








An updated checklist reveals strong incongruities with previous studies: insights after revisiting a regional orchid list

Edlley Pessoa^{1, 2*} , Maycon Jordan Costa da Silva³ , Miguel Sena de Oliveira² ,
Wagner Ribeiro da Silva Junior³  and Alessandro Wagner Coelho Ferreira³ 

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ABSTRACT

An updated checklist of the Orchidaceae from the state of Maranhão is provided. We confirmed 51 genera and 119 species, of which the most representative genera are *Habenaria* (17 spp.), *Catasetum* (14 spp.) and *Epidendrum* (10 spp.). Our checklist includes 30 species that are not listed in the Flora do Brasil for the state, many of which, however, have been recorded in previous publications. Thus, excluding these, six species are cited here for the first time to Maranhão, all of which are also new records for the Brazilian Northeast region. Comparing such data with previous lists, with 103 and 105 species, we detected a strong incongruity among the data. Of the former list, 25 species lack vouchers from the state and were not collected in our expeditions, thus these taxa are not confirmed, while of the latter we found 20 species that are also not confirmed for the same reasons. A list with the 34 excluded taxa is provided. Most of the collection effort in the state coincides with university campuses, and the northwestern region is the most species rich, but unfortunately it is also the most threatened area.

Keywords: Amazon, Cerrado, Maranhão, Orchidaceae, transition zone

Introduction

Updated species lists are important tools for taxonomy, and they are also fundamental for biogeographical analysis and conservation planning (Clark *et al.* 2011; Söderström *et al.* 2007; Konrat *et al.* 2010). Detailed checklists also have application in areas such as in vitro propagation, since they ensure solid botanical information to develop structured

conservation programs of endangered species (Silva & Acharya 2014).

Nevertheless, many biologically important regions lack updated species lists. As an example, the knowledge on species composition, richness, and endemism in Brazil is strongly biased especially in favor of the spatial distribution of the most important universities and research centers in the country (Oliveira *et al.* 2016). The Neotropics alone harbors about 37 % of the world's seed plant species (Antonelli & Sanmartín 2011), and specifically among the

¹ Laboratório de Estudos Integrados de Plantas, Departamento de Botânica e Ecologia, Universidade Federal de Mato Grosso, 78060-900, Cuiabá, MT, Brazil

² Programa de Pós-Graduação em Biodiversidade, Ambiente e Saúde, Departamento de Química e Biologia, Universidade Estadual do Maranhão, 65604-090, Caxias, MA, Brazil

³ Departamento de Biologia, Universidade Federal do Maranhão, 65080-805, São Luís, MA, Brazil

* Corresponding author: edlley_max@hotmail.com



Angiosperms, the monocot family Orchidaceae (APG IV 2016) is one of the most diverse in the region (Chase *et al.* 2015; Dressler 2005) as well as in Brazil (BFG 2015; 2018). In this country Orchidaceae are especially rich in the Amazon basin and Atlantic Forest (BFG 2015; 2018), which were pointed out by Oliveira *et al.* (2016) as the Brazilian ecosystems with the lowest and highest collection densities, respectively.

Although among the poorest studied areas of Brazil botanically speaking (BFG 2015; 2018), the northeastern state of Maranhão has great potential to have high levels of biodiversity due to its geographic position between the Amazon (30%) and Cerrado (69%) domains, and its variety of ecosystems and habitats (Abreu 1949; Froés 1953; Ribeiro 1971). However, before this study only about 200 records of Orchidaceae from Maranhão (excluding duplicates) were available in Brazilian herbaria, whereas smaller states (in territory) of northern and northeastern Brazil have many more orchid records (Amapá: ca. 500, Roraima: ca. 1000, Rondônia: ca. 700, Ceará: ca. 800, Paraíba: ca. 700, Pernambuco: ca. 2,000, Alagoas: ca. 1,200, Sergipe: ca. 700, based on Specieslink and Re flora, available at slink.org.br and re flora.jbrj.gov.br, respectively), indicating a strong Wallacean shortfall. It is also important to highlight that the majority of the orchid records from the state (ca. 55%) are deposited in the herbaria of other states (mainly CEN and MG, acronyms according to Thiers 2021).

The first known records of Orchidaceae from the state of Maranhão are presented by Cogniaux (1893–1896, 1898–1902, 1904–1906), who listed five species, later by Pabst & Dungs (1975; 1977), who cited ten species, which demonstrate the lack of collection efforts in the area for almost a century. The first more comprehensive list of species was provided by Silva *et al.* (1999), who included 103 orchid species in their checklist. However, for several taxa no voucher was cited, and some of the cited vouchers correspond to specimens collected in the neighboring state of Pará (available at MG); thus, the data are not accurate.

Currently, according to the Flora do Brasil 2020 (2020), 105 species and 41 genera are recorded in Maranhão. These data are mainly based on the list by Silva *et al.* (1999) and information from some recently published studies (Ferreira *et al.* 2017). This number of species is fairly low if compared to smaller but better studied states of northeastern Brazil such as Pernambuco (ca. 190 species, BFG 2015, 2018), whose territory corresponds to a third of that of Maranhão, but which has been studied in recent years (Pessoa & Alves 2012; 2014; 2015).

Thus, the aim of this study is to provide an updated checklist of the orchid species from the botanically poorly studied state of Maranhão, based on a review of herbaria and new field expeditions. A revised list will be important not only for taxonomic but also for conservation purposes, since Orchidaceae can be used as a model group for optimization of the conservation of plants in general (Swartz & Dixon

2009). Furthermore, it will clarify our knowledge on the composition of the orchid community in this Amazon border region that may have served as a corridor for species exchange with Atlantic Forest during the Pleistocene (Maciel *et al.* 2017; Pessoa *et al.* 2018; 2021). In addition to the list of species, this study presents maps of spatial distribution of collection records and species richness in the state, and for each species information is provided on life form and ecological domain of occurrence.

Materials and methods

Study area

The state of Maranhão is located in the Northeast region of Brazil, has a total area of 333,365.6 km², and is delimited to the west by the North region of Brazil (IMESC 2008; IBGE 2014). Its territory includes parts of the Amazon (30%), Cerrado (69%) and Caatinga (1%) (Fig. 1A) domains, therefore having markedly transitional vegetation (Abreu 1949; Froés 1953; Ribeiro 1971; Muniz 2004; Almeida & Vieira 2010; Celentano *et al.* 2017; Silva *et al.* 2017; Silva-Moraes *et al.* 2019). Its coastal northern portion has low altitudes that do not exceed 60 m elev., the western Amazonian portion can reach 300 m elev., while the highest points of the state are concentrated in its Center-South portion with altitudes up to 600 m in areas of Cerrado (Silva-Moraes *et al.* 2019). The climate is Tropical Savanna, dry in the summer along the coast (As sensu Köppen 1948), while dry in the winter toward the interior of the state (Aw sensu Köppen 1948), the annual mean temperature is 26–27 °C, and precipitation varies from 700–1700 mm in the southern half of the state to 1700–2900 mm in the northern half (Montes *et al.* 1997; Maranhão 2011).

Data collection

Our initial database was constructed based on the lists provided by Silva *et al.* (1999) and BFG (2015; 2018) and new records published more recently (Ferreira *et al.* 2017; 2019; Rodrigues *et al.* 2019; Saraiva *et al.* 2020; Oliveira *et al.* 2021; Gomes *et al.* 2021; Silva *et al.* in press). Subsequently, the main Brazilian herbaria and local herbaria were visited (CEN, HABIT, HB, HUEFS, INPA, IAN, MAR, MG, RB, SLUI, SP, SPF, UB, acronyms according to Thiers 2021, continuous adapted) in order to find specimens collected in the state to serve as vouchers of the taxa reported in the literature. Information available on the on-line platforms SpeciesLink and Re flora was also used for herbaria not visited (only if images were available). The occurrence in ecological domains and the geographic distribution in Brazil of each species were consulted in the Flora do Brasil 2020 (2020).

