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The Vochysiaceae family in a Cerrado fragment in the Mato Grosso, Brazil

Corresponding author

Graciele Lurdes Silveira

Federal University of Lavras

Federal University of Rondonópolis

gralurdes@gmail.com

Lucas Alencar da Silva Nogueira

GeoFlorestal-MT

Érica Pereira de Campos

Federal University of Rondonópolis

Gustavo Hiroaki Shimizu

State University of Campinas

Larissa Fonseca Andrade Vieira

Federal University of Lavras

Abstract. The family Vochysiaceae A.St.-Hil. (Order: Myrtales) has been reported to occur in South and Central America and the equatorial region of West Africa. Six genera and approximately 160 species belonging to this family occur in Brazil. The objective of the present study was to morphologically describe the species of Vochysiaceae that occur in the Cerrado fragment of the Federal University of Rondonópolis (UFR), to present identification keys and boards with images and illustrations, in addition to include taxonomic comments and on the distribution of species. For this, monthly surveys and collections were carried out in the area, which resulted in the description of five species: *Qualea grandiflora* Mart., *Qualea multiflora* Mart., *Qualea parviflora* Mart., *Vochysia cinnamomea* Pohl and *Vochysia divergens* Pohl. The present study contributed to expand knowledge about the Vochysiaceae family and the flora of the region, in addition to being able to serve as a subsidy for discussions on the preservation of the Cerrado.

Keywords: identification keys, floristics, *Qualea*, taxonomy, *Vochysia*.

Introduction

Vochysiaceae A.St.-Hil. belongs to the order Myrtales and is considered a sister group of Myrtaceae based on phylogenetic and morphology, distribution and biogeography studies (APG IV, 2016; Berger et al., 2016; Gonçalves et al., 2020). It comprises six genera: *Callisthene* Mart., *Erismia* Rudge, *Qualea* Aubl., *Ruizterania* Marc.-Berti, *Salvertia* A. St.-Hil. and *Vochysia* Aubl., which occur in South and Central America; and *Erismadelphus* Mildbr. and *Korupodendron* Litt & Cheek, which are found in the equatorial region of West Africa (Litt and Cheek, 2002; Azevedo et al., 2015).

The family is composed of trees, shrubs, or subshrubs with simple, opposite or

verticillate leaves with an entire margin, and may exhibit developed or vestigial stipules associated with extrafloral nectaries in the nodal region. The family is characterized as follows: inflorescences cymose or racemose, sometimes reduced to a single flower; flowers zygomorphic, bisexual, usually dichlamydeous; calyx pentamerous, usually with a developed spur in one of the sepals; corolla generally with 1, 3 or 5 petals; androecium formed by a single fertile stamen; ovary superior or inferior, trilocular or unilocular; fruits capsular with winged or samaroid seeds (Shimizu and Yamamoto, 2012; Souza, 2014; Azevedo et al., 2015).

In Brazil, Vochysiaceae is represented by six genera and approximately 160 species and has

been reported from all regions of the country (Passos and França, 2003; Carmo-Oliveira and Morretes, 2009; Azevedo et al., 2015; Shimizu and Gonçalves, 2017; Flora e Funga do Brasil). It is commonly listed in surveys involving the Cerrado Domain (Brazilian savanna), with the abundant occurrence of the *Qualea grandiflora* Mart., *Qualea parviflora* Mart. and *Qualea multiflora* Mart (Ratter et al., 2006; de Mendonça et al., 2008; Flora e Funga do Brasil).

A similar scenario is observed for the Cerrado vegetation of the Rondonópolis region, in which species of the Vochysiaceae are frequently described, with emphasis on the three *Qualea* mentioned above (Loverde-Oliveira et al., 2010; Santos et al., 2018).

Therefore, the objective of the present study was to morphologically describe the species of Vochysiaceae that occur in the Cerrado fragment that makes up the reserve of the Federal University of Rondonópolis (UFR), to present identification keys and boards with images and illustrations, in addition to include taxonomic comments and on the distribution of species, expanding knowledge about the flora of the Southeastern Mesoregion of Mato Grosso and arousing the interest of the academic community regarding the biodiversity that the campus has, in addition to serving as a subsidy for discussions on the preservation of the Cerrado.

Material and Methods

Study area

The collections were carried in a Cerrado fragment located on the UFR campus in the municipality of Rondonópolis, Mato Grosso, Brazil (geographic coordinates: -16° 27' 46.56" S, -54° 34' 49.40" W; Fig. 1).

The municipality has an average altitude of 227 m and a subhumid hot tropical climate, with total annual rainfall of approximately 1400 mm and an average annual temperature of 25 °C (Souza et al., 2013).

