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***Lacandonia brasiliiana* A. Melo & M. Alves (Triuridaceae), New Occurrence for the State of Ceará, Brazil¹**

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ABSTRACT

The Triuridaceae family is composed of saprophytic plants, chlorophylls, usually unbranched stems, leaves in alternate scales, bisexual or unisex racemous inflorescence, follicle or achene fruits. The species *Lacandonia brasiliiana* A. Melo & M. Alves was described as a new species at the beginning of this decade through its first occurrence in the state of Paraíba, Brazil and South America. The objective was to report the first occurrence of the species *Lacandonia brasiliiana* to Ceará State, the second occurrence for Brazil and South America, contributing to the knowledge of its distribution. The species was collected through expeditions in Cerrado fragments, in the municipality of Viçosa do Ceará-CE, during May/2019, which had fertile structures for later taxonomic identification. The collected material was herborized and later deposited in the Herbarium Prisco Bezerra (EAC) of the Federal University of Ceará. Identification was based on identification keys, specialized bibliography, expert consultation, comparison with herbarium and standard specimens. The species is presented with description, taxonomic and ecological comments, distribution data and images. It is a small, non-branched, myco-heterotrophic species found in a preserved area of Seasonal Semideciduous Forest, being the first record for a Cerrado phytophysognomy area. It's concluded that the new occurrence of *Lacandonia brasiliiana* for the State of Ceará highlights the importance of floristic surveys in Cerrado forest remnants, and it is possible to observe the expansion of its territorial distribution, degree of conservation and richness.

Keywords: Northeastern Brazil, Cerrado, Pandanales, saprophytes.

***Lacandonia brasiliiana* A. Melo & M. Alves (Triuridaceae), Nova Ocorrência para o Estado do Ceará, Brasil**

RESUMO

A família Triuridaceae é composta de plantas saprófitas, aclorofiladas, caule geralmente não ramificado, folhas em escamas alternas, inflorescência racemosa bissexuada ou unissexuada, frutos em folículo ou aquênio. A espécie *Lacandonia brasiliiana* A. Melo & M. Alves foi descrita como nova espécie no início desta década através de sua primeira ocorrência no Estado da Paraíba, no Brasil e na América do Sul. Objetivou-se relatar a primeira ocorrência da espécie *Lacandonia brasiliiana* para o Estado do Ceará, a segunda ocorrência para o Brasil e para a América do Sul, contribuindo para o conhecimento da sua distribuição. A espécie foi coletada através de expedições em fragmentos de Cerrado, no município de Viçosa do Ceará-CE, durante o mês de maio/2019, a qual possuía estruturas férteis para a posterior identificação taxonômica. O material coletado foi herborizado e posteriormente depositado no Herbário Prisco Bezerra (EAC) da Universidade Federal do Ceará. A identificação ocorreu a partir de chaves de identificação, bibliografia especializada, consulta aos especialistas, comparação com espécimes de herbário e espécimes-tipo. A espécie é apresentada com descrição, comentários taxonômicos e ecológicos, dados de distribuição e imagens. Trata-se de uma espécie de pequeno porte, mico-heterótrofa, não ramificada, encontrada em área preservada de Floresta Estacional Semidecidual, sendo o primeiro registro para uma área de fitofisionomia do Cerrado. Conclui-se que a nova ocorrência da *Lacandonia brasiliiana* para o Estado do Ceará evidencia a importância dos levantamentos florísticos em remanescentes florestais de Cerrado, sendo possível observar a expansão da sua distribuição territorial, o grau de conservação e a riqueza. Palavras-chave: Nordeste do Brasil, Cerrado, Pandanales, saprófita.