Fieldwork was carried out from July 2012 to February 2020, covering areas not yet collected in the state. The samples were submitted to the usual taxonomic procedures (Mori *et al.* 1989)



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and then deposited at HABIT, MAR, or SLUI, with duplicates sent to RB. The identification of the material collected and the re-identification of previously collected specimens in the herbaria analyzed were based upon the most important references on Orchidaceae taxonomy for species in northern and northeastern Brazil (Dunsterville & Garay 1959; 1961; 1965; 1966; 1972; 1976; Pabst & Dungs 1975; 1977; Carnevali *et al.* 2003; Toscano-de-Brito & Crib 2005) and analysis of type specimens when available on-line or in the herbaria visited.

A database of geographical coordinates from field collections and herbarium specimens was prepared to analyze the spatial distribution of collection records and species richness in the state. Specimens with no georeferenced data had their localities determined using online gazetteers (Google Earth). Kernel density maps (heat maps) were produced with the software QGIS v. 2.18.12 (QGIS Development Team 2020), using a radius of 30,000 m and the WGS84 datum.

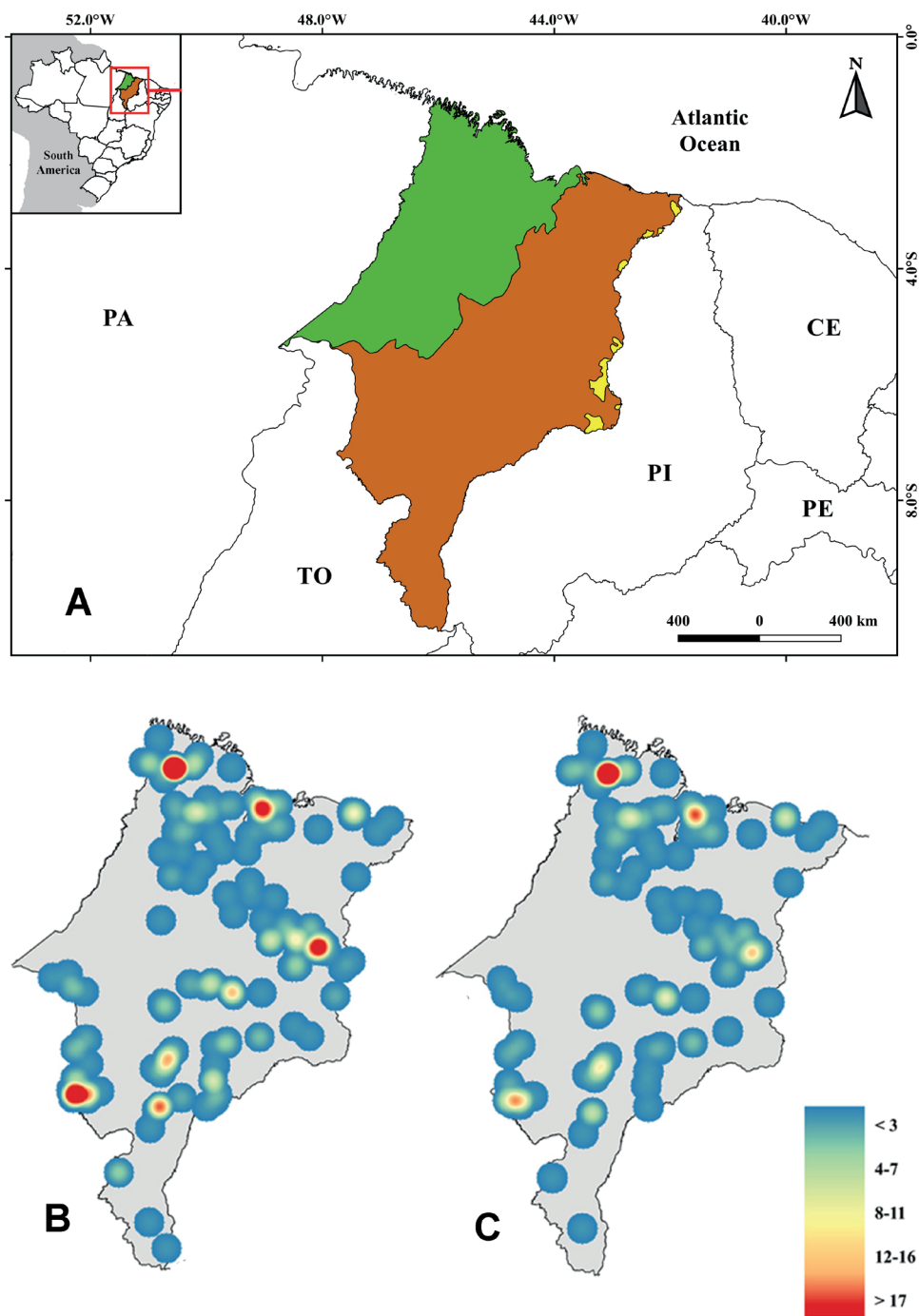


Figure 1. A. State of Maranhão and its three phytogeographic domains. Green = Amazon, Orange = Cerrado, Yellow = Caatinga. B. Distribution of the records of Orchidaceae. C. Species richness of Orchidaceae.

Results and discussion

The herbaria review and field expeditions recovered a total of 51 genera and 119 species of Orchidaceae with occurrences confirmed to Maranhão (Figs. 2-5), of which 77 species (64.7 %) are epiphytic, 38 species (31.9 %) are terrestrial, three species (2.5 %) are hemi-epiphytic, and one species (0.8 %) is myco-heterotrophic (Tab. 1). Epiphytic species occurred mainly (about 75 %) in environments in western Maranhão in the Amazon Forest, whereas the terrestrial species more often grow (about 84 %) in areas of Cerrado. Our results corroborate those described by Dressler (1993), who reported that in wet tropical forest at least 2/3 of the orchid species are expected to be epiphytic and also Dressler (1993), Batista & Bianchetti (2003) and Ferreira *et al.* (2010), who highlight the higher percentage of terrestrial species in open environments such as the Cerrado.

The most representative genera in Maranhão are *Habenaria* (17 spp.), *Catasetum* (14 spp.) and *Epidendrum* (10 spp.), while 35 other genera are represented by a single species in the state. Representatives of the subtribes Laeliinae (21 spp.), Oncidiinae (17 spp.), and Habenariinae (17 spp.) correspond to about 46 % of the species. Representatives of Laeliinae make up a large part of the orchid flora in the Neotropics (Van den Berg 2000) and have been pointed out as the most representative orchid subtribe in other studies in northeastern Brazil (Pessoa & Alves 2015; Monteiro *et al.* 2012). *Habenaria* has been found to be the most species-rich in areas of Cerrado, such as in the Federal District (Batista & Bianchetti 2003), and *Catasetum* is especially diverse in the transition zone between Amazon and Cerrado, as pointed out by Petini-Benelli (2012) for the Brazilian state of Mato Grosso.

Among the species, six (5 %) are endemic to Maranhão, all representatives of the genus *Catasetum*, and 27 (22.7 %) are endemic to Brazil. Although connections between the Amazon and Atlantic Forest along the coast have been hypothesized to have happened during the Pleistocene (Maciel *et al.* 2017), among the orchids of Maranhão, only nine species (7.6 %) have disjunct distributions between the Amazon domain and the Atlantic Forest of northeastern Brazil. The results show that most of the orchid species that grow in the state are widespread in South America (Govaerts *et al.* 2020). Most of the species (87, 73.7 %) grow in two or more Brazilian domains, pointing out the transitional characteristics of Maranhão, 27 species (22.9 %) are known only to the Amazon domain, while only six species (5 %) are exclusive to the Cerrado (Tab. 1).

Considering the Northeast region of Brazil, 27 species listed here are found only in Maranhão (BFG 2015; 2018), including its six endemic species and others restricted to the Amazon domain, which in the Northeast region is limited to Maranhão. However, this area, a part of the Belém Endemism Center (Almeida & Vieira 2010), is constantly being degraded by human activities and social

conflicts, a situation that puts the orchid flora increasingly at risk (Almeida & Vieira 2010; Silva-Moraes *et al.* 2019; Silva-Junior *et al.* 2020). According to the National Flora Conservation Center (CNCFlora 2020), four species are under some degree of threat: *Cynoches pentadactylon*, *Cyrtopodium poecilum* and *Notylia microchila* are endangered (EN), while *Cattleya nobilior* is near threatened (NT).