The UFR comprises an area of approximately 60 ha, which was part of a cattle farm, and since 1982, the remanescent vegetation has been undergoing natural regeneration (Campos et al., 2018). It's about a cerrado sensu stricto (savanna), where the vegetation in the herbaceous stratum is dominant, the arboreal stratum does not form a canopy, and the plants have tortuous stems and branches and thick bark (Felfili and Felfili, 2001; Coutinho, 2002).

Sampling and identification

The Vochysiaceae data used in the present study come from collections performed between the years 2017 and 2019. In this period, the individuals found and demarcated were inspected monthly, as well as voucher specimens were deposited in the Herbarium of the Federal University of Mato Grosso (UFMT).

The identification of the specimens was based on the available literature for Vochysiaceae, keys specific to the genera and species of this family (Yamamoto, 2009; Shimizu and Yamamoto, 2012; Souza, 2014; Azevedo et al., 2015; Sampaio, 2017; Shimizu and Gonçalves, 2017; Teixeira, 2017), and comparison with photos and illustrations available in the literature and on the internet (Flora e Funga do Brasil).

The illustrations were drawn by observing specimens and photos of the collected species and were improved and edited in Adobe Photoshop CS6.

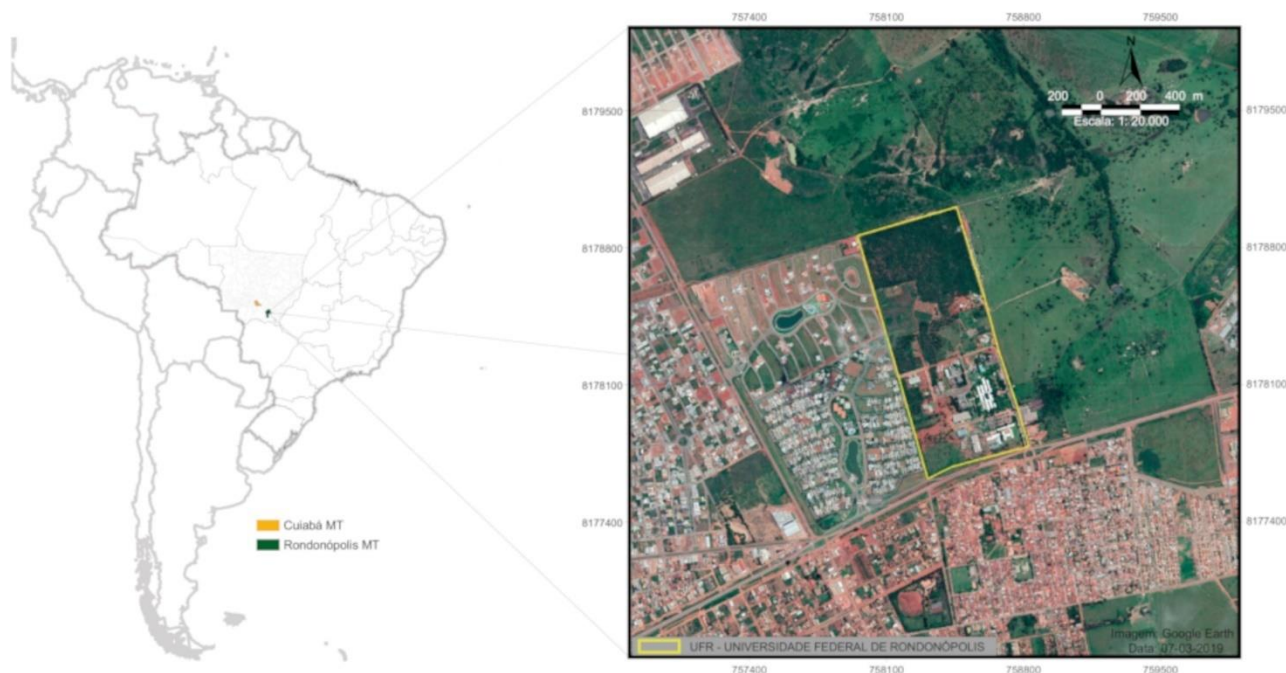


Figure 1. Area of the Federal University of Rondonópolis (yellow rectangle), where specimens of the Vochysiaceae A. St.-Hil. species were collected.

Results and discussion

Five species in the family Vochysiaceae were found: three belonging to the genus *Qualea* (*Qualea grandiflora* Mart., *Qualea multiflora* Mart., and *Qualea parviflora* Mart.) and two belonging to the genus *Vochysia* (*Vochysia cinnamomea* Pohl and *Vochysia divergens* Pohl).

Qualea Aubl.

