Revista Brasileira de Geografia Física

Homepage: <https://periodicos.ufpe.br/revistas/rbgfe>

New records of *Aristolochia bahiensis* F.Gonzalez for the State of Maranhão, Brazil

Lorran André de Moraes¹, Josiane Silva Araújo.², Francisco Soares Santos-Filho⁴

¹ Mestre em Biodiversidade, Ambiente e Saúde, Doutorando do Programa de Pós-Graduação em Desenvolvimento e Meio Ambiente, Universidade Federal do Piauí (UFPI), Campus Ministro Petrônio Portela, Teresina, Piauí, Brasil, CEP 64.049-550. lorranbio@hotmail.com ² Doutora em Botânica, Professor Adjunto III, Campus Heróis do Jenipapo, Universidade Estadual do Piauí (UESPI), Avenida Santo Antônio s/n Campo Maior, Piauí, Brasil, CEP 64280-000. josianesilva@cpm.uespi.br ³ Doutor em Botânica. Professor Associado II, Centro de Ciências da Natureza, Universidade Estadual do Piauí, Campus Torquato Neto (UESPI), Rua João Cabral, 2231, Pirajá, Teresina- Piauí, Brasil, CEP 64002-150. fsoaresfilho@gmail.com (autor correspondente).

Artigo recebido em 24/07/2020 e aceito em 01/12/2020

ABSTRACT

This study aimed to record the occurrence of the species *Aristolochia bahiensis* F. González in an area of the territory of the State of Maranhão, Brazil. The species was collected in the city of Timon, in an area of tension that brings together characteristics of the Cerrado, adjacent to Mata Ciliar. The study provides a brief characterization of the botanical family and descriptions of the genus and species, as well as data on its distribution. The species had already been found in the states of Alagoas, Bahia and Espírito Santo. In addition to portraying the geographic occurrence of the plant, a morphological characterization of the species was made, with the assembly of a board with images of the most relevant aspects of its morphology in addition to maps with its location.

Keywords: Aristolochiaceae, *Aristolochia*, *Aristolochia bahiensis*, Ecological Stress Area, Cerrado, Riparian Forest, Parnaíba River Basin, Northeast Brazil.

Novo registro de *Aristolochia bahiensis* F.Gonzalez para o Estado do Maranhão, Brasil

RESUMO

Este trabalho teve como objetivo registrar a ocorrência da espécie *Aristolochia bahiensis* F. González em área do território do Estado do Maranhão, Brasil. A espécie foi coletada na cidade de Timon, em área de tensão que reúne características de Cerrado, em adjacência com Mata Ciliar. O estudo traz uma breve caracterização da família botânica e descrições sobre o gênero e a espécie, além de dados sobre sua distribuição. A espécie já tinha sido encontrada nos estados de Alagoas, Bahia e Espírito Santo. Além de retratar ocorrência geográfica da planta foi feita uma caracterização morfológica da espécie, com a montagem de uma prancha com imagens dos aspectos mais relevantes da sua morfologia além de mapas com sua localização.

Palavras-chave: Aristolochiaceae, *Aristolochia*, *Aristolochia bahiensis*, Área de Tensão Ecológica, Cerrado, Mata Ciliar, Bacia do Rio Parnaíba, Nordeste Brasil.

Introdução

The state of Maranhão in northeastern Brazil covers an area of 331.983 km² (IBGE, 2020), which includes parts of five domains: i) the Amazon occupying the northwestern portion on the border with Pará; ii) the Cerrado occupying most of the State's area (about 60% of the territory) to the south, bordering the states of Tocantins and Piauí; iii) the coastal vegetation, to the north with formations of Mangroves and "Restingas",

constituting the second largest coast in the Northeast region of Brazil; iv) Mixed subcaduciferous forest areas forming babassu forests, in the eastern region on the border with Piauí and; v) small enclaves of Caatinga vegetation, along the Parnaíba River basin (Santos-Filho et al. 2013).

The city of Timon is located to the east of Maranhão, whose territory is configured as

belonging to the Mesoregion of the East of Maranhão. The city is 69 m above sea level and is characterized as a place of flat relief where there are also residual reliefs on hills, ridges, pontoons and hills that can reach altitudes ranging from 120 to 155 meters (Correia Filho, 2011). The vegetation is influenced by the climatic transition, relief and soil conditions, which is represented by the Open Evergreen Seasonal Forest, interspersed with babassu, Cerrado with its various phyto physiognomies, interspersed with buritizais, and the discreet presence of carnaubal patches (Conceição et al., 2015). The main types of soils found in Timon (MA) are Yellow Latosols, Plintosols, Red-Yellow Argisols and Fluvic Neosols, according to EMBRAPA (2006) and Cardoso and Aquino (2014). It's classified as a tropical climate according to the Köppen classification (Aw), with nine dry months and three rainy months. The mean annual temperature is relatively high, reaching around 20,1 – 36,2°C and with an annual mean temperature of 2,7°C with no significant oscillations. The total annual precipitation varies around to 1383 mm, with the wettest period in February and April (CLIMATEMPO, 2020).

