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Anatomical characterization of wood for identification of the Tachigali Aubl. species

In the Amazon many forest species present problems of identification and obtaining botanical material with reproductive structures is not always possible. The macro and microscopic characteristics of the wood of three species of the genus Tachigali Aubl were analyzed in order to determine basic differences among the species. The collection of material was carried at the Forest Management Unit III, in the Flona do Jamari (Jamari National Forest), where we selected arboreal individuals from the species Tachigali poeppigiana Tul., Tachigali setifera (Ducke) Zarucchi & Herend and Tachigali subvelutina (Benth.) Oliveira-Filho, commonly known in Brazil as Tachi Preto (Black Tachi), Tachi Vermelho (Red Tachi) and Tachi Amarelo (Yellow Tachi), respectively, in which the coloring of the core is the main attribute for assigning their vernacular name. Heartwood samples were collected for the making of the specimens. The axial parenchyma was vasicentric and unilateral for T. poeppigiana and T. setifera, and unilateral and sparse for T. subvelutina. Pores were classified as medium and large for T. setifera and T. poeppigiana and very uncommon for T. subvelutina; however, they are medium and very uncommon for the three species. All species showed uniseriate, non-stratified and homogeneous rays. We concluded there are anatomical characteristics that allow the differentiation of the species from the genus Tachigali, which may be used to assist in forest management plans, as well as the surveillance system.

Keywords: Forest management; Botanical identification; Dendrology; Wood structure.

Caracterização anatômica da madeira para fins de identificação de espécies Tachigali Aubl.

Na Amazônia muitas espécies florestais apresentam problemas de identificação e a obtenção de material botânico com estruturas reprodutivas nem sempre é possível. Assim, as características macro e microscópicas da madeira de três espécies do gênero Tachigali Aubl foram analisadas com o objetivo de determinar diferenças básicas entre as espécies. A coleta de material foi realizada na Unidade de Manejo Florestal III, na Flona do Jamari, Rondônia, onde selecionaram-se indivíduos arbóreos das espécies Tachigali poeppigiana Tul., Tachigali setifera (Ducke) Zarucchi & Herend e Tachigali subvelutina (Benth.) Oliveira-Filho, vulgarmente conhecidos como Tachi Preto, Tachi Vermelho e Tachi Amarelo, respectivamente, onde a coloração do cerne é o principal atributo para a atribuição do nome vernacular. Foram coletadas amostras de cerne para a confecção dos corpos de prova. O parênquima axial foi do tipo vasicêntrico e unilateral para T. poeppigiana e T. setifera e unilateral e escasso para T. subvelutina. Os poros foram classificados como médios e grandes para T. setifera e T. poeppigiana e pouco frequentes para T. subvelutina. Todas as espécies exibiram raios unisseriados, não estratificados e homogêneos. Conclui-se que há características anatômicas que permitem a diferenciação das espécies do gênero Tachigali, podendo ser usadas na identificação das espécies nos planos de manejo florestal, bem como o sistema de fiscalização.

Palavras-chave: Manejo florestal; Identificação botânica; Dendrologia; Estrutura da madeira.

Topic: **Ciências Florestais**

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INTRODUCTION

In forest inventories, botanical identification is one of the first and most important steps (LACERDA et al., 2010; LIMA et al., 2015). However, for management plans in the Amazon, this is still a challenge for administrators, inspection agencies and researchers, compromising the quality and sustainability of inventories and forest activity (PROCÓPIO, 2008; BOTOSSO, 2009; VIBRANS et al., 2012).

One of the main mistakes is grouping species with the same vernacular or scientific name, consequently denominating them as a single species (CYSNEIROS et al., 2018). This, in forest management, may result in imbalance of plant species populations, generate cutting rates not corresponding to the productive capacity of that species, reduce the introduction of new species in the market and also compromise the quality and homogeneity of the final product and the suitability of commercial relations between company and client, reflecting directly on environmental, social and economic aspects (SOUZA et al., 2007).

