



Expansion of the geographic distribution of a Brazilian endemic, *Encyclia gonzalezii* L.C. Menezes (Orchidaceae, Epidendroideae), to the Cerrado of Maranhão and the Northeast Region of Brazil

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Abstract

We report the first occurrence of *Encyclia gonzalezii* L.C. Menezes (Orchidaceae) from the state of Maranhão and the Northeast Region of Brazil. The species was collected in the Cerrado domain in Estreito, Maranhão. We present a map of the collection site, a morphological description, photographs, ecological comments, a provisional conservation assessment, and an identification key for the species of *Encyclia* from Maranhão.

Keywords

Cerrado, floristics, Laeliinae, new occurrence

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Introduction

The genus *Encyclia* Hook. comprises about 150 species distributed in tropical and subtropical regions of the Americas, from the southern United States through several countries of continental and insular Central America, to Argentina in southern South America. The genus includes epiphytic, rupicolous, and terrestrial species (Bastos et al. 2015, 2016, 2018; Bastos et al. 2020; Govaerts et al. 2021; Tropicos 2021).

Forty-eight species of *Encyclia* occur in Brazil, and 29 of them (60.4%) are considered endemic. The species

can be found in the phytogeographic domains of the Amazon Region, Caatinga, Cerrado, and Atlantic Forest (BFG 2015; Bastos et al. 2020; Flora do Brasil 2020; SpeciesLink 2021). In the Northeast Region of Brazil, 17 species of *Encyclia* are recorded (Bastos et al. 2020; Flora do Brasil 2020).

Encyclia gonzalezii L.C. Menezes is an epiphytic species endemic to Brazil, occurring in gallery forests in the Brazilian Cerrado, in the states of Goiás, Tocantins, and the Federal District (Bastos et al. 2020; Flora

do Brasil 2020). *Encyclia gonzalezii* has flowers with a mild aroma, brownish-greenish sepals and petals (more greenish in the basal portion and more brownish in the apical portion), a trilobed labellum with beige-greenish lateral lobes which projects to the sides in the apical region, and a rounded somewhat sinuous median lobe with irregularly wavy edges and longitudinal lamellae with or without branches.

During floristics studies in the Maranhão state, we found individuals of *E. gonzalezii*. Our objective here is to detail the first records of *E. gonzalezii* in the state of Maranhão, as well as the Northeast Region of Brazil, and to provide additional data of the species.

Methods

The study region is located in the municipality of Estreito on the border with the municipality of Carolina, Maranhão, Northeast Region of Brazil (Fig. 1). The relief is predominantly flat to undulating, with altitudes ranging from 250 to 500 m. The average annual temperature is 26 °C and the average annual precipitation is 1250–1500 mm. The dry season is from May to October, and the rainy season is from November to April (Saraiva et al. 2020). The collection site has a seasonal tropical climate (Alvares et al. 2013; Saraiva et al. 2020; INMET 2021). The predominant phytogeographic domain in the area between the municipalities of Riachão and Carolina

is the Cerrado in transition with the Amazon Region. The predominant phytophysognomy in the area of the Chapada das Mesas region, where the Prata waterfall is located, consists of the Cerradão and riparian forests (Pereira et al. 2011; Almeida et al. 2020; Saraiva et al. 2020; INMET 2021). This region has intense tourist activity with access trails to the Cachoeira do Prata, and it has been impacted by deforestation and fires due to surrounding agrarian activities (Silva et al. 2017).

Our fieldwork was carried out in March 2017 during a floristic survey of the Estreito. *Encyclia gonzalezii* was collected in the riparian forest of the river Farinha near the Cachoeira do Prata. Two specimens of *E. gonzalezii* were collected and cultivated in the greenhouse of the Plant Physiology Laboratory, Federal University of Maranhão (UFMA), Dom Delgado Campus, São Luís, Maranhão.