Our checklist includes 30 species that are not listed in Flora do Brasil 2020 (2020) to the state, however many of them have been recorded in previous publications (Silva *et al.* 1999; Ferreira *et al.* 2017; 2019; Rodrigues *et al.* 2019; Saraiva *et al.* 2020; Oliveira *et al.* 2021; Gomes *et al.* 2021; Silva *et al.* in press). Thus, excluding these, a total of six species are cited here for the first time to Maranhão, all also being new records for northeastern Brazil (Tab. 1). All specimens of these six species were found as unidentified or misidentified in the herbaria visited. We also provide the first record of *Cynoches* and *Paphinia* to northeastern Brazil.

Although representing only a small fraction of change in terms of the number of species when comparing the lists provided by Silva *et al.* (1999) and Flora do Brasil 2020 (2020), 103 and 105, respectively, vs. 119 in this study, we detected strong incongruity among the data. After an update of the names listed by Silva *et al.* (1999) following the current widely accepted systematics of the family, we found that of the 103 taxa, 25 species lack vouchers from the state and were not collected in our expeditions; thus, these taxa were not confirmed to Maranhão. For the Flora do Brasil 2020 (2020) list we found 20 species that were also not confirmed for the same reasons. The excluded species from Silva *et al.* (1999) and Flora do Brasil 2020 (2020) are not entirely the same, while 10 species excluded here are common to both lists, 14 are only in the former list and 10 are only in the latter. A list with the 34 excluded taxa is provided in Tab. 2; most of these species do occur in the neighboring state of Pará.

The new number of confirmed orchid species in Maranhão is still low, however according to Flora do Brasil 2020 (2020) it is higher than the majority of states in northeastern Brazil, except for Pernambuco (188 spp.) and Bahia (526 spp.), while it is equivalent of the species richness recorded for Acre (114 spp.) and Amapá (130 spp.) in the North region. The geographical position of the state in a transition zone, from a drier area along the border with the state of Piauí to a moister area along the border with Pará (Fig. 1A), can explain the wide distribution of the species, and low number of endemic species, since ecotones are characterized by the “edge-effect” (Dawson 2001). The central and southern portions of the state are still poorly collected (Fig. 1B), and a better collection effort in these regions may result in the discovery of more species from the Cerrado not listed here. It is also a reflection of the strongly biased botanical gathering in Brazil, especially due to the difficulties of access and infrastructure for researchers in some areas (Oliveira *et al.* 2016), as also reported by Siqueira *et al.* (2014).



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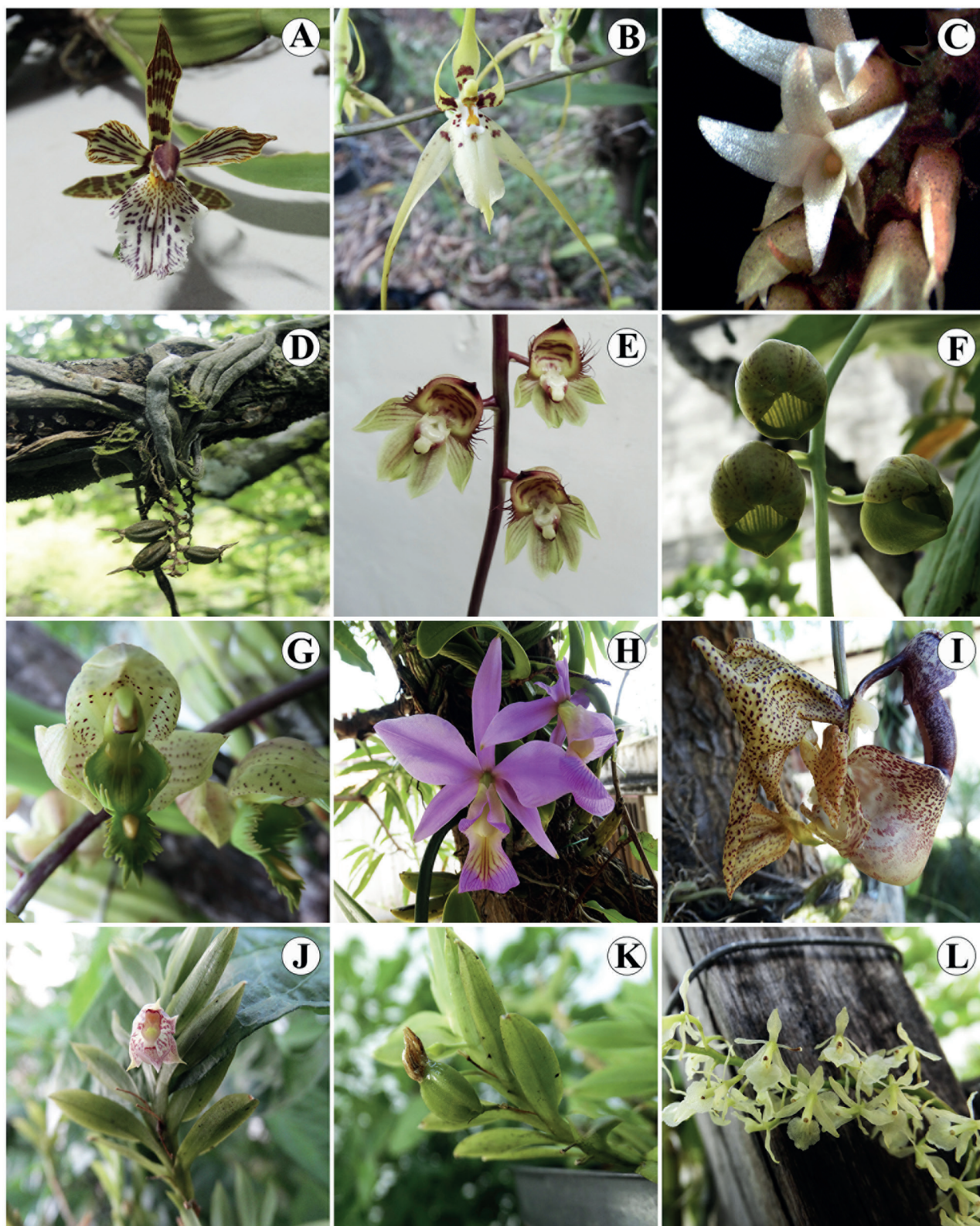


Figure 2. Orchidaceae from Maranhão. **A.** *Aspasia variegata*. **B.** *Brassia caudata*. **C-D.** *Campylocentrum pachyrrhizum* - **C.** flower; **D.** fruit. **E.** *Catasetum ciliatum*. **F.** *Catasetum maranhense*. **G.** *Catasetum seccoii*. **H.** *Cattleya nobilior*. **I.** *Coryanthes speciosa*. **J-K.** *Dichaea picta* - **J.** flower; **K.** fruit. **L.** *Epidendrum amblostomoides*. (A. M.J.C. Silva & A.W.C. Ferreira 01 (SLUI 5724); B. M.J.C. Silva & A.W.C. Ferreira 05 (SLUI 5726); C-D. M.J.C. Silva & A.W.C. Ferreira 07 (SLUI 5728); E. M.S. Oliveira & A.W.C. Ferreira 130 (MAR 11513); F. M.S. Oliveira 166 (HABIT 3423); G. M.S. Oliveira 50 (MAR 11518); H. M.J.C. Silva et al. 10 (SLUI 5789); I. M.J.C. Silva et al. 12 (SLUI 5731); J-K. W.R. Silva-Junior et al. s.n. (SLUI 5733); L. M.J.C. Silva et al. 16 (SLUI 5700)).