Introdução

Triuridaceae, of the order Pandanales, comprises mycoheterotrophic achlorophyllous plants with unbranching (in the New World) stems distributed in the tropical and subtropical forests of the Old and New World, generally growing in the shadows of the forests, being almost imperceptible, reaching up to 40 cm, making part of the monocot group. In addition to Triuridaceae, this order includes the families Cyclanthaceae, Pandanaceae and Velloziaceae (Maas & Rübsamen, 1986; Mercks et al., 2013; Nuraliev, Cheek & Beer, 2016; APG IV, 2016; Suetsugu et al., 2017) and is represented by nine genera with ca. 55 species (Christenhusz & Byng, 2016; Govaerts, Maas-van de Kamer, & Maas, 2016).

According to molecular data, the family Triuridaceae, includes 3 tribes, Kupeaeae (*Kihansia* and *Kupea*) which is endemic to Continental Africa; Sciaphileae (*Andruris*, *Hyalisma*, *Sciaphila*, *Seychellaria* and *Soridium*), which are part of the New and Old World, *Sciaphila* being a paraphyletic group in relation to *Seychellaria*, however there is still no reorganization of this tribe. The first three genera of Sciaphileae stand out as the greatest diversity of the family with 36 species in total. The Triurideae tribe (*Lacandonia*, *Peltophyllum*, *Triuridopsis* and *Triuris*), is endemic to the Neotropics (Cheek, 2003; Mennes, Smets, Moses, & Merckx, 2013; Tsukaya & Suetsugu, 2014; Govaerts et al., 2016; Nuraliev et al., 2016).

Representatives of Triuridaceae are characterized by small, alternate leaves, reduced to scales, usually racemose inflorescences with small actinomorphic, bisexual, or unisexual flowers, superior ovary, dichlamydeous or monochlamydeous, and fruits of follicles or achenes (Mennes et al., 2013; Merckx et al., 2013; Souza & Lorenzi, 2019).

The Triuridaceae family is found on decaying leaf litter in the interior of tropical forests, are often confused with fungi and poorly collected, for, apart from being small and achlorophyllous, have a very short reproductive cycle (Maas & Rübsamen, 1986; Melo & Alves, 2012; Mercks et al., 2013; Suetsugu et al., 2017; Sochor et al., 2018;).

In Brazil, Triuridaceae is represented by five genera (*Lacandonia*, *Peltophyllum*, *Sciaphila*, *Soridium*, and *Triuris*) and 13 species, with five of them Brazilian endemics *Lacandonia brasiliiana* A. Melo & M. Alves, *Peltophyllum caudatum* (Poulsen) R. Schmid & M.D. Turner, *Sciaphila*

oligantha Maas, *Sciaphila schwackeana* Johow, and *Triuris alata* Brade. *Sciaphila* is the most species-rich genus, with eight species in the Neotropics, of which seven occur in Brazil. *Peltophyllum* and *Triuris* have two species each, and *Soridium* and *Lacandonia* are monospecific (The Brazil Flora Group [BFG], 2018). Representatives of Triuridaceae are found predominantly in the North and Southeast regions of the country, in such phytogeographic domains as the Cerrado, and Amazonian and Atlantic Forests, with most of them restricted to Ombrophilous Forests, except for *Lacandonia brasiliiana* A. Melo & M. Alves, found in Semideciduous Seasonal Forests.

Lacandonia brasiliiana A. Melo & M. Alves is an herbaceous monoecious plant, to 9 cm in height, with filiform roots, unbranched hyaline stems, leaves lacking, terminal (2!)4–6-flowered inflorescences, and apocarpic numerous ovaries. It was recently described from a fragment of the Atlantic Forest for the State of Paraíba, Northeastern Brazil (Melo & Alves, 2012). It also presents tepals with subapical appendages, anther with slit-like opening, uniovulate carpels (Rudall, Alves, & Sajo, 2016).

Studies concerning mycoheterotrophs plants are quite scarce, due to the lack of data for the identification and comparison of species, as well as few collections, including their morphological characters, for example data on staminate flowers that are crucial for correct identification (Tsukaya & Okada, 2013; Tsukaya & Suetsugu, 2014; Suetsugu et al., 2017).