Trees. Leaves opposite; chartaceous; extrafloral nectaries arranged next to the petiole; leaf blade with entire margin; venation brochidodromous. Inflorescences terminal, of the thyrses type. Flowers dichlamydeous, zygomorphic. Calyx with 5 sepals, with spur. Corolla with 1 petal. Androecium with a single fertile stamen; anther basifixed, dithecal with longitudinal dehiscence. Gynoecium with superior, pilose, trilobular ovary; axillary placentation; 1 terminal stylus; 1 terminal stigma, undivided. Fruit dehiscent, loculicidal capsule. Winged seeds.

Qualea has approximately 50 species and is the second largest genus of Vochysiaceae (Vianna and Martins, 2001; Shimizu et al., 2016; Gonçalves et al., 2017; Shimizu and Gonçalves, 2017). In Brazil, there are 38 species of *Qualea* distributed throughout all the regions of the country and in several vegetation types (Flora e Funga do Brasil).

For all the *Qualea* trees monitored in the present study, it was observed that the dry and seedless fruit remained on the mother plant for long periods, even during the subsequent flowering and fruiting periods. A similar observation was made by Azevedo et al. (2015) for *Q. grandiflora* and *Q. parviflora* plants in the municipality of Caetité, state of Bahia.

Qualea grandiflora Mart.

Figs. 2a-b; 3a-c. Common name: "Pau-terra-de-folha-larga".

Trees 6-10 m tall. Stem with rugose, gray rhytidome, with fissures and sinuous ridges forming easily detachable plates. Leaves with petiole 0.2-1.3 cm long; stipules 0.1-0.4 cm long; leaf blade 3.4-18.4 x 2-7.8 cm, elliptical, abaxial surface slightly lighter than adaxial surface; base cordate; apex acute; primary and secondary veins prominent on abaxial surface; venation brochidodromous. Inflorescences terminal, 5.4-14.6 cm long; peduncle 0.5-1.0 cm long; rachis 4-10.7 cm long; cincinnus with up to 4 flowers; bracts 0.1-0.6 cm long; pedicel 0.7-1.7 cm long. Flower buds 0.8-2 cm long, straight, acute apex, with spur. Calyx with 5 light green sepals, 2 larger (1.2-1.7 x 0.8-1.4 cm), 2 smaller (0.8-1.1 x 0.6-1.4 cm) and 1 measuring 1.7-2.5 x 0.7-1.5 cm, with spur 2.1-3 cm long, straight and cylindrical. Corolla with 1 yellow petal 4-5 x 1.7-5 cm, without nectar guide. Androecium with filament 1.1-1.2 cm long; anther 0.9-1 x 0.3-0.4 cm. Fruit 3.2-8.8 cm long, oblong, exocarp smooth, not separating from endocarp, base rounded, apex slightly acute. Seeds 1.5-2.5 cm long.

Examined material: BRAZIL, MATO GROSSO, Rondonópolis, geographic coordinates: -16° 27' 45" S, -54° 34' 51" W, 19.I.2019, bot., fl. and fr., Silveira et al. (UFMT 44309); geographic coordinates: -16° 27' 44.18" S, -54° 34' 46.21" W, 19.I.2019, bot., fl. and fr., Silveira et al. (UFMT 44308); geographic coordinates: -16° 27' 40.8" S, -54° 34' 45.3" W, 05.II.2018, bot., fl. and fr., Nogueira et al. (UFMT 43790); geographic coordinates: -16° 27' 40.5" S, -54° 34' 44.4" W, 05.II.2018, bot., fl. and fr., Nogueira et al. (UFMT 43793); geographical coordinates: -16° 27' 41" S, -54° 34' 45" W, 30.IV.2018, fr., Nogueira et al. (UFMT 43807); geographic coordinates: -16° 27' 28.2" S, -54° 34' 57" W, 05.II.2018, bot., fl. and fr., Nogueira et al. (UFMT 44307); geographic coordinates: -16° 27' 44.8" S, -54° 34' 50.7", 05.II.2018, bot., fl. and fr. Nogueira et al., (UFMT 43791).

Flowering and fruiting: The trees identified as *Q. grandiflora* began flowering between October and November, and in February, it was still possible to find open flowers on most of them. Between the months of February and March, it was already possible to find immature fruits on the plants; this was the case until September, when the fruits began to open and the seeds were dispersed by the wind.

Distribution: *Qualea grandiflora* has been reported to occur in all regions of Brazil, in the Amazon, Caatinga (semi-arid), Cerrado, and Atlantic Forest phytogeographic domains (Flora e Funga do Brasil).

Qualea multiflora Mart.