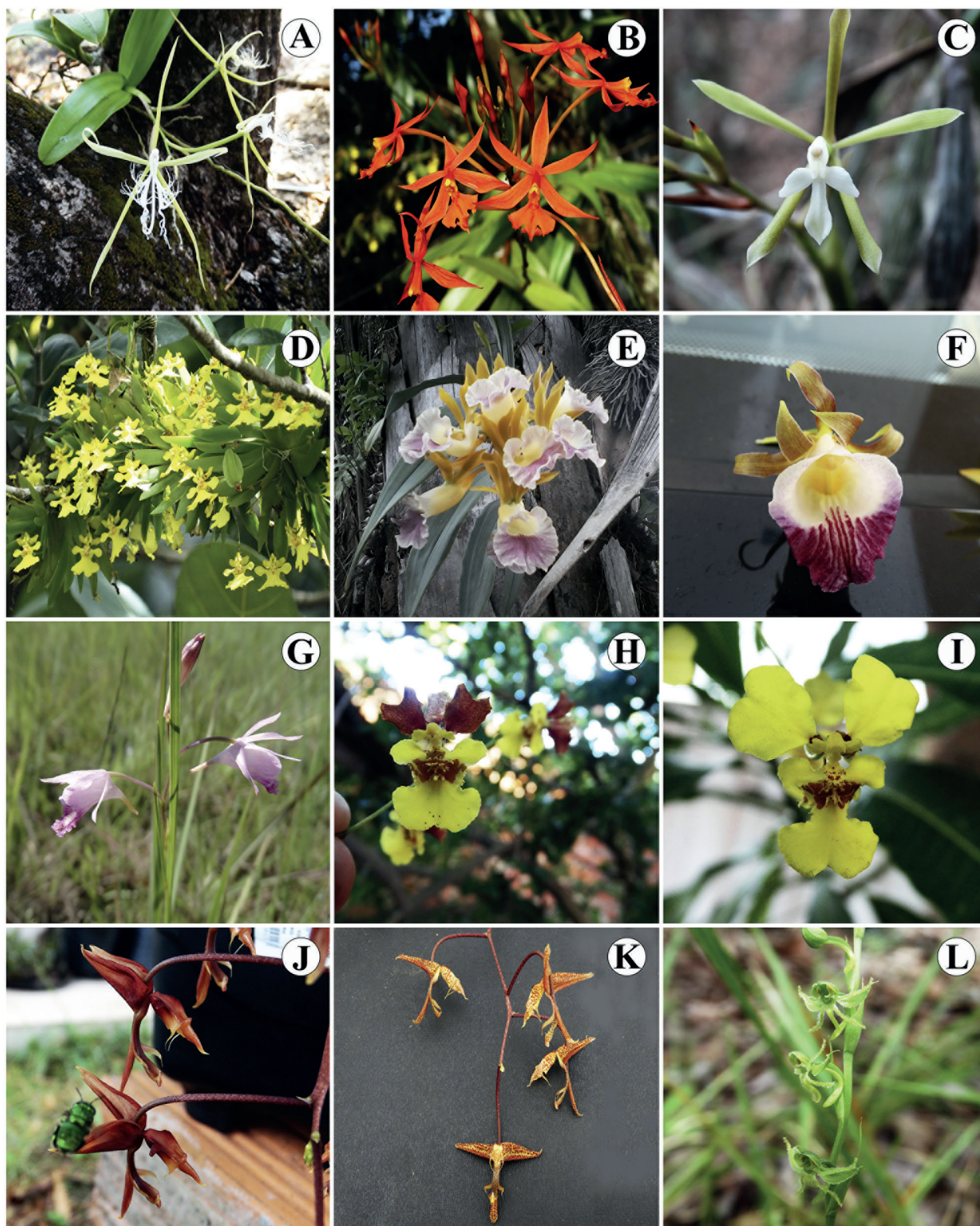


Figure 3. Orchidaceae from Maranhão. **A.** *Epidendrum ciliare*. **B.** *Epidendrum macrocarpum*. **C.** *Epidendrum purpurascens*. **D.** *Erycina pusilla*. **E.** *Galeandra blanchetii*. **F.** *Galeandra montana*. **G.** *Galeandra styllomissantha*. **H.** *Gomesa fuscopetala*. **I.** *Gomesa macropetala*. **J.** *Gongora nigrita*. **K.** *Gongora quinquenervis*. **L.** *Habenaria ludibundiciliata*. (A. A.W.C. Ferreira 29 (SLUI 5711); B. A.W.C. Ferreira s.n. (SLUI 5713); C. A.W.C. Ferreira s.n. (SLUI 5716); D. A.W.C. Ferreira 42 (SLUI 5735); E. M.S. Oliveira 95 (MAR 11519); F. M.S. Oliveira 157 (HABIT 3434); G. A.W.C. Ferreira s.n. (SLUI 5792); H. M.J.C. Silva et al. 46 (SLUI 5793); I. M.J.C. Silva et al. 47 (SLUI 5794); J. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5736); K. M.J.C. Silva & A.W.C. Ferreira 50 (SLUI 5738); L. A.W.C. Ferreira s.n. (SLUI 5795)).

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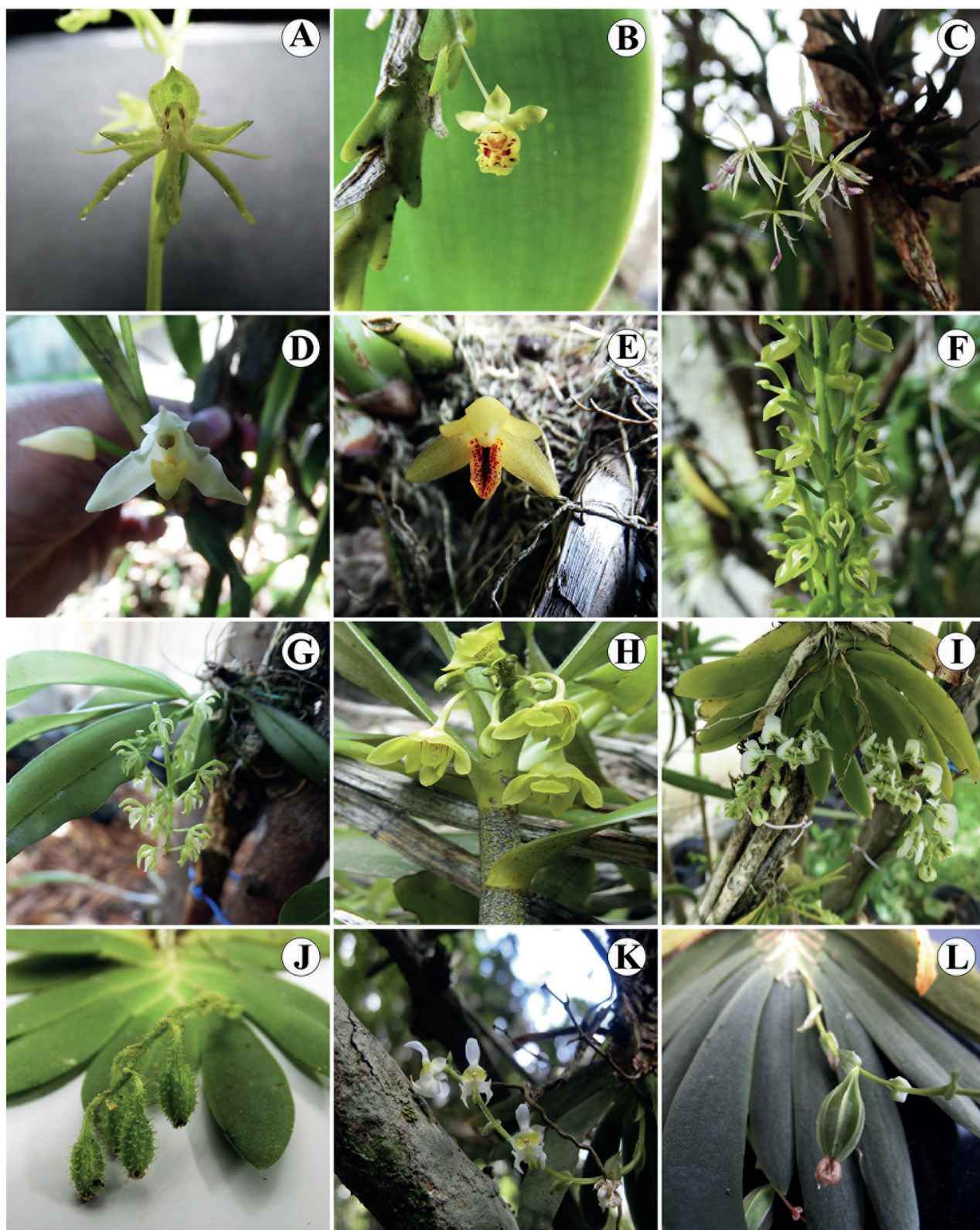