Based on this, the objective of this work was to report the first occurrence of the species *Lacandonia brasiliiana* A. Melo & M. Alves in the state of Ceará, the second occurrence in Brazil and South America, contributing to the knowledge of its distribution, demonstrating that floristic surveys of areas still poorly collected are of great importance for the knowledge of local floras and regional biodiversity, in addition to providing new ecological and taxonomic data for the species.

Materials and methods

Specimens of *Lacandonia brasiliiana* A. Melo & M. Alves were collected during field work conducted in preserved fragments of the Cerrado vegetation (Figure 1a-b) in May of 2019.

The collected samples were processed following the standard techniques (Mori, Silva, Lisboa, & Coradin, 1989) and deposited at the

Prisco Bezerra Herbarium (EAC) of the Federal University of Ceará.

Specialized literature was used for species identification and description (Maas & Rübsamen, 1986; Melo & Alves, 2012; Rudall et al., 2016).

Morphological terminology followed Radford, Dickison, Massey and Bell (1974) and Gonçalves and Lorenzi (2011).

The distribution data was obtained from the NY, SP, and UFP herbarium collections (acronyms following Thiers, 2019) and the distribution map was generated using QGIS ver. 3.4.3.

Classification of vegetation followed the Brazilian Vegetation Technical Manual (Instituto Brasileiro de Geografia e Estatística [IBGE], 2012).

Results and discussion

Lacandonia brasiliiana A. Melo & M. Alves, *Phytotaxa* 40: 22–24, 2012 (Figure 2a–e).

Mycoheterotrophic monoecious herb, unbranched, to 6 cm high; stems filiform, hyaline, glabrous. Leaves lacking. Inflorescences racemose, terminal, (2!)4–6-flowered, bracteoles 1.25–1.5 × 0.5–0.75 mm, triangular, apex acute, with simple hyaline adpressed trichomes; Flowers 2–3.3 mm in diam., actinomorphic, bisexual; pedicels 1.5–2 mm in the apical flowers, 2.5–4 mm in the basal, tepals 5–6, 1–1.75 × 1–1.25 mm, deltoid, yellow, brown in senescence, equal in size, with simple, hyaline, adpressed, sparse trichomes and a prominent central vein; ovaries numerous, apocarpic, papillose, surrounding the androecium, style 0.2–0.75 mm long; stamens 3, tiny. Fruit achenes, 0.75–1.5 mm diam., yellow.

Material examined:—BRASIL. CEARÁ: Viçosa do Ceará, Serra das Flores, 23.V.2019, fl. and fr., E.M.P. Lucena et al. 666 (EAC).

Additional material examined:—BRASIL. PARAÍBA: Mamanguape, Reserva Biológica de Guaribas, 25.IX.2010, fl., A. Melo et al. 487 (NY, UFP); Trilha Cabeça de Boi, 21.VIII.2013, fl., A. Melo et al. 1195 (SP).

Lacandonia brasiliiana A. Melo & M. Alves is a mycoheterotrophic achlorophyllous plant, recognized by its small size, less than 10 cm

in height, hyaline stems, and terminal yellowish flowers. The collected specimens showed presence of simple trichomes on their bracts, a new character for the species and other representatives of the achlorophyllous herbs occurring in Brazil, the feature not mentioned by Melo and Alves (2013).

The new occurrence of *Lacandonia brasiliiana* A. Melo & M. Alves for the State of Ceará represents a second such occurrence for Brazil and South America (Figure 3). *Lacandonia brasiliiana* A. Melo & M. Alves was found on the moist decaying leaf litter in protected areas of a Semideciduous Seasonal Forest, with fertile soil, at an altitude of 370 m, with the average annual temperatures between 22 and 24°C and 1,349 mm of rainfall, typical of the Tropical Warm Subhumid climate (Instituto de Pesquisa e Estratégia Econômica do Ceará [IPECE], 2018).