According to a study by the Brazilian Institute of Forest Development (IBDF, 1985), there are three reasons that may cause the incorrect use of scientific names: (1) the presence of similar characteristics among different species; (2) the same popular name common to several species; (3) the use of a characteristic to designate its name. Therefore, proper identification of wood should be based on its macro and/or microscopic anatomical characteristics, since each species has individual characteristics that allow them to be differentiated. Thus, possible misconceptions and even fraud may be avoided, contributing to the commercialization of the correct species and greater control by inspection agencies.

The study of wood anatomy is, undoubtedly, the indicated method to identify and differentiate the species, also showing simple application for the correct nomenclature of woods (ALVES et al., 2013). In addition to wood identification, knowledge on the composition and quantitative occurrence of its main anatomical elements is important for its qualification and indication of uses, thus avoiding inappropriate use and waste (PAULA, 2003).

We highlight the genus *Tachigali* Aubl., belonging to the Fabaceae family, standing out for its vast richness of species in Amazon forest formations, which hinders its identification (CYSNEIROS et al., 2018; REIS et al., 2019) at the same time it has sufficient stock of growth in the forest and wood properties that evidence its potential for commercial use (REIS et al., 2019). Despite the economic importance of some species of the genus, their exploration has not been authorized in management plans in the Amazon due to the lack of correct identification.

From the understanding that the correct identification is the base for the proper use and conservation of forest species, this study aimed to characterize the structures of the genus *Tachigali* Aubl. occurring in an area of forest concession in the Jamari National Forest in the state of Rondônia, Brazil, to provide information that may be used to differentiate the species in Forest Management Plans.

MATERIALS AND METHODS

Samples were collected from the Annual Production Unit (UPA) 11, located in the Forest Management Unit III (UMF), in the Jamari National Forest, state of Rondônia.

The climate in the region is classified as Am, tropical wet with well-defined seasons, average annual temperature of 26°C and average rainfall of 2300mm.year^{-1} (ALVARES et al., 2013). Relief varies from gently undulating to flat, and the soils occurring in the area are classified as Latosols and Acrisols, with the occurrence of Dystrophic Red-Yellow Acrisol (IBGE, 2012). The natural vegetation of the region is predominantly composed of Open Ombrophilous Forest, with variations of Submontane Open Ombrophilous Forest (IBGE, 2012; NUNES et al., 2012).

The study was conducted with three arboreal forest species of the genus *Tachigali* Aubl. (Fabaceae): *Tachigali poeppigiana* Tul., *Tachigali setifera* (Ducke) Zarucchi & Herend and *Tachigali subvelutina* (Benth.) Oliveira-Filho, commonly known in Brazil as *Tachi Preto* (Black Tachi), *Tachi Vermelho* (Red Tachi) and *Tachi Amarelo* (Yellow Tachi).

Six arboreal individuals were randomly selected, two per species, with diameter at breast height (DBH) ≥ 50 cm and height greater than 20m. The trees were initially identified by their vernacular name, through consultation with the parataxonomist of the concessionary company, and had botanical material collected for species confirmation at the Herbarium of the National Research Institute of the Amazon, with catalog No. 141169 for Black Tachi, No. 232803 for Red Tachi and No. 189592 for Yellow Tachi.

Core samples were collected from each tree and were sent to the Microscopy Laboratory of the Federal University of Rondônia, campus Rolim de Moura, for drying and preparation of the specimens. Specimens with dimensions 2×2×2cm were made, according to the Pan American Standards Commission (COPANT, 1973) and the International Association of Wood Anatomists (IAWA, 1989).

The specimens were polished with a sharp blade to facilitate visualization of organoleptic (color, taste, odor, grain, texture, luster and cut resistance) and macroscopic characteristics (distinction of growth layers; pores – visibility, porosity, grouping, arrangement, content; rays – visibility, contrast; axial parenchyma – type). The organoleptic characteristics of the wood analyzed in the samples followed the literature by Coradin et al. (2002) and Botosso (2009).

Cooking, preparation and analysis activities of histological slides of wood were performed in the Laboratory of Wood Technology of the Federal University of Mato Grosso (UFMT), campus Cuiabá-MT.

