen diameter of 4.56 µm.

Heterogeneous, multiseriate, and non-stratified rays are present (Fig. 3B), mostly 2 cells wide, with an average width of 16.23 µm, featuring a body of procumbent cells and one to several marginal rows of square, erect cells (Fig. 3C). They are very low, with an average height of 188.31 µm. Their frequency is high, with an average of 24 rays/mm². The yessel-ray pits range from scalariform (radially extended) to opposite.

The quantitative characteristics of the vessel elements, rays, fibers, and pits are presented in Table 1.

Table 1. Functional attribute of *Myrrhinium atropurpureum* wood. Values expressed as minimum (mean) maximum.

Functional attribute	**Values**
Vessel diameter (µm)	20,64(35,53)63,08
Length of vessel elements (µm)	177,06(497,55)822,81
Vessel frequency (vessels/mm²)	16(48)115
Fiber length (µm)	553,83(950,75)1437,62
Fiber lumen diameter (µm)	1,28(4,56)7,71
Fiber wall thickness (µm)	4,63(6,33)8,99
Ray height (µm)	78,05(188,31)356,12
Ray width (µm)	8,00(16,23)25,30
Ray frequency (raios/mm²)	14(24)34
Height of the intervessel pits (µm)	1,83(3,06)6,57
Width of the intervessel pits(µm)	2,66(3,96)6,45

Some notable characteristics of Myrtaceae include the presence of simple perforation plates, medium-length vessel elements, and narrow, heterogeneous rays (Kniess, 2016; Marchiori & Muñiz, 1987; Santos & Marchiori, 2011b; Santos & Marchiori, 2011a), characteristics that were observed in *M. atropurpureum*. Some authors have studied the wood anatomy of four species of *Myrceugenia* O. Berg in Rio Grande do Sul: *M. myrtoides* O.Berg. (Marchiori & Muñiz, 1987), *M. glaucescens* (Cambess.) D.Legrand & Kausel (Marchiori & Muñiz, 1988), *M. euosma* (O.Berg) D.Legrand (Santos & Marchiori, 2009), and *M. miersiana* (Gardner) D.Legrand & Kausel (Santos & Marchiori, 2011a), stating that species of this genus typically exhibit characteristics uncommon in Myrtaceae, such as scalariform perforation plates, vessels with spiral thickening, and scalariform (radially extended) intervessel pits. Santos & Marchiori (2009) stated that the occurrence of this latter characteristic is restricted to *Myrceugenia*; however, this trait has also been found in the wood of some *Myrcia* species from other regions of Brazil (Barros & Callado, 1997), as well as in the wood of *Myrrhinium atropurpureum*.

As described by Kniess (2016), species of Myrtaceae typically have small-diameter vessels that are solitary or multiple and lack a defined arrangement, as observed in *M. atropurpureum*. The occurrence of small-diameter vessels at higher elevations and lower temperatures has already been documented by several authors (Carlquist, 2001; Sperry, 2003; Cosmo, 2012), as the relationship between vessel diameter and water-conducting efficiency. Larger vessel diameters increase conduction efficiency, even with a higher likelihood of air bubble formation, whereas smaller diameters enhance conductivity because water adheres to the vessel wall, preventing the water column from breaking and the formation of bubbles (Kniess, 2016). Furthermore, in higher-altitude locations, where soils have higher moisture content, longer vessels are expected (Kniess, 2016), a finding that was also observed in *M. atropurpureum*.

Marchiori and Muñiz (1987) describe the vessels of *Myrceugenia myrtoides* as extremely numerous, solitary, small in diameter, long, with simple perforation plates, spiral thickening in the cell wall, and generally short appendages. *Myrceugenia euosma* exhibits the same pattern in almost all characteristics, differing only in the presence of medium-sized vessels with oblique, simple, and multiple perforation plates and barely visible spiral thickenings (Santos & Marchiori, 2009). *Myrceugenia glaucescens*, on the other hand, exhibits the same characteristics as *M. myrtoides*, except for the presence of oblique perforation plates of the simple, reticulate, and scalariform types (Marchiori & Muñiz, 1988). Finally, *Myrceugenia miersiana* differs in that the vessels come into lateral contact when very abundant, while the other characteristics are consistent with those described for *M. myrtoides* (Santos & Marchiori, 2011a). In *M. atropurpureum*, similar characteristics were observed, consistent with the studies presented; the main difference was marked by the exclusive presence of simple perforation plates and the absence of spiral thickening in the vessel walls.

Myrtaceae generally exhibit diffusely arranged parenchyma, as described by Kniess (2016) and Marchiori & Muñiz (1987), who also described the same pattern in *Myrceugenia* species. In this regard, *M. atropurpureum* conformed to the expected pattern for the family.

Crystals are products of secondary plant metabolism, and it is expected that in low-latitude regions there is a greater propensity for their formation due to higher metabolic rates (Santos & Marchiori, 2009). The abundant presence of prismatic crystals in *M. atropurpureum* is a justifiable finding, considering the location, phytophys-

iognomy, and climate classification of the study area, both factors that drive an increase in plant metabolism.

The presence of crystals in wood can be useful for identifying certain groups and may even occur occasionally (Santos & Marchiori, 2009). Prismatic crystals have been observed in about 10 other genera of Myrtaceae, predominantly in the axial parenchyma (Marchiori & Muñiz, 1987; Santos & Marchiori, 2009; Santos & Marchiori, 2011b; Santos, 2019). According to Santos (2019), who studied the axial parenchyma of various families, within the Myrtaceae, *Campomanesia* Ruiz et Pav. lacks crystals, whereas in *Eugenia* L., their presence was consistently observed. Occasional occurrence, however, was noted in a species of *Blepharocalyx* O.Berg, as well as in other members of the family.

According to Ragonese (1978) and Kniess (2016), the rays in Myrtaceae can be either homogeneous or heterogeneous, the latter type being present in *M. atropurpureum*, and are predominantly uniseriate; however, this species differs in that it exhibits multiseriate rays. One of the striking characteristics of Myrtaceae is the occurrence of fused rays, which form through vertical fusion when very long rays join via a series of overlapping cells (Ragonese, 1978). However, no fused rays were observed in the studied species, a fact that can be taken into account during identification. According to Marchiori & Muñiz (1987), the presence of scalariform (radially extended) vascular pits are notable in *Myrceugenia* species and is one of the characteristics used to identify the genus. Therefore, the presence of this same characteristic in *M. atropurpureum* is a factor that makes it similar to *Myrceugenia*, which may cause difficulty in differentiating between the genera.

Conclusion

The species analyzed, *Myrrhinium atropurpureum*, had its stem wood described, and the results of this study may serve as a basis for identification, assisting other researchers in the future. Notable characteristics include growth rings with fibrous zones, diffuse porosity, simple perforation plates, diffuse-in-aggregates axial parenchyma in series of 5–7 cells high and containing prismatic crystals, and heterogeneous, multiseriate, and non-stratified rays, which are consistent with the wood characteristics of other described Myrtaceae species.

The anatomical description of the wood of *M. atropurpureum*, the objective of this study, aimed to expand knowledge about the wood structure of native Myrtaceae, as well as to contribute in the future to the clarification of taxonomic issues within the family. It is recommended that studies continue, with an expansion of collection areas and an increase in the number of plants sampled to confirm the anatomical characteristics described.

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