The flowers of *E. gonzalezii* were photographed with a digital camera and described with the use of a stereomicroscope. The identification of the species and its morphological description were based on the characteristics observed in the two individuals, which were collected in Maranhão and bloomed under cultivation, and on the available published information of the species (Cogniaux 1898, 1906; Pabst and Dungs 1975, 1977; Menezes 1991; Castro Neto and Campacci 2000; Campacci 2003; Castro Neto 2006; Menegueto et al. 2010, 2012; Bastos et al. 2015, 2016, 2018). Two voucher specimens of *E. gonzalezii* were collected according to the procedures of Fidalgo

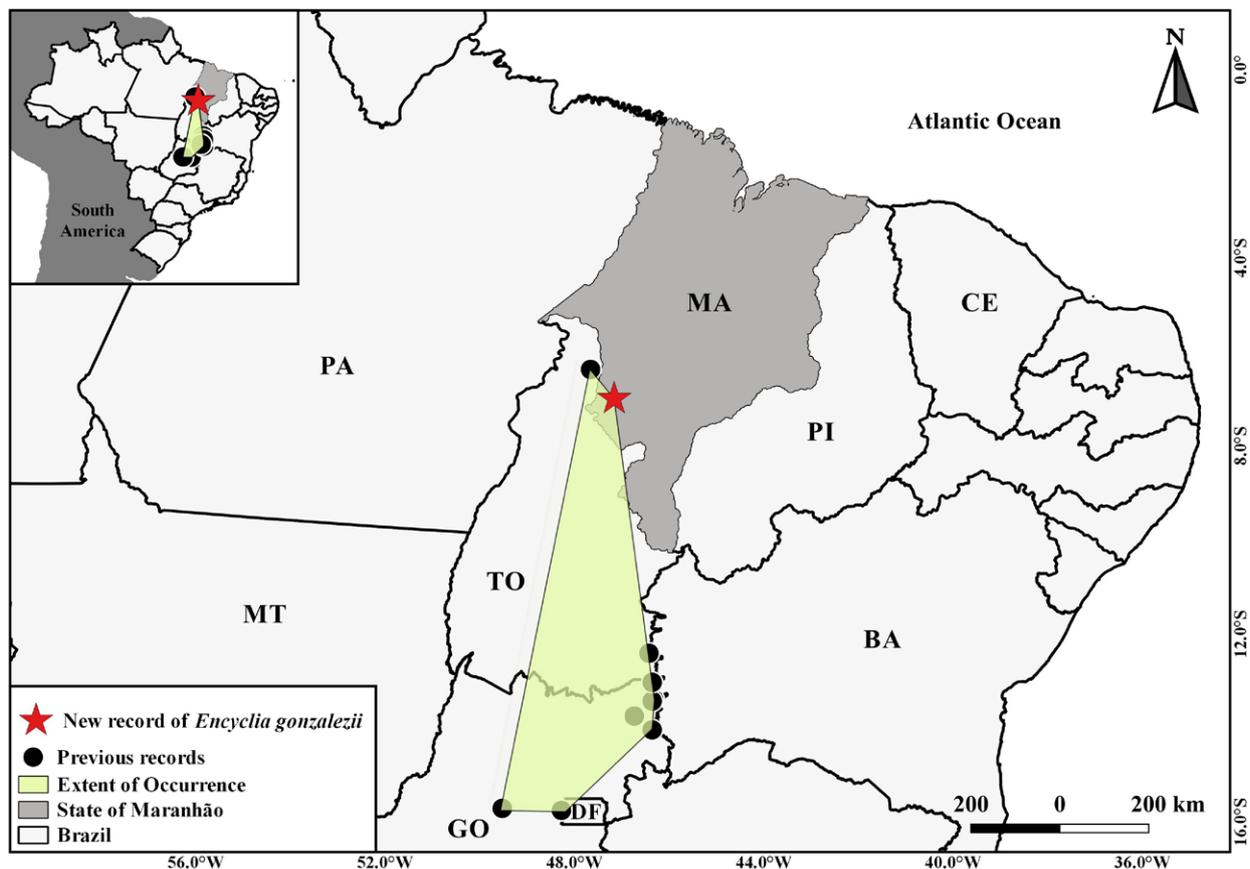


Figure 1. Distribution map of *Encyclia gonzalezii* in Maranhão highlighting the new record (red star) compared to its main previous records in Brazil.

and Bononi (1989) and deposited in the SLUI herbarium, State University of Maranhão (UEMA), São Luís Campus (the acronym follows Thiers 2021). Geographical distribution follows Bastos et al. (2020), Flora do Brasil (2020), SpeciesLink (2021), and Tropicos (2021). The acronyms of the consulted herbaria in Flora do Brasil (2020) and SpeciesLink (2021) follow Thiers (2021).