Figure 4. Orchidaceae from Maranhão. **A.** *Habenaria schenckii*. **B.** *Lockhartia imbricata*. **C.** *Macroclinium wuellschlaegelianum*. **D.** *Maxillaria alba*. **E.** *Maxillaria aureoglobula*. **F.** *Notylia microchila*. **G.** *Notylia yauaperiensis*. **H.** *Orleanesia amazonica*. **I–J.** *Ornithocephalus cujeticola* - **I.** flower; **J.** fruit. **K–L.** *Ornithocephalus gladius* - **K.** flower; **L.** fruit. (A. M.S. Oliveira & A.W.C. Ferreira 154 (MAR 11522); B. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5742); C. M.J.C. Silva & A.W.C. Ferreira 58 (SLUI 5743); D. W.R. Silva-Junior & A.W.C. Ferreira 105 (SLUI 5744); E. A.W.C. Ferreira 100 (MAR 11538); F. M.J.C. Silva & A.W.C. Ferreira 69 (SLUI 5753); G. W.R. Silva-Junior & A.W.C. Ferreira s.n. (SLUI 5755); H. A.W.C. Ferreira s.n. (SLUI 5759); I–J. A.W.C. Ferreira s.n. (SLUI 5761); K–L. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5762)).

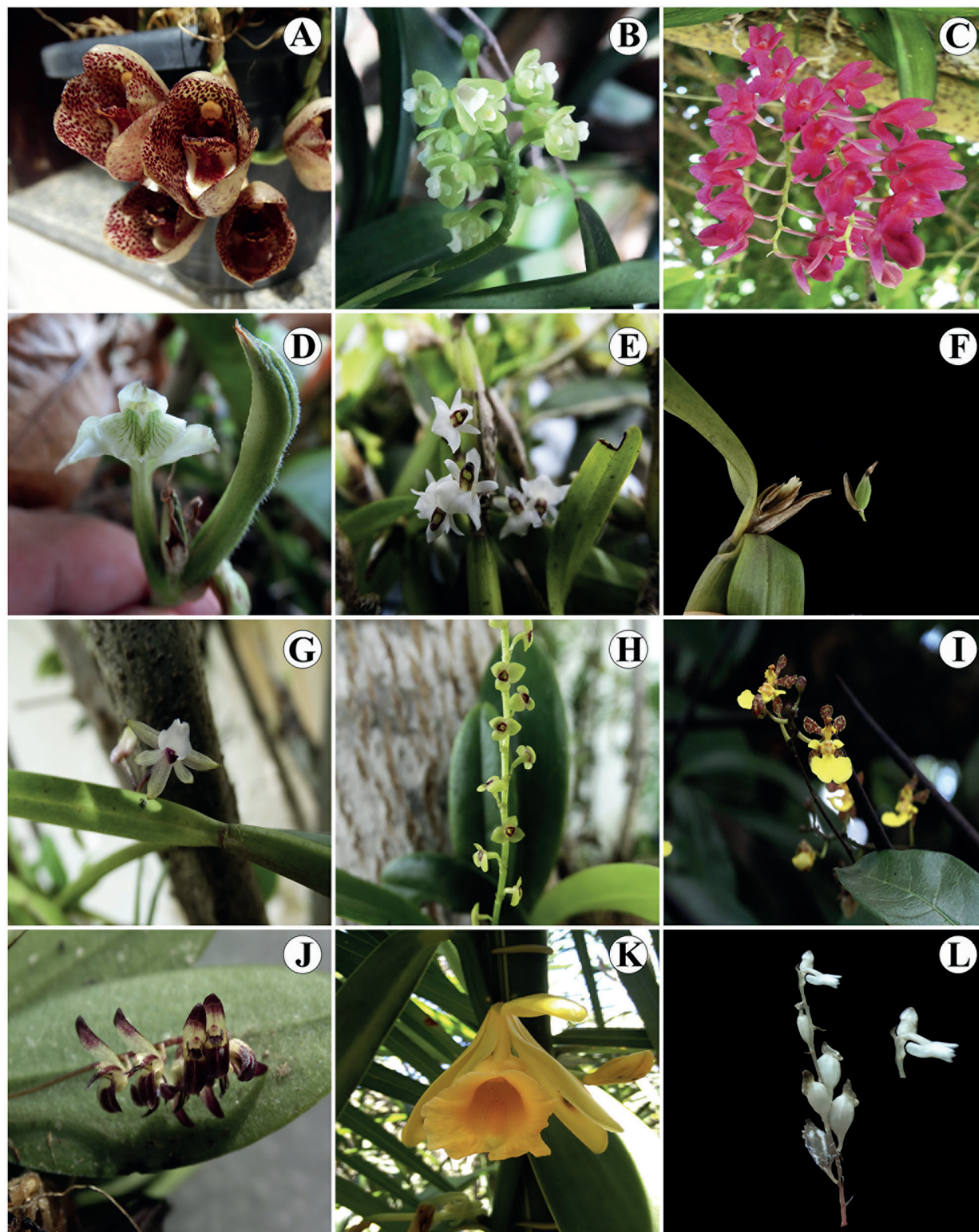


Figure 5. Orchidaceae from Maranhão. **A.** *Peristeria serroniana*. **B.** *Polystachya concreta*. **C.** *Rodriguezia lanceolata*. **D.** *Sarcoglottis acaulis*. **E.** *Scaphyglottis prolifera*. **F.** *Scaphyglottis sickii*. **G.** *Scaphyglottis stellata*. **H.** *Stelis papaquerensis*. **I.** *Trichocentrum cepula*. **J.** *Trichosalpinx egleri*. **K.** *Vanilla pompona*. **L.** *Wulfschlaegelia calcarata*. (A. M.J.C. Silva & A.W.C. Ferreira 81 (SLUI 5764); B. M.J.C. Silva & A.W.C. Ferreira 82 (SLUI 5765); C. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5768); D. A.W.C. Ferreira s.n. (SLUI 5771); E. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5772); F. M.J.C. Silva & A.W.C. Ferreira 91 (SLUI 5774); G. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5776); H. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5778); I. M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5780); J. M.J.C. Silva & A.W.C. Ferreira 98 (SLUI 5781); K. A.W.C. Ferreira 102 (SLUI 5784); L. W.R. Silva-Junior & A.W.C. Ferreira s.n. (SLUI 5785)).



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Table 1. List of species of Orchidaceae from Maranhão. **Habit:** E = epiphytic; T = terricolous; He = hemiepiphytic; My = mycoheterotrophic. **Occurrence:** Amaz. = Amazon; At. Fl. = Atlantic Forest; Ca. = Caatinga; Cerr. = Cerrado; Pam = Pampa; Pan = Pantanal. * = New record for Maranhão; ## = New record for northeastern Brazil. Species endemic to Maranhão in bold.