Initially, the samples were submerged in a solution of water, glycerin and ethyl alcohol 70%, in equal proportions. Soon after, they were cooked for four hours at 120°C in a table top autoclave, according to Lopes (2013). An automatic slide microtome, by the brand Thermo, model HM355S, was used to cut the already cooked samples. Wood cuts were performed with height and width varying from 1 to 2cm, and thickness from 20 to 25µm in the different anatomical planes (transverse, tangential longitudinal and radial longitudinal), according to the recommendations of the Normative Instruction NBR 15066 (2004).

Wood samples obtained from the different planes were discolored in sodium hypochlorite at a

concentration of 60%, with immersion time of 15min. Shortly after, to facilitate visualization of the characteristics of pores, parenchyma and cell differentiation, samples were colored using safrablau, a solution prepared with 70% astra blue and 30% safranin. Sufficient time for staining the core samples was approximately 15 minutes.

Subsequently, in order to remove moisture from the inside of the sample cells and provide greater durability to the slides, we proceeded to dehydration, in an alcoholic series (30%, 50%, 70%, 95% and 100%, and again in 100% ethyl alcohol). In each concentration, samples remained for approximately 6 min.

The samples were also submitted to a butyl acetate and alcohol solution at concentrations of 50% alcohol and 50% butyl acetate, then, 100% butyl acetate. For each prepared solution, the sections remained submerged for approximately 5 to 7 minutes. Finally, the wood samples were accommodated in common, unpolished glass slides with dimensions of 26×76mm, fixed with Entellan® mounting medium.

After preparing the specimens and assembling the histological slides of the different wood planes, the microscopic analysis and measurements of the microscopic characteristics of the species started. In the anatomical planes of the different wood sections, we analyzed and measured the qualitative characteristics of axial and radial parenchyma, arrangements, cell types and qualitative characteristics, such as pore frequency and diameter, and ray height and width. For quantitative and qualitative analyses, we used a trinocular microscope with coupled camera, by the brand Zeiss, model Primo Star, and the Zen Lite® software, version 2.3.

RESULTS

Individuals of *T. poeppigiana* showed wood with yellowish-brown color (Figure 1A), indistinct taste, present odor, reverse grain, medium texture, absent luster and resistance to the use of cutting blades, both at the time of sample sizing and when obtaining cuts in a microtome, even after the cooking period. It is worth mentioning that, according to Botosso (2009), organoleptic characteristics are subjective information, being interpreted in different ways according to each person, and still suffer variations over time as a result of oxidation by air or light.

The species *T. poeppigiana* did not show growth layers distinguishable by naked eye in the transverse plane (Figure 1B); pores were rounded (Figure 1B – red arrow) to elliptical (Figure 1B – yellow arrow), porosity was diffuse, and pores were solitary, twinned (Figure 1B – white arrow) and triple (Figure 1B – purple arrow), in radial arrangements. The presence of tyloses was also observed in the pores. Rays verified in the tangential and radial plane were noticeable to the naked eye, a little contrasted (Figure 1C and 1D – red arrows).

Individuals of *Tachigali setifera* had a brownish core (Figure 2A) with dark tones near the edges of the pores (Figure 2A – red arrows) and, eventually, presence of a crystalline or yellowish-brown substance in their center (Figure 2A – yellow arrow). Porosity is diffuse and non-uniform (Figure 2B), in radial arrangement and mixed grouping, being solitary with rounded shape (Figure 2B – red arrow) and predominantly twinned (Figure 2B – yellow arrows), rarely triple (Figure 2B – white arrow) with the presence of tyloses (Figure 2B – blue arrows). No distinct growth layers were observed.