Figs. 2c-d; 3d-f. Common name: "Pau-terra".

Trees approximately 8 m high. Stem with rough, yellowish brown rhytidome, fissures and ridges absent. Leaves with short petiole, 0.3-0.5 cm long; axillary stipules 0.2-0.5 cm long; leaf blade 5-12 x 3.1-5.3 cm long, elliptical, pilose on the abaxial and adaxial surfaces, base obtuse, apex cuspidate; penninerved; primary and secondary veins prominent on abaxial surface; venation brochidodromous. Inflorescences terminal, 16.7-28 cm long; peduncle 0.5-1.0 cm long; rachis 15-25 cm long; usually 2 opposite flowers; bracts sometimes present (0.3-0.4 cm long); pedicel 0.3-0.7 cm long. Flower buds 0.3-1 cm long; straight, acute apex; with spur. Calyx with 5 brown/green sepals, 2 larger (0.4-0.7 x 0.3-0.5 cm), 2 smaller (0.3-0.5 x 0.1-0.3 cm) and 1 larger than the others (0.7-0.9 x 0.6-0.7 cm), with spur, 0.4-0.6 x 0.2-0.3 cm, recurved and clavate. Corolla with 1 white petal, 2-2.5 x 1-1.4 cm, with yellow nectar guide and pink spots. Androecium with filament 0.8-0.9 cm long; anther basifixed, 0.2-0.3 cm long. Gynoecium with superior ovary approximately 0.4 cm long; 1 terminal stylus 0.6-1 cm long. Fruit approximately 3 cm long, ovoid, exocarp striated and rough, not separating from endocarp, base rounded, apex apiculate. Seeds approximately 1 cm long.

Examined material: BRAZIL, MATO GROSSO, Rondonópolis, geographic coordinates: -

16° 27' 28.70" S, -54° 34' 57.43" W, 30.IV.2018, bot., fl. and fr., Nogueira et al. (UFMT 43806).

Flowering and fruiting: Flowers were observed on the tree identified as *Q. multiflora* in the study area in April and July, and some immature fruits were observed in May and June.

Distribution: In Brazil, *Q. multiflora* has been reported to occur in the states of Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Piauí, Rio de Janeiro, São Paulo, and Tocantins, in the Amazon, Caatinga, Cerrado, and Atlantic Forest phytogeographic domains (Flora e Funga do Brasil).

1Qualea parviflora Mart.

Figs. 2e-f; 3g-i. Common name: "Pau-terra-roxo".

Trees approximately 7 m high. Stem with rugose, gray rhytidome. Leaves with short petiole, 0.2-0.4 cm long; stipules axial, 0.1-0.2 cm long; leaf blade 2.5-8.2 x 0.8-3.5 cm, elliptical, abaxial surface slightly lighter than adaxial surface, base cordate, apex acute; primary vein prominent on the abaxial surface; venation brochidodromous. Inflorescences terminal, approximately 15 cm long; peduncle 0.5-1.0 cm long; rachis approximately 14 cm long; cincinnus with up to 6 flowers; bracts sometimes present (0.2-0.3 cm long); pedicel 0.3-0.7 cm long. Flower buds 0.3-0.7 cm long, straight, acute apex; with spur. Calyx with 5 green sepals, 2 larger (0.7-0.8 x 0.4-0.5 cm), 2 smaller (0.4-0.5 x 0.3-0.4 cm) and 1 larger than the others (approximately 0.7 x 0.3 cm), with spur, approximately 1 cm long,

subrecurved and cylindrical. Corolla with 1 purple petal, approximately 1.7 x 1.8 cm, with pink/white nectar guide. Androecium with filament 0.4-0.5 cm long; anther basifixed approximately 0.1 cm long. Gynoecium with superior ovary approximately 0.3 cm long; 1 terminal stylus, approximately of 0.5 cm long. Fruit 1.7-2.9 cm long, globular to ovoid, exocarps separating from endocarp, rounded base and apex. Seeds approximately 1 cm long.

Examined material: BRAZIL, MATO GROSSO, Rondonópolis, geographic coordinates: -16° 27' 38.3" S, -54° 34' 53.3" W, 04.X.2016, bot., fl. and fr., Nogueira et al. (UFMT 43792); geographic coordinates: -16° 27' 34.3" S, -54° 34' 44.4" W, 20.VII.2018, fr., Silveira et al. (UFMT 44042); geographic coordinates: -16° 27' 40.4" S, -54° 34' 43.1" W, 05.II.2018, bot., fl. and fr., Nogueira et al. (UFMT 43789).

Flowering and fruiting: The trees identified as *Q. parviflora* on the UFR campus were in bloom in April and from September to November, while fruits were observed in February, from April to August and December.