Photographs were edited using Adobe Photoshop CS5 (Adobe Systems Inc.). The distribution map (Fig. 1), which includes the previous records and the new records of *E. gonzalezii*, was based on the geographic coordinates available in Bastos et al. (2018), Flora do Brasil (2020), and SpeciesLink (2021). The map was prepared with QGIS v. 2.18.0 (QGIS Development Team 2021) using SIRGAS 2000. The geographical coordinates of the specimens collected in Estreito and cultivated in the greenhouse of the Laboratory of Vegetal Physiology, UFMA were recorded using a GPS receiver.

The preliminary conservation status of *E. gonzalezii* in Brazil was prepared based on the International Union for the Conservation of Nature (IUCN 2012), guidelines for the application of IUCN Red List Criteria at regional and national levels, version 4 (IUCN 2010) and using the geographic coordinates of 16 specimens, 15 of them from online databases (Bastos et al. 2018; Flora do Brasil 2020; SpeciesLink 2021), and one from our recent collection. The Extent of Occurrence (EOO) and Area of Occupation (AOO) were calculated using the Geospatial Conservation Assessment Tool (GeoCAT; <http://geocat.kew.org>). AOO was based on a defined cell width of 2 km (Bachman et al. 2011).

Results

Encyclia gonzalezii L.C. Menezes

Figure 2A–H

Type: BRAZIL – **Distrito Federal** • N.C. Cazelato sub L.C. Menezes UBI leg. (holotype: UBI!); border with state of Goiás, Rio Descoberto, blooming in cultivation, VII.1990, fl.

Synonym: *Encyclia tocaninensis* V.P. Castro & Campacci, Orquidário 10(3): 74. 1996.

Type: BRAZIL – **Tocantins** • V.P. Castro Neto leg. (holotype: SP!); Taguatinga, VIII.1982, (blooming in cultivation in X.1983).

New records. BRAZIL – **Maranhão** • Estreito, near the Carolina border, Cachoeira da Prata, 06°59'41.1"S, 047°09'55.6"W, 206 m alt.; 17.III.2017; (blooming in cultivation in 15.XI.2019); I. Zanandrea, J. Santos, W.A.J. Pereira leg.; exsiccate (SLUI 5945) • same locality; 17.III.2017; (blooming in cultivation in 10.XI.2020); I. Zanandrea, J. Santos, W.A.J. Pereira leg.; exsiccate (SLUI 5946).

Additional material examined. BRAZIL – **Tocantins** • Aurora do Tocantins, Serra do Espigão Mestre; 12°24'43"S, 046°25'55"W; III.1955; C. Neto leg.; exsiccate (SP) • Nazaré, banks of the Mombuca Stream; 06°22'19"S, 047°39'50"W; VII.1990; Silva & Silva 124 leg.; exsiccate (MG138893).

Identification. Herb epiphytic. Roots white, glabrous, 15–40 cm long × 0.1–0.2 cm wide. Rhizome inconspicuous. Pseudobulbs conic-elongate, reddish in nature or green in cultivation, 3.0–5.0 cm long × 1.2–2.2 cm wide. Leaves 1–2, lanceolate, apex acute, flat, fleshy-leathery, 20.0–42.0 cm long × 1.0–1.8 cm wide. Inflorescences terminal, cylindrical, glabrous, erect a slightly arched, simple or weakly compound raceme, with 10–20 flowers, 36.0–52.0 cm long × 0.15 cm wide; eventually branched raceme, 3–5 flowers, 4.5–6.5 cm long; peduncle 10.0–12.0 cm long; rachis 26.0–40.0 cm long. Flowers with brownish-green sepals and petals and whitish lip, soft aroma. Ovary straight to curved, glabrous, 1.8–2.0 cm long × 0.15 cm wide. Dorsal sepal lanceolate, wider in the upper portion, greenish-brownish, being more greenish in the basal portion and more brownish in the apical portion, 1.1–1.2 cm long × 0.4–0.5 cm wide. Lateral sepals slightly falcate, elliptical-elongated, brownish-green (being more greenish in the basal portion and more brownish in the apical portion), 1.1–1.2 cm long × 0.3–0.4 cm wide. Petals spatulated, acute apex, erect at an angle of about 50 degrees, brownish-green, 1.2–1.3 cm long × 0.3–0.4 cm wide. Lip 3-lobed (1.2–1.4 cm long × 0.8–1.0 cm wide), attached to the base of the column through a short unguicule (0.15 cm long × 0.2 cm wide); lateral lobes partially superimposed on the column, turned sideways in the apical portion, rectangular, with slightly rounded lateral margins, straight apices, greenish-beige with reddish-brown venules, 0.7–0.8 cm long × 0.3–0.4 cm wide; midlobe rounded, whitish, with irregularly wavy margins, with linear-branched calluses and small reddish-brown macules and venules, 0.5–0.6 cm long × 0.6–0.7 cm wide; callus cymbiform, whitish, starting at the isthmus between the median lobes and aligned with the median lobe of the lip, apex with three teeth, with the middle tooth larger than the lateral teeth, 0.5 cm long × 0.2 cm wide, with reddish-brown lines, furrow median longitudinal narrower in the third part of the basal portion and wider in the remaining two-thirds. Column clavate, 0.7–0.8 cm long × 0.3 cm wide, bidentate at the apex (when without anther cap), convex in the adaxial portion and with a median longitudinal groove in the abaxial portion, cream-greenish, with a small (0.1 cm long) pair of rectangular arms in the apex of the column; stigma triangular, 0.2 cm long × 0.2 cm wide; anther cap purplish, somewhat quadrangular in frontal view, with an emarginate apical portion, 0.2 cm long × 0.2 cm wide. Pollinia 4, yellow, rounded, flattened laterally, 0.1 cm long × 0.05 cm wide. Fruit capsular, greenish, globose-spindle-shaped, irregular surface, 2.7–3.0 cm long × 0.9–1.3 cm wide.