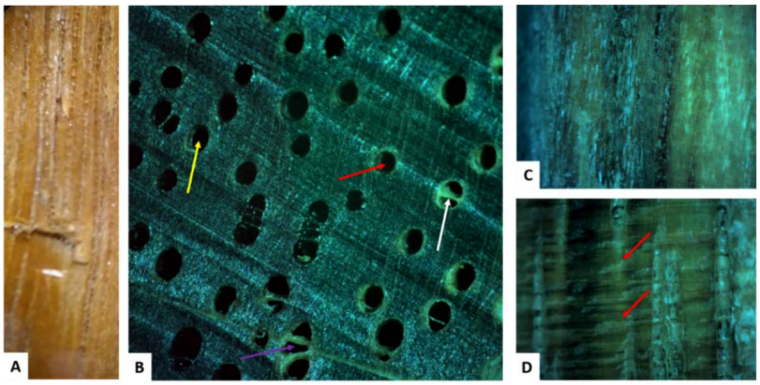

Figure 1: Macroscopic aspects of *Tachigali poeppigiana* wood seen in transverse, tangential and radial planes. A) Tangential plane showing organoleptic characteristic of yellowish-brown color. B) Transverse plane with presence of round (red arrow), elliptical (yellow arrow), twinned (white arrow) and triple pores (purple arrow). C) Tangential longitudinal plane with rays visible to the naked eye. D) Radial plane with horizontal rays (red arrows).

Rays in the tangential plane were visible to the naked eye (Figure 2C – red arrows), however, it was not possible to distinguish their characteristics. In the radial plane, rays were contrasted (Figure 2D – red arrows).

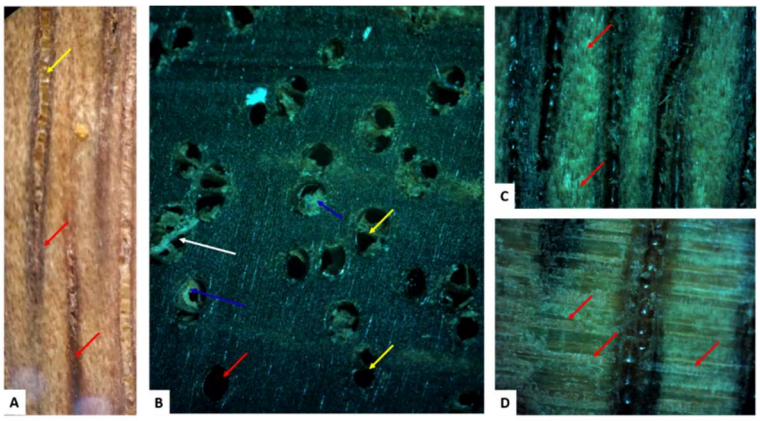

Figure 2: Macroscopic aspects of *Tachigali setifera* wood, seen in transverse, tangential and radial planes. A) Tangential plane with brownish color, pores with dark edges (red arrows) and presence of brown-yellowish content (yellow arrow). B) Transverse plane with solitary pores (red arrow) and presence of tyloses (blue arrows), twinned (yellow arrows) and triple pores (white arrow). C) Tangential plane with rays visible to the naked eye (red arrows). D) Radial plane with contrasting rays.

The species *Tachigali subvelutina* showed a yellowish-brown wood color (Figure 3A), similar to the color found in *T. poeppigiana*, with indistinct taste, odorless, straight grain, medium texture and absent luster. Eventually, crystallized substances of general white or whitish color (Figure 3A – red arrow) were observed in the center of the pores.

The anatomical macroscopic aspects of the wood of this species were characterized with predominantly elliptical and round pores (Figure 3B – red arrows), radial arrangement, diffuse, non-uniform porosity, predominantly solitary grouping unobstructed with occasional twinned groupings (Figure 3B – yellow arrow) or rarely triple radials. Growth rings are not visible to the naked eye.

In the tangential plane, it was possible to observe rays with naked eye (Figure 3C – red arrows), however, their anatomical characteristics were not defined. As in the radial plane, rays were contrasted and visible to the naked eye (Figure 3D – red arrows), however, their classification was only possible with the use of 10× magnifying lenses.