Distribution: *Qualea parviflora* is found in several Brazilian regions in the states of Amazonas, Bahia, Ceará, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraíba, Pernambuco, Piauí, Rondônia, São Paulo, and Tocantins, in the Amazon, Caatinga, Cerrado and Atlantic Forest phytogeographic domains (Flora e Funga do Brasil).

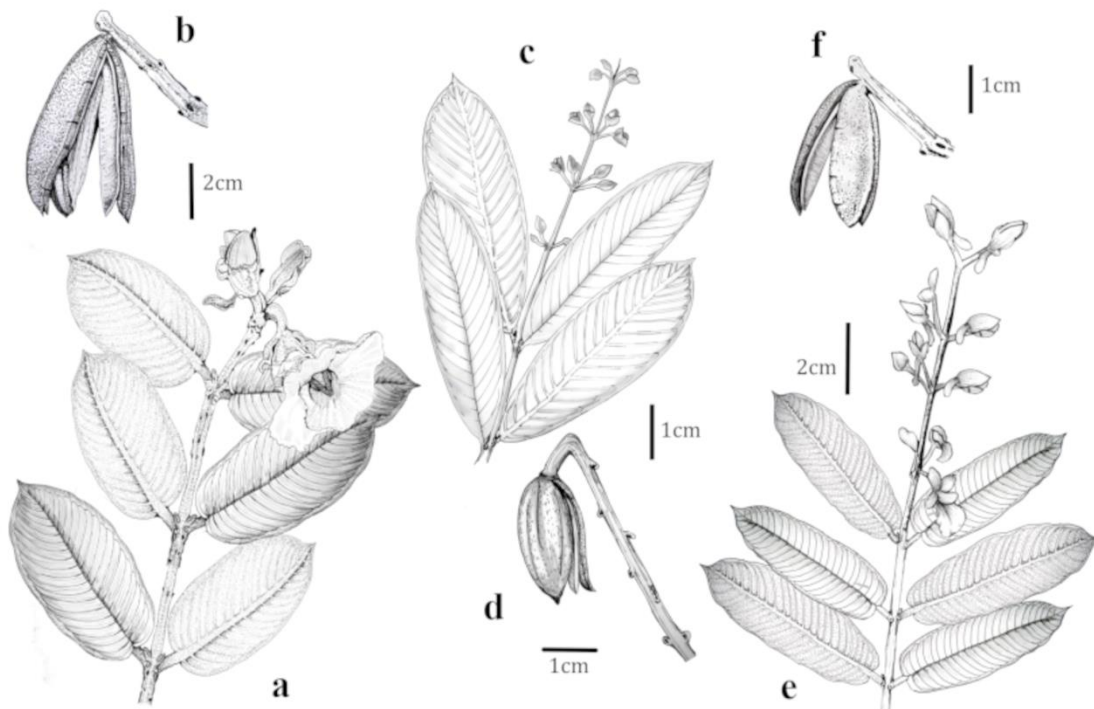


Figure 2. *Qualea* species collected at the Federal University of Rondonópolis. a-b. *Qualea grandiflora* – a. Branch with leaves, flower buds and open flowers; b. Fruit. C-D. *Qualea multiflora* – c. Branch with leaves and flower buds; d. Fruit. e-f. *Qualea parviflora* – e. Branch with leaves, flower buds and open flowers; f. Fruit. (a-b. Silveira et al., UFMT 44308; c-d. Nogueira et al., UFMT 43806; e-f. Nogueira et al., UFMT 43789). Illustration: Milton Omar Córdova Neyra (2019).