| Species | Vouchers | Habit | Ecosystem |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-------|-------------|
| <i>Aganisia pulchella</i> Lindl. | J.B.F. Silva 224 (MG 145508) | E | Amaz. |
| <i>Aspasia variegata</i> Lindl. | M.J.C. Silva & A.W.C. Ferreira 01 (SLUI 5724); M.J.C. Silva & A.W.C. Ferreira 02 (SLUI 5725) | E | Amaz. |
| <i>Bletia catenulata</i> Ruiz & Pav. | J.B.F. Silva et al. 475 (MG 148492); T.M. Sanaïotti 159 (MG146955) | T | Cerr. |
| <i>Brassavola gardneri</i> Cogn. | A.C. Sevilha 5411 (CEN 97578); W.R. Silva-Júnior et al. s.n. (SLUI 5787); W.R. Silva-Júnior et al. s.n. (SLUI 5788) | E | Cerr. |
| <i>Brassia caudata</i> (L.) Lindl. | M.J.C. Silva & A.W.C. Ferreira 05 (SLUI 5726); R.L. Fróes 34481 (IAN 103300) | E | Amaz. |
| <i>Bulbophyllum setigerum</i> Lindl. | J.B.F. Silva & A. Oliveira 475 (MG 150590) | E | Amaz. |
| <i>Campylocentrum matogrossense</i> Hoehne | R.L. Fróes 34394 (IAN 103733) | E | Amaz. |
| <i>C. micranthum</i> (Lindl.) Maury | J. Jangoux & R.P. Bahia 684 (MG 71207); M.J.C. Silva & A.W.C. Ferreira 06 (SLUI 5727). | E | Amaz. |
| <i>C. pachyrrhizum</i> (Rchb. f.) Rolfe | M.J.C. Silva & A.W.C. Ferreira 07 (SLUI 5728) | E | Amaz. |
| <i>Catasetum albuquerquei</i> Oliveira & J.B.F. da Silva | J.B.F. Silva, & R. Carrenho 518 (MG 150573) | E | Amaz. |
| <i>C. barbatum</i> (Lindl.) Lindl. | J.B.F. Silva 796 (MG 156472); J.B.F. Silva 209 (MG 145493); M.S. Oliveira 03 (MAR 11510) | E | Cerr. |
| <i>C. bifidum</i> Oliveira & J.B.F. da Silva | J.B.F. Silva 523 (MG 156672) | E | Cerr. |
| <i>C. carolinianum</i> Miranda & K.G. Lacerda | J.B.F. Silva s.n. (MG 140889) | E | Cerr. |
| <i>C. carrenhianum</i> Oliveira & J.B.F. da Silva | J.B.F. Silva & R. Carrenho 520 (MG 150572) | E | Amaz. |
| <i>C. ciliatum</i> Barb.Rodr. | M.S. Oliveira & A.W.C. Ferreira 130 (MAR 11513) | E | Cerr. |
| <i>C. discolor</i> Linden & Rchb.f. | R.L. Fróes 34566 (IAN 103385); O. Silva 72 (IAN 181086) | T | Amaz. |
| <i>C. galeritum</i> Rchb.f. | J.B.F. Silva 74 (MG 138849) | E | Amaz. |
| <i>C. lanciferum</i> Lindl.* ## | J.B.F. Silva 128 (MG 138897) | E | Amaz. |
| <i>C. macrocarpum</i> Rich. ex Kunth | M.S. Oliveira 07 (HABIT 3432); M.J.C. Silva & A.W.C. Ferreira 09 (SLUI 5730) | E | Amaz./Cerr. |
| <i>C. maranhense</i> K.G. Lacerda & J.B.F. da Silva | M.S. Oliveira 166 (HABIT 3423); J.B.F. Silva 90 (MG 138861); M.S. Oliveira 159 (MAR 11516) | E | Cerr. |
| <i>C. palmeirinhense</i> Oliveira & J.B.F. da Silva | J.B.F. Silva 510 (MG 156673) | E | Cerr. |
| <i>C. rigidum</i> Oliveira & J.B.F. da Silva | J.B.F. Silva 825 (MG 156674) | E | Cerr. |
| <i>C. seccoii</i> Oliveira & J.B.F. da Silva | J.B.F. Silva & R. Carrenho 528 (MG 150574); M.S. Oliveira 50 (MAR 11518); | E | Cerr. |
| <i>Cattleya nobilior</i> Rchb.f. | M.J.C. Silva et al.10 (SLUI 5789); | E | Cerr. |
| <i>Cleistes rosea</i> Lindl. | A.C.A.M. Araújo s.n. (IAN 189475); A.W.C. Ferreira s.n. (SLUI 5790) | T | Amaz./Cerr. |
| <i>Coryanthes speciosa</i> Hook. | M.J.C. Silva et al. 12 (SLUI 5731); M.J.C. Silva et al. s.n. (SLUI 5732) | E | Amaz. |
| <i>Cynoches pentadactylon</i> Lindl.* ## | A.C. Sevilha 5783 (CEN 97945) | E | Cerr. |
| <i>Cyrtopodium blanchetii</i> Rchb.f. | R.C. Oliveira 426 (HEPH) | T | Cerr. |
| <i>C. cristatum</i> Lindl. | A.C. Sevilha 5606 (CEN 97773) | T | Cerr. |
| <i>C. holstii</i> L.C. Menezes | J.B.F. Silva 907 (MG 150581) | T | Amaz. |
| <i>C. poecilum</i> Rchb.f. & Warm. | J.A.N. Batista 1374 (CEN 46066) | T | Cerr. |
| <i>C. virescens</i> Rchb.f. & Warm. | G. Pereira-Silva 14669 (CEN 83971) | T | Cerr. |
| <i>Dichaea picta</i> Rchb.f. | R.L. Fróes 34403 (IAN 103733) W.R. Silva-Junior et al. s.n. (SLUI 5733) | E | Amaz. |
| <i>Dimerandra emarginata</i> G. Mey | M.F. Pires & L.P. Felix 157 (EAN 10461); W.R. Silva-Junior et al. s.n. (SLUI 5734) | E | Amaz. |
| <i>Encyclia granitica</i> (Lindl.) Schltr. | R.L. Fróes 1998 (NY 1031698) | E | Amaz. |
| <i>E. linearifolioides</i> (Kraenzl.) Hoehne | G. Pereira-Silva 13402 (CEN 91568) | E | Cerr. |
| <i>Epidendrum amapense</i> Hágsater & L. Sanchez | R.L. Fróes 34390 (IAN 103731) | E | Amaz. |



Table 1. Cont.

| Species | Vouchers | Habit | Ecosystem |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------|
| <i>E. amblostomoides</i> Hoehne | M.J.C. Silva et al. 16 (SLUI 5700); M.J.C. Silva et al. 17 (SLUI 5701) | E | Cerr. |
| <i>E. anceps</i> Jacq. | A.W.C. Ferreira s.n. (SLUI 5699) | E | Amaz. |
| <i>E. carpophorum</i> Barb. Rodr. | A.B. Almeida 1235282 (UB); M.J.C. Silva et al. s.n. (SLUI 5698); M.J.C. Silva et al. 21 (SLUI 5700) | E | Amaz./Cerr. |
| <i>E. ciliare</i> L. | A.W.C. Ferreira 29 (SLUI 5711); K.N. Santos & A.W.C. Ferreira s.n. (SLUI 5712) | E | Amaz. |
| <i>E. flexuosum</i> G. Mey | J.M. Pires & G.A. Black 1753a (IAN 50332) | E | Cerr. |
| <i>E. macrocarpum</i> Rich. | A.W.C. Ferreira s.n. (SLUI 5713); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5714); A.W.C. Ferreira s.n. (SLUI 5715) | E | Amaz./Cerr. |
| <i>E. purpurascens</i> Focke. | E.R. Pansarin s.n. (LBMBP 660); A.W.C. Ferreira s.n. (SLUI 5716); A.W.C. Ferreira s.n. (SLUI 5717); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5718) | E | Amaz. |
| <i>E. rigidum</i> Jacq. | G.T. Prance 1980 (NY418392); W.R. Silva-Junior et al. s.n. (SLUI 5719); M.J.C. Silva & A.W.C. Ferreira 38 (SLUI 5720) | E | Amaz. |
| <i>E. strobiliferum</i> Rchb.f. | L.R. Marinho & G. Pinheiro 620 (IAN 154392); A.W.C. Ferreira s.n. (SLUI 5721); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5722); K.N. Santos & A.W.C. Ferreira s.n. (SLUI 5723) | E | Amaz. |
| <i>Epistephium ellipticum</i> R.O. Williams & Summerh. | J.B.F. Silva et al. 873 (MG 157193) | T | Amaz. |
| <i>E. parviflorum</i> Lindl.* ## | P. Lisboa s.n. (MG2528) | T | Cerr. |
| <i>E. sclerophyllum</i> Lindl. | G. Marinho s.n. (IAN 187860) | T | Cerr. |
| <i>Erycina pusilla</i> (L.) N.H. Williams & M.W.Chase | G.A. Black et al. 54-16504 (IAN 83902); A.W.C. Ferreira 42 (SLUI 5735); M.G. Silva 5552 (MG 84382) | E | Amaz. |
| <i>Eulophia alta</i> (L.) Fawc. & Rendle | M.F. Simon 2724 (CEN 95330) | T | Cerr. |
| <i>Galeandra blanchetii</i> E.S. Rand | M.S. Oliveira 95 (MAR 11519); K.N. Santos & A.W.C. Ferreira s.n. (SLUI 5806) | E | Amaz./Cerr. |
| <i>G. montana</i> Barb Rodr. | M.S. Oliveira 157 (HABIT 3434); M.S. Oliveira & A.W.C. Ferreira s.n. (SLUI 5791) | T | Cerr. |
| <i>G. stylloisantha</i> (Vell.) Hoehne | J.B.F. Silva 542 (MG 149896); A.W.C. Ferreira s.n. (SLUI 5792) | T | Cerr. |
| <i>Gomesa fuscopetala</i> (Hoehne) M.W. Chase & N.H. Williams | M.J.C. Silva et al. 46 (SLUI 5793); | E | Cerr. |
| <i>G. macropetala</i> (Lindl.) M.W. Chase & N.H. Williams | M.J.C. Silva et al. 47 (SLUI 5794); | E | Cerr. |
| <i>Gongora nigrita</i> Lindl. | B.G.S. Ribeiro & G.S. Pinheiro 1284 (IAN 151943); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5736); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5737) | E | Amaz. |
| <i>G. quinquenervis</i> Ruiz & Pavon. | M.J.C. Silva & A.W.C. Ferreira 50 (SLUI 5738); M.J.C. Silva & A.W.C. Ferreira 51 (SLUI 5739) | E | Amaz. |
| <i>Habenaria crucifera</i> Rchb.f. & Warm. | J.A.N. Batista 1369 (CEN 46062) | T | Cerr. |
| <i>H. cruegeri</i> Cogn.* ## | M.F. Simon 2845 (CEN 95449); M.F. Simon 2726 (CEN 95332) | T | Cerr. |
| <i>H. culicina</i> Rchb.f. & Warm.* ## | J. D.C. Aruok-Ferreira s.n. (MG 147797) | T | Cerr. |
| <i>H. depressifolia</i> Hoehne | N.F.O. Mota et al. 3201 (MG 214830) | T | Cerr. |
| <i>H. heringeri</i> Pabst | G. Pereira-Silva 14967 (CEN 100032) | T | Cerr. |
| <i>H. leuprieri</i> Rchb.f. | N.F.O. Mota et al. 3175 (MG 214804) | T | Cerr. |
| <i>H. longicauda</i> Hook. | Oliveira, R.S. 282 (CEN 30556) | T | Cerr. |
| <i>H. ludibundiciata</i> J.A.N. Batista & Bianch. | N.F.O. Mota et al. 3198 (MG 214827); A.W.C. Ferreira s.n. (SLUI 5795) | T | Cerr. |
| <i>H. nuda</i> Lindl. | J.A.N. Batista 1368 (CEN 46061) | T | Cerr. |
| <i>H. obtusa</i> Lindl. | Brito & Mendonça 65 (MG 154875); A.W.C. Ferreira s.n. (SLUI 5796) | T | Cerr. |