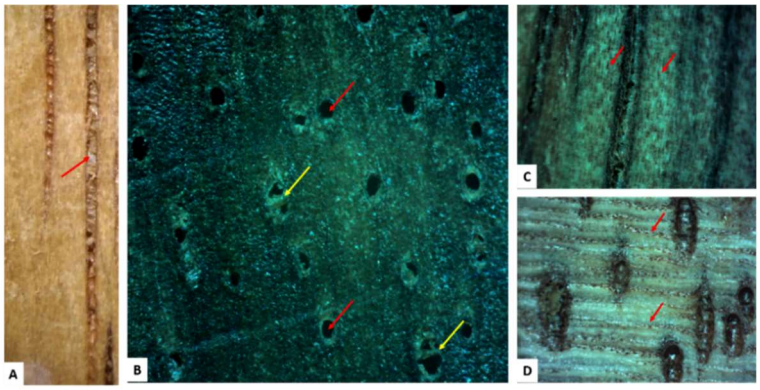

Figure 3: Macroscopic aspects of *Tachigali subvelutina* wood, seen in transverse, tangential and radial planes. A) Longitudinal plane showing yellowish-brown color and crystallized substance inside the pore (red arrow). B) Transverse plane with round, elliptical (red arrows), and twinned pores (yellow arrows). C) Longitudinal plane with rays visible to the naked eye (red arrows). D) Radial plane, highlighting contrasted rays (red arrows).

As for the microscopic characteristics of the wood, for *T. poeppigiana*, in the transverse plane, vasicentric paratracheal (Figure 4A – blue arrows) and unilateral paratracheal parenchyma (Figure 4A – yellow arrows) was observed, the latter being the most frequent.

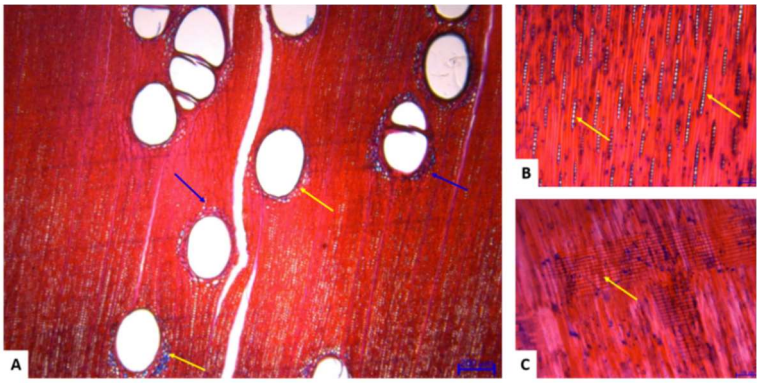

Figure 4: Micrographs of the anatomical planes of *Tachigali poeppigiana* wood from the Jamari National Forest, RO. A) Transverse plan with predominantly solitary pores and unilateral paratracheal (yellow arrows) and vasicentric parenchyma (blue arrows). B) Tangential plane showing the distribution of exclusively uniseriate and non-stratified rays (yellow arrows). C) Radial plane showing procumbent cells (yellow arrow).

Pores of *T. poeppigiana* were uncommon (2.44pores.mm^{-2}), with tangential diameter of 190.54 ± 46.40µm, thus classified as medium, according to the COPANT classification (1973). Porosity is diffuse, arrangement is radial, with predominantly solitary grouping and presence of twinned and tiple pores.

The rays of *T. poeppigiana* are exclusively uniseriate (Figure 4B – yellow arrows), distributed in a non-stratified way, with an average of 9.67 rays per linear mm^{-1}, mean height of 462.94±122.49µm and approximate width of 22.60±10.42µm, with numbers of 2 to 17 cells in height. Cells from the radial plane are characterized as procumbent (Figure 4C – yellow arrow), therefore, these rays are classified as homogeneous.

Individuals of *T. setifera* had unilateral paratracheal parenchyma, arranged only on one side of the pores (Figure 5A – yellow arrows).

Pores of *T. setifera* are rounded and arranged diagonally (Figure 5A – blue arrow), uncommon (4.05 pores per mm^{-2}), with mean tangential diameter of approximately 261.41±54.60µm, classified thus as large. Porosity was characterized as diffuse, in dendritic arrangement and in predominantly twinned and triple

grouping.