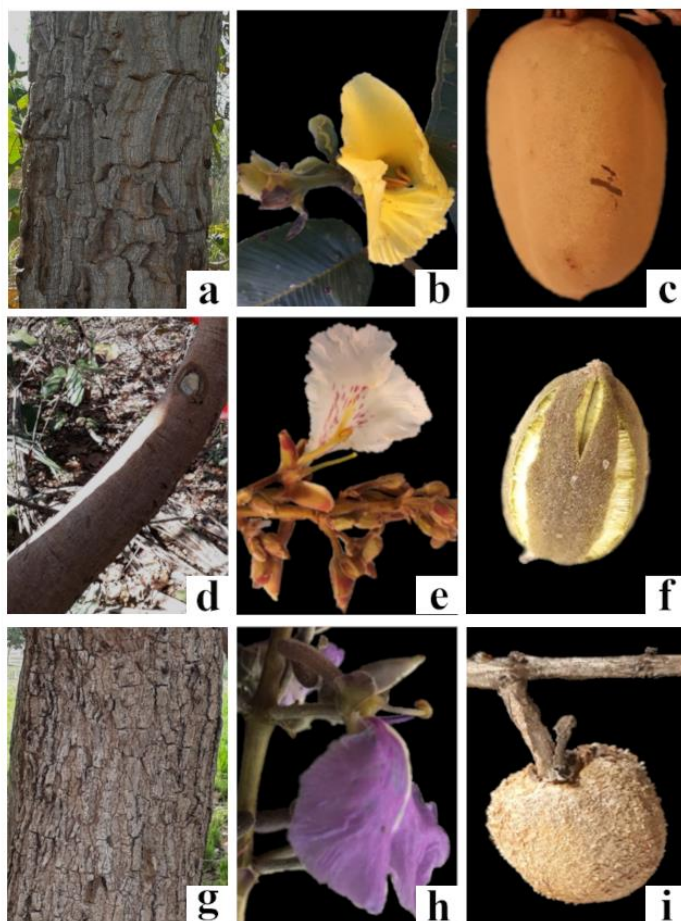


Figure 3. *Qualea* species collected at the Federal University of Rondonópolis. a-c. *Qualea grandiflora* – a. Stem with tree location information; b. Flower; c. Fruit. d-f. *Qualea multiflora* – d. Stem with tree location information; e. Flower; f. Fruit. g-i. *Qualea parviflora* – G. Stem with tree location information; h. Flower; i. Fruit. (a-c. Silveira et al., UFMT 44308; d-f. Nogueira et al., UFMT 43806; g-i. Nogueira et al., UFMT 43789).

Vochysia Aubl.

Trees. Leaves verticillate; chartaceous; leaf blade with entire margin; penninerved. Inflorescences terminal, of the thyrses type. Flowers dichlamydeous, zygomorphic. Calyx with 5 sepals; with spur. Corolla with 3 petals. Androecium with a single fertile stamen; anther basifixed, dithecous with longitudinal dehiscence. Gynoecium with superior, pilose, trilobular ovary, axial placentation; 1 terminal stylus; 1 terminal stigma, undivided. Fruit dehiscent, loculicidal capsule. Winged seeds.

Vochysia is the largest genus of Vochysiaceae, with approximately 140 species (Gonçalves et al., 2017; Shimizu and Gonçalves, 2017), of which 88 are found in various vegetation types in Brazil (Flora e Funga do Brasil).

Vochysia cinnamomea Pohl.

Figs. 4a-b; 5a-c. Common name: “Pau-Doce”.

Trees 3-6 m tall. Stem with gray/brown rhytidome, with fissures forming plates. Leaves verticillate, 6-merous; short petiole, 0.4-1.5 cm long; leaf blade 7.7-18.9 x 3.4-6 cm, elliptical; pilose on the abaxial surface and glabrous on the adaxial surface; abaxial surface lighter than adaxial surface; base cuneate; apex mucronate; primary and

secondary veins prominent on the abaxial surface. Inflorescences terminal, 50-76.3 cm long; peduncle 0.5-1.5 cm long; rachis 10.8-75.3 cm long; cincinnus with up to 4 flowers; bracts 0.2-0.6 cm long; pedicel 0.4-3.0 cm long. Flower buds 0.6-1.9 cm long, cylindrical, curved, apex rounded; with spur. Calyx with 5 yellow sepals, 2 larger (0.3-0.5 x 0.2-0.4 cm), 2 smaller (0.2-0.4 x 0.2-0.3 cm) and 1 larger than the others (1.6-2.2 x 0.6-0.9 cm), with spur 0.7-0.9 cm long, recurved and cylindrical. Corolla with 3 yellow petals, 1 central (0.8-1.2 x 0.4-0.7 cm) and 2 laterals (0.5-0.9 x 0.2-0.5 cm). Androecium with filament 0.2-0.4 cm long; anther 1.3-2.2 cm long. Gynoecium with superior ovary 0.1-0.2 cm long; 1 terminal stylus 0.9-2.1 cm long. Fruit 2-3.1 cm long, oblong, exocarp striated, base rounded, apex mucronate.

Examined material: BRAZIL, MATO GROSSO, Rondonópolis, geographical coordinates: -16° 27' 42.2" S, -54° 34' 42.4" W, 25.IV.2018, bot., fl. and fr., Nogueira et al. (UFMT 43809); geographic coordinates: -16° 27' 36.23" S, -54° 34' 53.93" W, 30.IV.2018, bot. and fl., Nogueira et al. (UFMT 43808); geographic coordinates: -16° 27' 36.49" S, -54° 34' 54.42" W, 30.IV.2018, bot., fl. and fr., Nogueira et al. (UFMT 43805).