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Table 1. Cont.

| Species | Vouchers | Habit | Ecosystem |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------|-------------|
| <i>H. orchioalcar</i> Hoehne | N.F.O. Mota et al. 3173 (MG-214802) | T | Amaz./Cerr. |
| <i>H. petalodes</i> Lindl. | L.P. Felix et al. 8081 (HST 8718); L.P. Felix et al. 8023 (HST 8719); O. Carvalho 82 (SP 8109) | T | Cerr. |
| <i>H. pratensis</i> (Salz. Ex Lindl.) | G.A. Black et al. 54-16540 (IAN 83938); R.S. Oliveira et al. 281 (UB 107626) | T | Cerr. |
| <i>H. schenckii</i> Cogn. | M.S. Oliveira & A.W.C. Ferreira 154 (MAR 11522) | T | Cerr. |
| <i>H. schwackei</i> Barb.Rodr. | R.S. Oliveira 269 (CEN 30561) | T | Cerr. |
| <i>H. sprucei</i> Cogn. | N.F.O. Mota et al. 3165 (MG-214794) | T | Cerr. |
| <i>H. trifida</i> Kunth | J.A.N. Batista 1373 (CEN 46065); A.W.C. Ferreira s.n. (SLUI 5797) | T | Cerr. |
| <i>Ionopsis utricularioides</i> (Sw.) Lindl. | Jarbas s.n. (EAC 21838) | E | Cerr. |
| <i>Laelia gloriosa</i> (Rchb.f.) L.O. William | M.J.C. Silva & A.W.C. Ferreira 55 (SLUI 5740); A.W.C. Ferreira s.n. (SLUI 5741) | E | Amaz. |
| <i>Lockhartia imbricata</i> (Lam.) Hoehne | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5742) | E | Amaz. |
| <i>Macroclinium wulfschlaegelianum</i> Focke (Dodson) | M.J.C. Silva & A.W.C. Ferreira 58 (SLUI 5743) | E | Amaz. |
| <i>Maxillaria alba</i> (Hook.) Lindl. | W.R. Silva-Junior & A.W.C. Ferreira 105 (SLUI 5744) | E | Amaz. |
| <i>M. aureoglobula</i> Christenson | A.W.C. Ferreira 100 (MAR 11538) | E | Amaz. |
| <i>M. crassifolia</i> (Lindl.) Rchb.f. | R.L. Frões 34567 (IAN 103386) | E | Amaz. |
| <i>M. lutescens</i> Scheidw. | M.R. Santos 698 (MG 81079); M.J.C. Silva & A.W.C. Ferreira 59 (SLUI 5745); M.J.C. Silva & A.W.C. Ferreira 60 (SLUI 5746) | E | Amaz. |
| <i>M. subrepens</i> (Rolfe) Schuit. & M.W. Chase | W.L. Balée 882 (NY 910915); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5747); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5748) | E | Amaz. |
| <i>M. uncatata</i> Lindl. | R.L. Froes 34395 (IAN 110218); M.J.C. Silva & A.W.C. Ferreira 63 (SLUI 5749); M.J.C. Silva & A.W.C. Ferreira 64 (SLUI 5750) | E | Amaz. |
| <i>Mormodes gurupiensis</i> Campaccii & J.B.F. da Silva | J.B.F. Silva 2122 (MG 190658) | E | Amaz. |
| <i>Notylia aromatica</i> Barker ex. Lindl. | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5751); M.J.C. Silva & A.W.C. Ferreira 66 (SLUI 5752) | E | Amaz. |
| <i>N. lyrata</i> S.Moore | W.R. Silva-Junior et al. s.n. (SLUI 5803); W.R. Silva-Junior et al. s.n. (SLUI 5804) | E | Cerr. |
| <i>N. microchila</i> Cogn. | M.J.C. Silva & A.W.C. Ferreira 69 (SLUI 5753); M.J.C. Silva & A.W.C. Ferreira 70 (SLUI 5754) | E | Amaz. |
| <i>N. yauaperiensis</i> Barb. Rodr. | L.R. Marinho & G.S. Pinheiro 621 (IAN 154893); W.R. Silva-Junior & A.W.C. Ferreira s.n. (SLUI 5755) | E | Amaz. |
| <i>Octomeria grandiflora</i> Lindl. | I.J. Jangoux & R.P. Bahia 1212 (MG 84024); M.J.C. Silva & A.W.C. Ferreira 72 (SLUI 5756) | E | Amaz. |
| <i>Oeceoclades maculata</i> (Lindl.) Lindl. | M.S. Oliveira 140 (MAR 11525); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5757); K.N. Santos & A.W.C. Ferreira s.n. (SLUI 5807) | T | Amaz. |
| <i>Oncidium baueri</i> Lindl. | A.W.C. Ferreira s.n. (SLUI 5758) | E | Amaz. |
| <i>Orleanesia amazonica</i> Barb. Rodr. | A.W.C. Ferreira s.n. (SLUI 5759) | E | Amaz. |
| <i>O. mineirosensis</i> Garay | G. Pereira-Silva 13688 (CEN 98224) | E | Cerr. |
| <i>Ornithocephalus cujeticola</i> Barb. Rodr. | M.J.C. Silva & A.W.C. Ferreira 77 (SLUI 5760); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5761) | E | Amaz. |
| <i>O. gladiatus</i> Hook. | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5762); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5763) | E | Amaz. |
| <i>Paphinia cristata</i> Lindl.* ## | R.L. Frões 34757 (IAN 103556) | E | Amaz. |
| <i>Peristeria serroniana</i> (Barb.Rodr.) Garay | J.B.F. Silva 737 (MG 150588); M.J.C. Silva & A.W.C. Ferreira 81 (SLUI 5764) | E | Amaz. |
| <i>Polystachya concreta</i> (Jacq.) Garay & H.R.Sweet | M.J.C. Silva & A.W.C. Ferreira 82 (SLUI 5765) | E | Amaz. |
| <i>P. foliosa</i> (Hook.) Rchb.f. | M.R. Santos 730 (MG 81111); M.R. Santos 730 (INPA 125573) | E | Amaz. |