Identification key to the species of *Encyclia* from Maranhão (based on this study, Castro Neves and Campacci (2000), Meneguzzo et al. (2012), and Bastos et al. (2018)).

1. Rhizome inconspicuous 2
- 1'. Rhizome conspicuous *E. granitica*

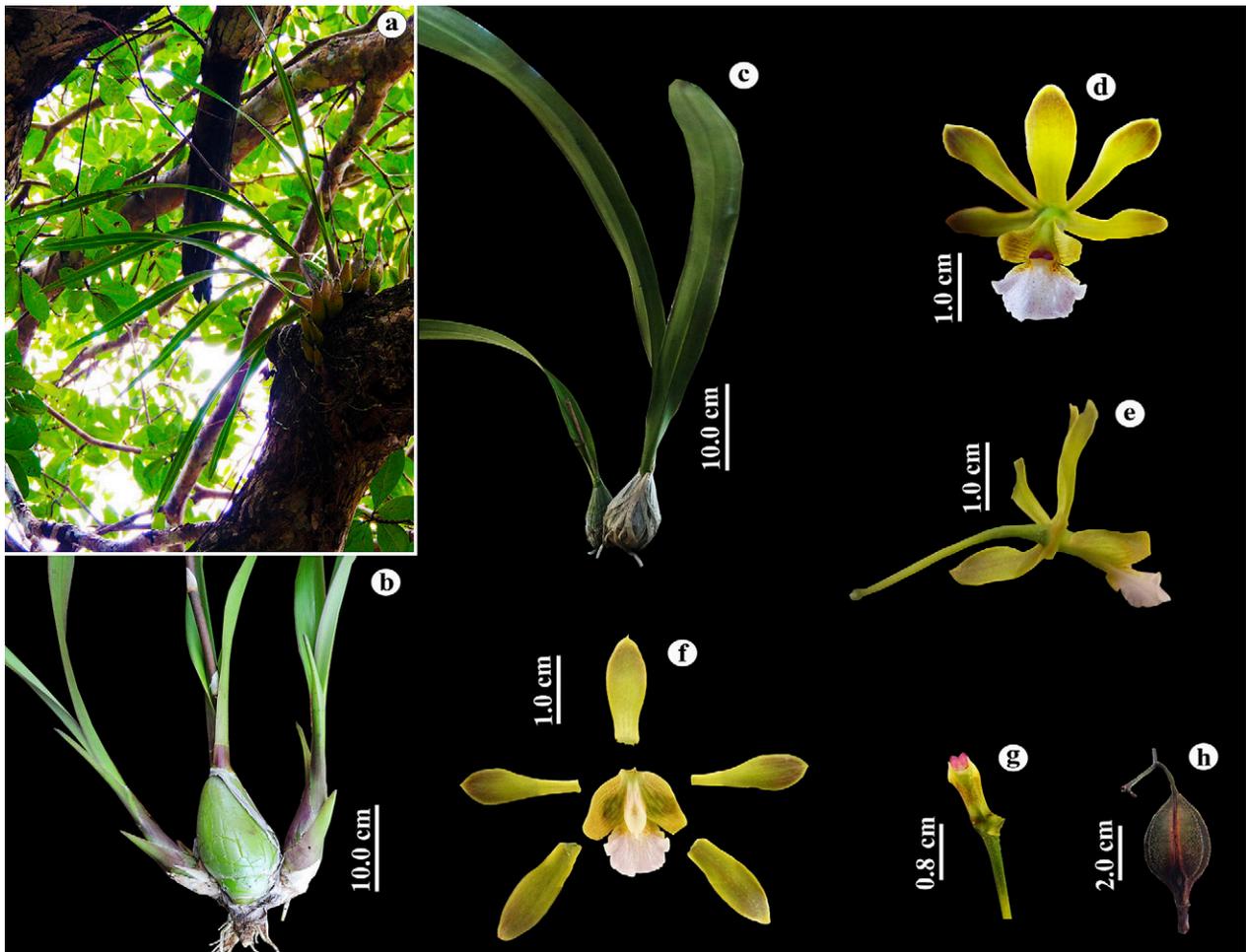


Figure 2. *Encyclia gonzalezii* (SLUI 5945). **A.** Plant in habitat, in the crown of the phorophyte *Terminalia* sp. (Combretaceae). **B.** Plant newly collected in the field, showing a reddish color in part of the leaves and pseudobulbs. **C.** Plant in cultivation, without the presence of reddish color. **D.** Flower in front view. **E.** Flower in lateral view. **F.** Dissected perianth, with labellum distended. **G.** Ovary, column and anther cap in abaxial view. **H.** Fruit.

2. Pseudobulbs conic-elongated, 3.0–5.0 cm long \times 1.2–2.2 cm wide; lip 3-lobed, whitish in the midlobe rounded, 1.2–1.4 cm long \times 0.8–1.0 cm wide; column clavate, apex bidentate, 0.7–0.8 cm long \times 0.3 cm wide *E. gonzalezii*
- 2'. Pseudobulbs conical, 1.5–3.0 cm long \times 1.0–1.5 cm wide; lip 3-lobed, white in the midlobe rounded to elliptic, 0.7–0.8 cm long \times 0.3–0.4 cm wide; column clavate, apex tridentate, 0.8–1.0 cm long \times 0.2–0.3 cm wide *E. linearifolioides*

Discussion