Flowering and fruiting: The plants found on the UFR campus flowered in the months of April to June and fruited in April and between June and September.

Distribution: According to data available in the Flora e Funga do Brasil, *V. cinnamomea* has been confirmed in the states of Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Rondônia, and São Paulo, in the Cerrado phytogeographic domain.

Vochysia divergens Pohl.

Figs. 4c-d; 5d-f. Common name: "Cambará".

Trees 9-11 m tall. Stem with brown rhytidome, with fissures. Leaves verticillate, 4-merous; petiole 2.1-4.4 cm long; leaf blade 3.6-11.5 x 1.9-4.2 cm, elliptical; glabrous on both sides; adaxial surface darker and brighter than abaxial surface; base cuneate; apex retuse; primary vein

prominent on the abaxial surface. Inflorescences terminal, 27.6-40.7 cm long; peduncle 1.0-2.5 cm long; rachis 26.5-39.5 cm long; cincinnus with up to 4 flowers; bracts absent; pedicel 1.1-9.9 cm long. Flower buds 0.8-1.4 cm long, cylindrical, curved, apex rounded; with spur. Calyx with 5 yellow sepals, 2 larger (0.4-0.9 x 0.2-0.4 cm), 2 smaller (0.2-0.4 x 0.2-0.3 cm) and 1 larger than the others (1.2-1.6 x 0.4-0.8 cm), with spur, 0.8-1.2 cm long, recurved and cylindrical. Corolla with 3 yellow petals, 1 central (0.9-1.7 x 0.4-0.8 cm) and 2 laterals (0.6-0.9 x 0.3-0.5 cm). Androecium with filament 0.2-0.5 cm long, anther 0.8-1.5 cm long. Gynoecium with superior ovary 0.1-0.2 cm long, 1 terminal stylus 0.7-1.7 cm long. Fruit 0.3-2.8 cm long, elongated, exocarp slightly striated, base rounded, apex mucronate. Seeds approximately 2.4 cm long.

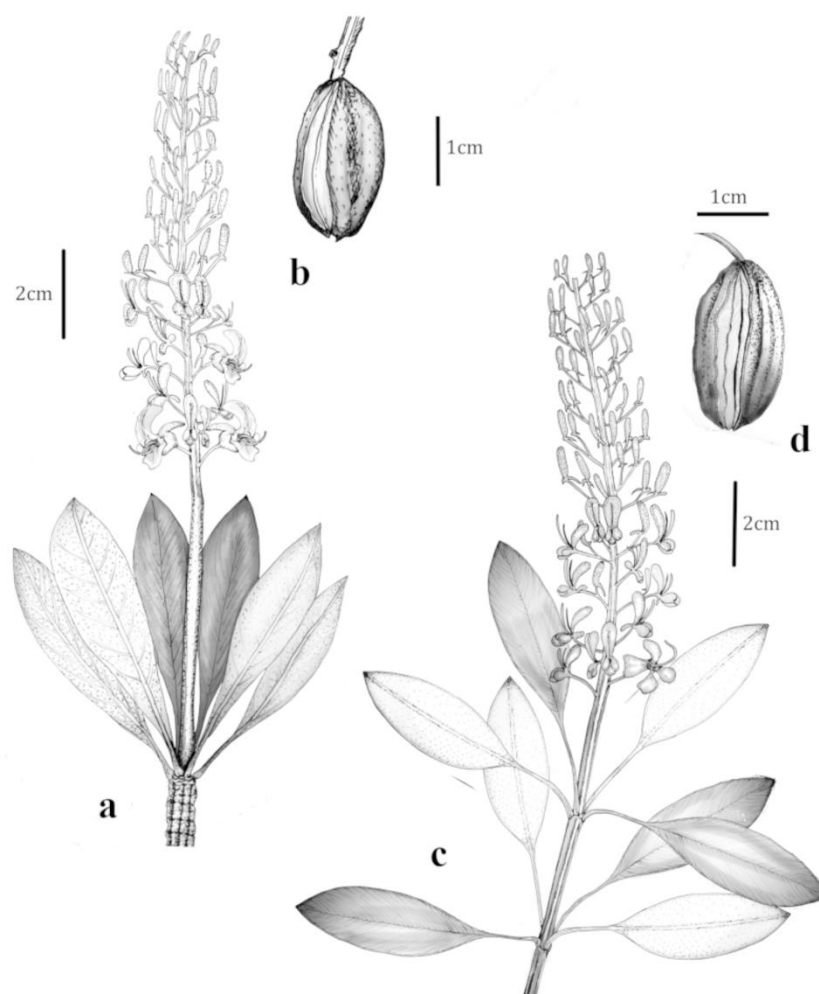


Figure 4. *Vochysia* species collected at the Federal University of Rondonópolis. a-b. *Vochysia cinnamomea* – a. Branch with leaves, flower buds and open flowers; b. Fruit. c-d. *Vochysia divergens* – c. Branch with leaves, flower buds and open flowers; d. Fruit. (a-b. Nogueira et al., UFMT 43809; c-d. Silveira et al., UFMT 44043). Illustration: Milton Omar Córdova Neyra (2019).