Table 1. Cont.

| Species | Vouchers | Habit | Ecosystem |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------|-------------|
| <i>Prosthechea aemula</i> (Lindl.) W.E. Higgins | R.L. Fróes 1715 (US 1663963); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5766); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5767) | E | Amaz. |
| <i>Rodriguezia lanceolata</i> Ruiz & Pavon | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5768); M.J.C. Silva & A.W.C. Ferreira 86 (SLUI 5769) | E | Amaz. |
| <i>Sacoila lanceolata</i> (Aubl.) Garay | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5770); M.S. Oliveira 17 (MAR 11527); N.A. Rosa & H. Vilar 2818 (MG 66950) | T | Amaz./Cerr. |
| <i>Sarcoglottis acaulis</i> (Sm.) Schltr. | A.S.F. Castro 272 (EAC 24932); A.W.C. Ferreira s.n. (SLUI 5771) | T | Amaz. |
| <i>Scaphyglottis prolifera</i> (R.Br.) Cogn. | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5772); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5773) | E | Amaz. |
| <i>S. sickii</i> Pabst | M.J.C. Silva & A.W.C. Ferreira 91 (SLUI 5774); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5775) | E | Amaz. |
| <i>S. stellata</i> Lodd. Ex Lindl. | D.C. Daly et al. D191 (MG 88295); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5776) | E | Amaz. |
| <i>Sobralia macrophylla</i> Rchb.f. | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5777) | E | Amaz. |
| <i>S. sessilis</i> Lindl. | R.L. Fróes 34423 (IAN 103734) | T | Amaz. |
| <i>Stelis papaquerensis</i> Rchb.f. | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5778); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5779) | E | Amaz. |
| <i>Trichocentrum cepula</i> (Hoffmans.) J.M.H. Shaw | D.C. Daly et al. D653 (MG 88716); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5780); M.L. Rodrigues & T.R. Pereira s.n. (MG 228255) | E | Amaz./Cerr. |
| <i>Trichosalpinx eglerti</i> Pabst | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5781) | E | Amaz. |
| <i>Vanilla bahiana</i> Hoehne | M.S. Oliveira 151 (MAR 11530) | He | Cerr. |
| <i>V. mexicana</i> Mill. | M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5782) | He | Amaz. |
| <i>V. palmarum</i> (Salz.) ex Lindl. | N.T. Silva 4244 (IAN 151424); M.J.C. Silva & A.W.C. Ferreira s.n. (SLUI 5783) | E | Amaz./Cerr. |
| <i>V. pompona</i> Schiede | A.W.C. Ferreira 102 (SLUI 5784); G.T. Prance 28146 (NY 794645); M.S. de Oliveira et al. s.n. (HENAC 155) | He | Amaz./Cerr. |
| <i>Veyretia simplex</i> (Griseb.) Szlach. | G. Pereira-Silva 14891 (CEN 99330) | T | Cerr. |
| <i>Wulfschlaegelia calcarata</i> Benth. | W.R. Silva-Junior & A.W.C. Ferreira s.n. (SLUI 5785); W.R. Silva-Junior & A.W.C. Ferreira s.n. (SLUI 5786) | My | Amaz. |

Table 2. List of species cited in the literature to Maranhão but excluded here due to the lack of voucher specimens.

| Species | Reference |
|--------------------------------------------------------|---------------------------------------|
| <i>Anathallis barbulata</i> Pridgeon & M.W.Chase | BFG (2015; 2018) |
| <i>A. brevipes</i> (Lindl.) Pridgeon & M.W.Chase | BFG (2015; 2018) |
| <i>Bulbophyllum insectiferum</i> Barb.Rodr. | BFG (2015; 2018), Silva et al. (1999) |
| <i>Campylocentrum amazonicum</i> Cogn. | Silva et al. (1999) |
| <i>Cleistes grandiflora</i> (Aubl.) Schltr. | BFG (2015; 2018) |
| <i>Cyrtopodium andersonii</i> (Lamb. ex Andrews) R.Br. | Silva et al. (1999) |
| <i>Epidendrum nocturnum</i> Jacq. | BFG (2015; 2018), Silva et al. (1999) |
| <i>E. sculptum</i> Rchb.f. | BFG (2015; 2018) |
| <i>E. viviparum</i> Lindl. | BFG (2015; 2018), Silva et al. (1999) |
| <i>Galeandra cristata</i> Lindl. | BFG (2015; 2018) |
| <i>H. hexaptera</i> Lindl. | BFG (2015; 2018) |
| <i>H. seticauda</i> Lindl. ex Benth. | BFG (2015; 2018) |
| <i>H. spathulifera</i> Cogn. | BFG (2015; 2018) |
| <i>Ionopsis satyrioides</i> (Sw.) Lindl | BFG (2015; 2018), Silva et al. (1999) |
| <i>Lepanthes brasiliensis</i> Pabst | BFG (2015; 2018), Silva et al. (1999) |
| <i>L. helicocephala</i> Rchb.f. | BFG (2015; 2018), Silva et al. (1999) |
| <i>Lockhartia goyazensis</i> Rchb.f. | Silva et al. (1999) |
| <i>L. lunifera</i> (Lindl.) Rchb.f. | Silva et al. (1999) |



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Table 2. Cont.

| Species | Reference |
|-----------------------------------------------------------------------|----------------------------------------------|
| <i>Macradenia rubescens</i> Barb.Rodr. | Silva <i>et al.</i> (1999) |
| <i>Maxillaria notylioglossa</i> Rchb.f. | Silva <i>et al.</i> (1999) |
| <i>M. rufescens</i> Lindl. | Silva <i>et al.</i> (1999) |
| <i>Orleanesia yauaperyensis</i> Barb.Rodr. | Silva <i>et al.</i> (1999) |
| <i>Peristeria guttata</i> Knowles & Westc. | BFG (2015; 2018), Silva <i>et al.</i> (1999) |
| <i>Pleurothallis pruinosa</i> Lindl. | BFG (2015; 2018), Silva <i>et al.</i> (1999) |
| <i>Polystachya stenophylla</i> Schltr. | Silva <i>et al.</i> (1999) |
| <i>Quekettia microscopica</i> Lindl. | Silva <i>et al.</i> (1999) |
| <i>Scaphyglottis modesta</i> (Rchb.f.) Schltr. | BFG (2015; 2018), Silva <i>et al.</i> (1999) |
| <i>S. reflexa</i> Lindl. | BFG (2015; 2018) |
| <i>Solenidium lunatum</i> (Lindl.) Schltr. | Silva <i>et al.</i> (1999) |
| <i>Stanhopea grandiflora</i> Lindl. | BFG (2015; 2018), Silva <i>et al.</i> (1999) |
| <i>Trichocentrum morenoi</i> (Dodson & Luer) M.W.Chase & N.H.Williams | Silva <i>et al.</i> (1999) |
| <i>T. nanum</i> (Lindl.) M.W.Chase & N.H.Williams | Silva <i>et al.</i> (1999) |
| <i>Vanilla planifolia</i> Jacks. ex Andrews | BFG (2015; 2018) |
| <i>Zygosepalum labiosum</i> (Rich.) Garay | Silva <i>et al.</i> (1999) |

From the four hotspots of collection effort in the state (Fig. 1C), three coincide with university campuses (municipalities of Caxias, Imperatriz and São Luís). Only the one in the northwest region (in the vicinity of the municipality of Candido Mendes) is the result of a previous study (Silva *et al.* in press). This area is also the richest in orchid species in the state (Fig. 1C), but also the most exposed to threats such as change in land use/deforestation and altered fire regime (Almeida & Vieira 2010; Silva-Moraes *et al.* 2019; Silva-Junior *et al.* 2020).

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