Our new records expands the geographical distribution in Brazil of *Encyclia gonzalezii* by approximately 88 km to the east from Nazaré (banks of Ribeirão Mombuca, Tocantins) and by 608 km to the north from Aurora do Tocantins (Serra do Espigão Mestre, Tocantins) (Species-Link 2021) (Fig. 1). The newly found occurrence of *E. gonzalezii* is threatened by human activities, mainly tourism on the access trails to the Cachoeira do Prata, in addition to impacts caused by deforestation and fires (Silva et al. 2017). Deforestation in the Cerrado for the creation of pastures has reduced the area of native flora.

The trampling and foraging of herds of cattle make it difficult for the native species to survive. In addition, fire also mainly threatens epiphytic species, including *E. gonzalezii*.

Based on the 16 records of *E. gonzalezii*, the EOO is calculated to be 226,691,951 km², and the AOO, 28,000 km² (Fig. 1). Therefore, according to the IUCN criteria used (IUCN 2010) and the mentioned threats and only 16 locations, we provisionally assess *E. gonzalezii* as Endangered (EN) under B2a,b(ii–iv). Contributing to this criterion is the fact that this species is endemic to Brazil, there are few records of its occurrence (only 16), and it occurs in areas with constant human interference, such as deforestation and fires.

Encyclia gonzalezii occurs in gallery forests in the Brazilian Cerrado of the states of Goiás, Tocantins, and now Maranhão, as well as the Federal District (Bastos et al. 2018, 2020; Flora do Brasil 2020). This species was described in 1991 by Lou Christian Menezes, based on collection from the the Descoberto River in the Federal District and bordering the state of Goiás (Menezes 1991).