Examined material: BRAZIL, MATO GROSSO, Rondonópolis, geographic coordinates: -16° 27' 56.81" S, -54° 34' 43.81" W, 18.VII.2018, bot., fl. and fr., Silveira et al. (UFMT 44043); geographic coordinates: -16° 27' 55.13" S, -54° 34'

40.20" W, 23.VII.2018, bot. and fl., Silveira et al. (UFMT 44044); geographic coordinates: -16° 27' 55.17" S, -54° 34' 40.43" W, 23.VII.2018, bot., fl. and fr., Silveira et al. (UFMT 44045).

Flowering and fruiting: The trees identified as *V. divergens* flowered in the months of May to July and had fruit in July, October and November.

Distribution: According to the Flora e Funga do Brasil, *V. divergens* is reported from the states of Amazonas, Bahia, Goiás, Maranhão, Mato Grosso,

Mato Grosso do Sul, Pará, Rondônia, and Tocantins, mainly in gallery forests and cerrado *lato sensu*. In Mato Grosso, this species is commonly observed in wetlands in the Pantanal, in seasonally flooded monodominant forests, locally known as “cambarazais” (Arieira and Nunes da Cunha, 2012).

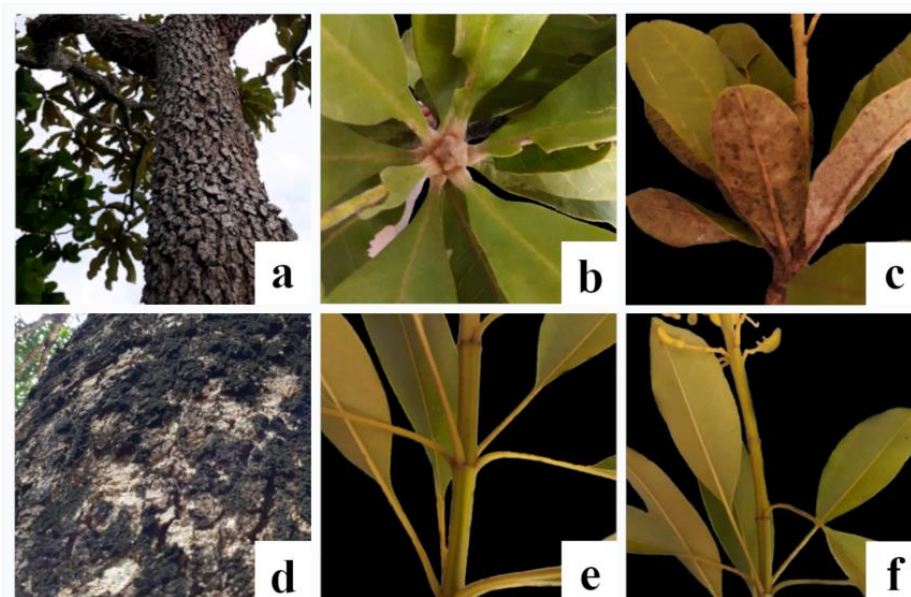


Figure 5. *Vochysia* species collected at the Federal University of Rondonópolis. a-c. *Vochysia cinnamomea* – a. Stem with tree location information; b. Phyllotaxis; c. Branch with a view of the abaxial and adaxial surfaces of the leaves. d-f. *Vochysia divergens* – d. Stem with tree location information; e. Phyllotaxis; f. Branch with a view of the abaxial and adaxial surfaces of the leaves and with flower buds and open flowers. (a-c. Nogueira *et al.*, UFMT 43809; d-f. Silveira *et al.*, UFMT 44043).

Conclusion

Even with the small size of the fragment, five species of Vochysiaceae were found in the area sampled, which may be an indicator of the species richness in the local Cerrado.

Through surveys and collections, it was possible to observe the morphological characters of the species and assemble the identification keys, as well as the boards with images and illustrations.

This study contributed to expanding the knowledge on the characteristics and distribution of Vochysiaceae species and on the flora of the Southeastern Mesoregion of Mato Grosso, in addition to being able to serve as a subsidy for discussions on the preservation of the Cerrado.

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