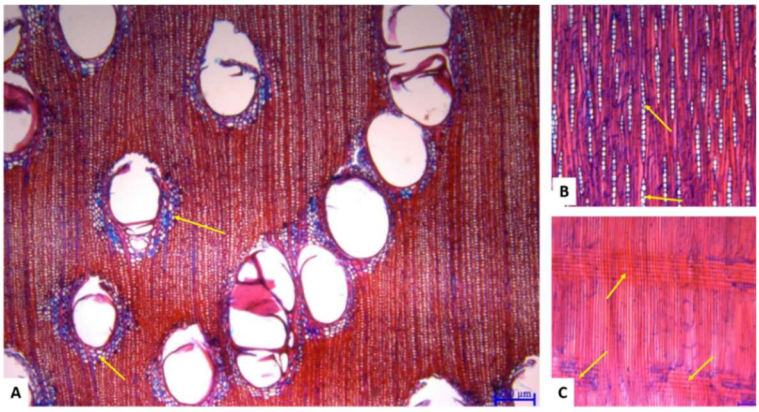

Figure 5: Micrography of the anatomical planes of *Tachigali setifera* wood, collected from the Jamari National Forest, RO. A) Transverse plane with unilateral paratracheal parenchyma (yellow arrow) and round pores arranged diagonally. B) Tangential plane with non-stratified arrangement and predominantly uniseriate, with emphasis on biseriate initiations (yellow arrows). C) Rays in the radial plane with procumbent cells (yellow arrows).

The rays of *T. setifera* are arranged in a non-stratified manner, predominantly uniseriate and rarely biseriate (Figure 5B – yellow arrows), with an average of 7.83 rays per linear mm^{-1}, approximate height of 480.30±144.31µm and width of 35.70±14.75µm. Also, a height from 2 to 15 numbers of cells was verified. Cells from the radial plane were characterized as procumbent (Figure 5C – yellow arrows), forming homogeneous rays.

T. subvelutina showed sparse paratracheal axial parenchyma, that is, it does not have a complete circular formation around the pore (Figure 6A – yellow arrows). Pore frequency showed an average of 1.7 pores per mm^{-2}, classified as very little. The mean tangential pore diameter was 194.84±47.92µm, which is considered medium. Porosity was defined as diffuse, in a radial arrangement and predominantly solitary grouping, with presence of twinned and triple pores.

The rays of *T. subvelutina* were distributed in a non-stratified manner, predominantly uniseriate with indications of biseriate rays (Figure 6B – yellow arrows); they were uncommon (8.44 rays per linear mm^{-1}), considered low since they have mean height of 594.89±182.26µm with a number of cells varying from 2 to 15, approximate width of 37.03±7.86µm, therefore classified as thin. The radial plan has procumbent cells (Figure 6C – yellow arrows), that is, the rays are homogeneous.

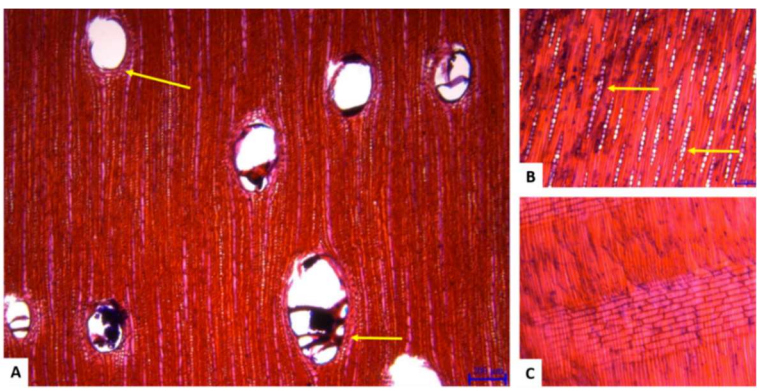

Figure 6: Micrographs of anatomical planes of *Tachigali subvelutina* wood collected in the Jamari National Forest, RO. A) Transverse plan with sparse paratracheal parenchyma (yellow arrows). B) Tangential plane with predominantly uniseriate rays (yellow arrows). C) Radial plan with arrangement of procumbent cells (yellow arrow).