According to Meneguzzo et al. (2012) and Bastos et al. (2018), *E. gonzalezii* is similar to *E. argentinensis*

(Speg.) Hoehne but differs in vegetative characters: in *E. argentinensis*, pseudobulbs are conical, 3.5–5.0 cm long \times 0.4–2.0 cm wide and leaves are 1–2, oblong, 29.0–41.0 cm long \times 0.6–1.8 cm wide, and with an acute apex, but in *E. gonzalezii*, pseudobulbs are conic-elongate and 3.0–5.0 cm long \times 1.2–2.2 cm wide, and leaves are 1–2, lanceolate, 20.0–42.0 cm long \times 1.0–1.8 cm wide. In addition, *E. gonzalezii* plants are always reddish, while those of *E. argentinensis* are not. We also noted that there is a similarity between the floral morphology of *E. gonzalezii* and that of *E. andrich* Menezes. Both species have similar sepals and petals, a callus with a trifid apical portion, and a median lobe of the rounded lip and with wavy edges. However, the vegetative part is distinct. In *E. andrich*, pseudobulbs are conical, 4.6–8.1 cm long \times 1.2–2.0 cm wide, and leaves are 2–3, oblong, 23.7–33.5 cm long \times 1.0–1.3 cm wide, and with an acute apex. And, as observed in the comparison with *E. argentinensis*, *E. gonzalezii* plants are reddish in their habitat, while those of *E. andrich* are not.

According to Bastos et al. (2020), Flora do Brasil (2020), SpeciesLink (2021), and Pessoa et al. (in press), two species of *Encyclia* have been confirmed thus far for Maranhão: *E. granitica* (Lindl.) Schltr. and *E. linearifolioides* (Kraenzl.) Hoehne. So, our new data are the first records of *E. gonzalezii* from the state of Maranhão and also for the Northeast Region of Brazil, bringing to three the number of *Encyclia* species in the state.

At the collection site, we observed about 20 individuals of *E. gonzalezii* in phorophytes of the genus *Terminalia* sp. (Combretaceae) (Fig. 2A) at about 15 m above the ground. Although *E. gonzalezii* preferentially occurs as an epiphyte and protected from direct sunlight, it is occasionally found as rupicolous on quartzite rocks (Meneguzzo et al. 2012). At the study site, although rocky outcrops occur, we did not observe rupicolous specimens of *E. gonzalezii*.

The epiphytic specimens observed in the field had reddish-colored pseudobulbs and leaves, probably due to greater exposure to sunlight (Fig. 2B). However, when cultivated in a greenhouse at the Laboratory of Vegetal Physiology, UFMA, the reddish color was lost, leaving only the greenish color (Fig. 2C). The reddish color in *E. gonzalezii* was also reported by Meneguzzo et al. (2012) for individuals both in the field and under cultivation. This divergence between individuals with the presence (Meneguzzo et al. 2012) or absence of reddish coloration (this study), may be related to specific cultivation conditions. Probably, the individuals cited by Meneguzzo et al. (2012) were cultivated in the presence of a shading screen which allowed the passage of a greater amount of sunlight, while the specimens cultivated at UFMA were grown in the presence of a shading screen that permitted the passage of 70% of the sunlight.

Another distinct aspect of this population of *E. gonzalezii* from the Cerrado Maranhense is the purple anther cap (Fig. 2). In the study by Meneguzzo et al. (2012), the anther caps varied in color between beige and yellow,

while in Bastos et al.'s (2018) review of *Encyclia* of Brazil, the anther cap of *E. gonzalezii* was whitish.

Encyclia gonzalezii bloomed under cultivation between October and November, a time similar to the flowering period mentioned by Meneguzzo et al. (2012), i.e., between September and October.

Despite the botanical potential of Maranhão, not much research is available about surveying species. Recent studies in Maranhão have shown that, with increasing sampling effort, new records of Orchidaceae (Ferreira et al. 2017, 2019a; Gomes et al. 2021; Oliveira et al. 2021; Pessoa et al. in press) and other plant families (Ferreira et al. 2018, 2019b; Guarçoni et al. 2020b; Silva et al. 2020; Silva Júnior et al. 2020) are discoverable. Even new species are found in Maranhão, as attested by Scatigna et al. (2019), Guarçoni et al. (2020a), and Santos et al. (2020).

Knowledge of the diversity and distribution of species in the region of the Chapada das Mesas National Park is helpful in understanding the local biogeography, which is important for interpreting ecological relationships and establishing conservation measures (Oliveira et al. 2018).

Our new occurrence record of *E. gonzalezii* in Maranhão and the Northeast Region of Brazil, highlights the Cerrado's remarkable presence in that state and also points to the need for further floristic surveys.

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Authors' Contributions

Conceptualization: IZ. Formal analysis: MO, AF. Funding acquisition: IZ. Investigation: AF. Methodology: MO. Writing – original draft: AF. Writing – review and editing: WP, MO, AF, IZ, JS.

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