Specimens of *Lacandonia brasiliiana* A. Melo & M. Alves were collected in May of 2019, both with flowers and fruit (Figure 2c–e). The forest fragment has the phytophysiognomy of a Cerrado forest, with the shrubby and tree vegetation forming a canopy, ranging in height from 40 cm to 12 m, and including representatives of herbaceous and climbing plants (Ribeiro & Walter, 1998). This is a first record of *Lacandonia brasiliiana* A. Melo & M. Alves for the Brazilian Cerrado.

Guilherme et al. (2016) states that the collection of mycoheterotrophic plants in an environment of savanna vegetation, such as the Cerrado, is quite unusual, as the environmental characteristics aren't conducive, bringing subsidies to the understanding of the biogeography and diversity of this ecosystem, as seen that most collections are related to the woody flora.

With this record, it shows the importance of floristic studies in areas of Cerrado remnants, since this biome is quite degraded, mainly due to anthropogenic actions and the expansion of the agricultural frontier, thus being able to assist in the conservation and management of certain species (Andrella & José Neto, 2017).

According to Strassburg et al. (2017) if by the year 2050 no preservation attitude occurs in the Cerrado, 31–34% of its remaining area will disappear. This will occur due to the increase in deforestation, causing damage to the harmony of the ecosystem, such as the decrease of native and

Figure 1. Fragment of Cerrado in the Serra das Flores, Viçosa do Ceará-CE. a. Serra das Flores profile. b. Phytophysiology of Cerrado *stricto sensu* in the Serra das Flores plateau.

Figure 2. Seasonal Semideciduous Forest and *Lacandonia brasiliiana* A. Melo & M. Alves, Viçosa do Ceará-CE. a. Fragment of Seasonal Semideciduous Forest (Phytophysognomy of Cerrado). b. Individuals of *Lacandonia brasiliiana* A. Melo & M. Alves in leaf litter. c. Height of *Lacandonia brasiliiana* A. Melo & M. Alves. d. Flowers (fl) and fruits (fr) in highlight. e. Herbarium specimen showing bracts (br), flowers (fl), tepals (te), carpels (ca), and fruit (fr) (a-e. Lucena et al. 666).

Projection: Universal Transverse Mercator. Coordinate System: Geographic Coordinates.
Geodetic Datum: WGS 84. Date: JUN/2019

Figure 3. Distribution of *Lacandonia brasiliiana* A. Melo and M. Alves (Triuridaceae) in Brazil: only in the Northeast region, one occurrence in Ceará (Viçosa do Ceará, Serra das Flores, 23.V.2019, Lucena et al. 666) and another in Paraíba (Mamanguape, Reserva Biológica de Guaribas, 25.IX.2010, Melo et al. 487).

endemic species (Bordino, José Neto, & Blini, 2018).

Lacandonia belongs to tribe Triurideae of the Triuridaceae and includes two species, *Lacandonia schismatica* E. Martínez & Ramos and *Lacandonia brasiliiana* A. Melo & M. Alves, both endemic to the Neotropics. *Lacandonia schismatica* E. Martínez & Ramos is known from the Lacandon region of Chiapas, Mexico (Martínez & Ramos, 1989; Ambrose et al., 2006), whereas *Lacandonia brasiliiana* A. Melo & M. Alves, first described for South America by Melo and Alves (2012), was recorded for the Atlantic Forest in the State of Paraíba, Northeastern Brazil, ca. 20 km from the Atlantic coast, where the average annual temperature is 26°C and the annual rainfall 1,700 mm. It grows in preserved protected forest areas in the moist decaying leaf litter on sandy soils and was collected fertile in August and September (Melo & Alves, 2012). According to Rudall et al. (2016) the flowering period of *Lacandonia schismatica* E. Martínez & Ramos occurs from November to December, thus occurring in the second half of the year. The appearance of *Lacandonia brasiliiana* A. Melo & M. Alves in Brazil didn't occur from a mutation of the species *Lacandonia schismatica* E. Martínez & Ramos, as the two species are considered evolutionarily close (Rudall et al., 2016).