DISCUSSION

In general, it was found that most of the macro and microscopic characteristics of *Tachigali poeppigiana, Tachigali setifera and Tachigali subvelutina* wood are similar to each other.

Wood odor was distinguished only for *T. poeppigiana*. It was not possible to characterize the anatomical structures of the wood with the naked eye, and they were only defined with 10× magnifying lenses.

In studies on the anatomy of the secondary xylem, Reis et al. (2011) also pointed out a group of macro and microscopic characteristics of wood similar among species of the genus *Tachigali.* In that study, the authors observed that the species *Tachigali poeppigiana, Tachigali setifera* and *Tachigali subvelutina* showed solitary, twinned, triple or even quadruple pores, diffuse porosity and rays visible only with 10× approximation. These characteristics, according to Reis et al. (2011), and Machado et al. (2017), are common for species from the Fabaceae family, which generally have paratracheal parenchyma, few pores, short and libriform fibers.

In addition, the presence of a unilateral paratracheal parenchyma, as observed in the species *T. poeppigiana*, represents, according to Burger et al. (1991), characteristics of evolved species with a higher degree of adaptation.

However, it is noticed that, even with similar characteristics, some macroscopic anatomical features may assist in the distinction of species, to identify both genus and species, avoiding problems with the inappropriate use of species due to their common name. Souza et al. (2007) differentiated, through anatomical analysis of the wood of individuals called "cumaru," five species grouped in two genera, *Dipteryx* Schreber and *Tabebuia* Gomes ex DC. These species, according to the authors, were explored and marketed under the same vernacular name.

Thus, in the absence of vegetative and reproductive botanical material, it was verified that it is possible to identify species using wood structures. Reis et al. (2019) recommended the macroscopic identification of wood as another tool in species distinction, so as to avoid the overexploitation of mistakenly identified species.

In general, the identification and characterization of forest species in the Amazon still represent a problem in forest management plans, and it is necessary to provide solid and safe bases to differentiate species, allowing the planning and sustainable use of forest resources.

CONCLUSIONS

Wood color and odor are organoleptic characteristics that may assist in the distinction of the species of the genus *Tachigali*. Type of axial parenchyma, pore frequency and diameter are the main anatomical characteristics that differed between the species *T. poeppigiana, T. setifera* and *T. subvelutina*, and may be used as identification keys.

REFERENCES

ALVARES, C. A.; STAPE, J. L.; SENTELHAS, P. C.; MORAES GONÇALVES, J. L.; SPAROVEK, G.. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, v.22, n.6, p.711-728, 2013.

ALVES, R. C.; OLIVEIRA, J. T. S.; MOTTA, J. P.; PAES, J. B.. Elaboração de uma chave de identificação das principais madeiras comercializadas no estado do Espírito Santo. **Enciclopédia Biosfera,** Goiânia, v.9, n.16, p.979-988, 2013.

BOTOSSO, P. C.. **Identificação macroscópica de madeiras:** guia prático e noções básicas para o seu reconhecimento. Documentos 194. Colombo: Embrapa Florestas, 2009.

BRAZ, D. M.; MOURA, M. V. L. P.; ROSA, M. M. T.. Chave de identificação para as espécies de Dicotiledôneas arbóreas da Reserva Biológica do Tinguá, RJ, com base em caracteres vegetativos. **Acta Botânica Brasileira,** v.18, n.2, p.225-240, 2004.

BURGER, L. M.; RICHTER, H. G.. **Anatomia da madeira.** São Paulo: Nobel, 1991.

COPANT. Comission Panamericana de Normas Ténicas. **Descrição macroscópica, microscópica e geral da madeira**. COPANT, 1973.

CORADIN, V. T. R.; CAMARGOS, J. A. A.. **A estrutura anatômica da madeira e princípios para sua identificação**. Brasília: LPF, 2002.

CYSNEIROS, V. C.; MENDONÇA JÚNIOR, J. O.; LANZA, T. R.; MORAES, J. C. R.; SAMOR, O. J. M.. Espécies madeireiras da Amazônia: riqueza, nomes populares e suas peculiaridades. **Pesquisa Florestal Brasileira**, v.38, n.201801567, p.1-14, 2018.

IAWA. IAWA list of microscopic features for hardwood identification. **IAWA Bulletin**, v.10, n.3, p.221-332, 1989.

IBDF. Instituto Brasileiro de Desenvolvimento Florestal**. Identificação e agrupamento de espécies de madeiras tropicais amazônicas:** síntese. Brasília: IBDF, 1985.

IBGE. Instituto Brasileiro de Geografia e Estatística. **Manual técnico da vegetação brasileira**. Rio de Janeiro: IBGE, 2012.

LACERDA, A. E. B.; NIMMO, E. R.; FARIA, B. S.; KELLERMANN, B.; ALBERGONI, L.; GARRASTAZU, M. C.; OLIVEIRA, Y. M. M.; MATTOS, P. P.; ROSOT, M. A. D.. **A identificação botânica no manejo florestal na Amazônia.** Documento 204. Colombo: Embrapa Floresta, 2010.

LIMA, H. C.. **Tachigali in Lista de Espécies da Flora do Brasil.** Jardim Botânico do Rio de Janeiro, 2015.

LOPES, O. P.. **Anatomia e identificação da madeira de genótipos de *Eucalyptus* sp. plantados no estado de Minas Gerais**. Dissertação (Mestrado) - Universidade Federal de Lavras, Lavras, 2013.

MACHADO, P. F. S.; MARCHIORI, J. N. C.. Anatomia da madeira de *Mimosa balduinii* Burkart. **Balduinia**, v.15, n.58, p.25-32, 2017. **DOI:** http://dx.doi.org/10.5902/2358198028147

NUNES, S.; MILANES, M.; SOUZA JUNIOR, C.. Pressão Humana na Floresta Nacional do Jamari e a Implantação de Concessões Florestais. In: A. PAESE, A.; UEZU, A.; LORINI, M. L.; CUNHA, A.. **Conservação da Biodiversidade com SIG**. São Paulo: Oficina de Textos, 2012. p.191-209.

PAULA, J. E.. Caracterização anatômica da madeira de sete espécies da Amazônia com vistas à produção de energia e papel. **Acta Amazônica**, v.33, n.2, p.243-262, 2003.

PROCÓPIO, L. C.; SECCO, R. S.. A importância da identificação botânica nos inventários florestais: o exemplo do "tauari" (Couratari spp. e Cariniana spp. - Lecythidaceae) em duas áreas manejadas no estado do Pará. **Acta Amazônica**, v.38, n.1, p.31-44, 2008.

REIS, A. R. S; REIS, P. C. M.; BRANDÃO, A. T. O.; LISBOA, P. L. B.. Anatomia do xilema secundário de sete espécies do gênero *Tachigali* Aubl. (Fabaceae), disponíveis na Xiloteca Walter A. Egler, do Museu Paraense Emílio Goeldi, Pará, Brasil. **Boletim do Museu Paraense Emílio Goeldi, Ciências Naturais,** v.6, n.3, p.335-347, 2011.

REIS, P. C. M. R.; SOUZA, A. L.; REIS, L. P.; CARVALHO, A. M. M. L.; MAZZEI, L.; REIS, A. R. S.; TORRES, C. M. M. E.. Agrupamento de espécies madeireiras da Amazônia com bases em propriedades físicas e mecânicas. **Ciência Florestal,** Santa Maria, v.29, n.1, 2019. **DOI:** https://doi.org/10.5902/1980509828114

SOUZA, M. A. R.; MOUTINHO, V. H. P.; SILVA, S. S.. Levantamento das espécies comercializadas vernaculamente como cumaru no Estado do Pará. **Revista Brasileira de Biociências,** Porto Alegre, v.5, n.1, p.81-83, 2007.

VIBRANS, A. C.; GASPER, A. L.; MÜLLER, J. J. V.. Para que inventariar florestas? Reflexões sobre a finalidade do inventário florístico florestal de Santa Catarina. **REA-Revista de Estudos,** v.14, n.1, p.6-13, 2012.