Lacandonia is a genus with a disjunct distribution between the Mesoamerican forests of Chiapas, Mexico and the Atlantic Forest of Northeast Brazil. With this new occurrence, it brings subsidies on its evolution and distribution (Martínez & Ramos, 1989; Melo & Alves, 2012; Maas, Maas, & Melo, 2015; Rudall et al., 2016). It belongs to the group of plants called mycoheterotrophs, or saprophytes, which convert organic matter with the aid of mycorrhizal fungi. Such an association can classify plants as total or initial mycoheterotrophic and partial or myxotrophic. The initial mycoheterotrophic only use the association of fungi only in the initial stage of their development, obtaining nutrients indirectly, whereas mixotrophic need the fungi more directly in the photosynthetic process (Mercks et al., 2013; Gebauer, Preiss, & Gebauer, 2016; Jia, Nakano, Hattori, & Nara, 2017). However, to date, it's not known whether *Lacandonia brasiliiana* A. Melo & M. Alves is initial mycoheterotrophic or myxotrophic.

According to Nuraliev, Kuznetsov, Kuznetsova and Averyanov (2019) non-photosynthetic plants, as is the case with some representatives of mycoheterotrophs, present a notable number of species, producing little or no amount of chlorophyll, thus giving their whitish

color, failing to carry out the process of photosynthesis thus differentiating it from autotrophic plants.

Their representatives in Brazil, from Gentianaceae, Triuridaceae, Burmanniaceae and Orchidaceae, all occur in its Northeast region (Melo & Alves 2012; Melo & Alves, 2013; Melo, Araújo, & Alves, 2010, Ferreira et al., 2019).

In the Southeastern region, we have representatives from Burmanniaceae (Souza, Blum, & Brotto, 2019), Thismiaceae (Guilherme, Coelho, Smidt, Gomes, & Souza, 2016), Orchidaceae (Bittencourt & Gasper, 2016; Mancinelli & Quadros, 2016). In the South region we have studies with the family Triuridaceae (Valadares, Arçari, Martins, & Schneider, 2015).

Such characteristics are also present in club mosses, liver (Marchantiophyta), gymnosperms (Lycopodiopsida and Polypodiopsida) (Mercks et al., 2012; Renny et al., 2017; Nuraliev et al., 2019), with about 20,000 species of plants (Mercks et al., 2013).

Scarcity of collectons of the mycoheterotrophic plants is due to the difficulty of their identification in the field (Santos, Barbosa, Santos, Bao, & Rodrigues, 2013; Tsukaya & Suetsugu, 2014;). Nevertheless, representatives of this little studied group continue to appear in herbarium collection databases around the world, especially in Brazil (Valadares et al., 2015).

The vast majority of mycoheterotrophic plants prefer extensive and well-preserved forest fragments, whether in temperate or tropical areas (Gomes, Bodegom, Merckx, & Soudzilovskaia, 2019) and thus may be considered to be good bioindicator species (Melo et al., 2010).

Conclusions

Based on the results obtained, it can be concluded that:

1. The new occurrence of *Lacandonia brasiliiana* A. Melo & M. Alves for Ceará State, the second occurrence for Brazil and South America expanded its territorial distribution and the records of plant species that occur in the Cerrado of Ceará;
2. The importance of floristic surveys, in particular the forest remnants of the Cerrado in the State of Ceará, help to assess the degree of richness and conservation of their species, thus knowing the regional taxonomic flora.
3. Studies of new records involving mycoheterotrophic plants may provide subsidies

for studies involving recovery of degraded areas since these species have preferences with a lot of nutrients and low anthropic action.

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