Aristolochiaceae is a family of Magnoliids positioned in Piperales (APG IV, 2016). The family Aristolochiaceae Juss. is represented by four genera, *Aristolochia* L., *Asarum* L., *Saruma* Oliv. and *Thottea* Rottb., which together have approximately 600 species with a cosmopolitan distribution (González, 1990, 1998, 2012), with *Aristolochia* being the most diverse, with 450 recognized species and with tropical and temperate distribution (Wanke et al., 2006a; Wanke et al., 2006b; González, 2011, 2012). In South America, *Aristolochia* is the only genus of Aristolochiaceae, and Brazil is configured as the main center of diversity of the genus with 93 described species, of these 38 endemic to the Brazilian territory and 40 to the Cerrado (Freitas, Alvez-Araújo, 2017; Aristolochiaceae, 2020). In addition, in the country, the species of this family occur in all regions, distributed in all the phytogeographic domains and their phyto physiognomies, as well as in the different vegetation formations, being the Cerrado (40 spp.), the Amazon (39) and the Atlantic Forest (39), the richest in number of species, followed by the Caatinga (8) and two in Moraes, L. A.; Araújo, J.S.; Santos-Filho, F.S.

the Pampas (Aristolochiaceae, 2020). The family is formed by low, annual herbs, branched from the base, with tuberous roots, decumbent or supportive herbs and robust vines, with 62 spp. in Brazil (Barroso et al., 2002).

In Brazil, the states of Minas Gerais (32), Amazonas (27), Mato Grosso (24), Rio de Janeiro (23), Pará (23), São Paulo (22) and Bahia (21) are the most representative in terms of number of species in the family. The other states have one to 18 species (Aristolochiaceae, 2020). For the Northeast region, 29 species are cataloged, of these 18 are endemic, and the richest states are Bahia (21 spp.), followed by Maranhão with eight known species, which represents the second state in the region that is richest in number. In terms of the number of species of the Aristolochiaceae family, the eight registered for the state represent 1.45% of the world flora (550 spp.), 8.6% (93 spp.) in Brazil and 20% (40 spp.) for the Cerrado.

Aristolochia plants have alternate leaves, petiolate, with or without pseudostipules, considered undeveloped leaves. They have solitary flowers, axillary or rarely arranged in short flowering branches. Zygomorphic perigone of varying dimensions with three main parts: utricle, the perigone tube and the limb or lip, as an expanded part of the perigone. The limb or lip can have different shapes, from peltate to uni or bilabiate. The inner surface of the lip or lip may be smooth or warty and still have marginal fimbriae. In the utricle are the sexual organs that form a column (gynostemium). The gynostemium can be campanulate or cylindrical, presenting six erect stigmatiferous lobes with hairy edges. They have sessile, oblong or linear anthers inserted in the back of the spine. The ovary is located as inferior, formed by six carpels. The fruit is a hexagonal septicidal capsule (Barroso et al., 2002; Souza and Lorenzi, 2012).

Among the registered species listed for the state of Maranhão, are: *Aristolochia cordigera* Willd. ex Klotzsch, *A. holostylis* F. González, *A. odoratissima* L., *A. papillaris* Mast., *A. rugosa* Lam., *A. setosa* Duch., *A. stomachoides* Hoehne and *A. warmingii* Mast (Aristolochiaceae, 2020). It should also be noted that in the literature consulted, none of the eight species cited in the online (Barros et al. 2015) for the state were sampled in studies

with a floristic listing bias from samples from various locations carried out in the Amazon region of Maranhão, Cerrado, on the coast and sandbank (Cabral-Freire and Monteiro, 1993; Muniz et al., 1994; Medeiros et al., 2008; Silva et al., 2008; Conceição and Castro, 2009; Neres and Conceição, 2010; Amorim et al., 2016; Loch and Muniz, 2016; Serra et al., 2016; Almeida Jr. et al. 2017; Camelo Jr. et al., 2017; Lima and Almeida Jr., 2018; Rodrigues et al., 2019; Santos et al., 2019).

Methods

Our study was based on field collections, a literature review (Flora of Brazil 2020), and of

The present study records the first occurrence of the species *Aristolochia bahiensis*, collected in the county of Timon, Maranhão, Northeastern Brazil, in a preserved area adjacent to the riparian forest of the Parnaíba River, characterized as belonging to the Cerrado phyto physiognomy. The study provides a brief morphological description and illustrations of the species, as well as their location.

digital collections in Re flora databases (<http://reflora.jbrj.gov.br>; accessed on: 2020-7-6) and SpeciesLink (<http://www.splink.org.br/>; accessed on: 2020-7-6) reviews

Figure 1. Geographic location of the species *Aristolochia bahiensis*, in Timon, Maranhão, Northeast, Brazil.

For identification and confirmation of the species, specialized literature was used, being (Harris and Harris, 2001) for the descriptions of general morphological characters, and the unique characters in the flowers were described according to Freitas, Lírio and González (2013a), Abreu, Giulietti (2016); Freitas, Alves-Araújo (2017); Freitas et al., (2019). Supplemented with Moraes, L. A.; Araújo, J.S.; Santos-Filho, F.S.

information on the analysis of the *typus* material, exclusive characteristics of the group, geographical distribution, flowering and fruiting periods and the species terminology, obtained from Flora do Brasil's online data networks (www.floradobrasil.jbrj.gov.br), NYBG (<http://sweetgum.nybg.org/science/vh/>), Mobot /

tropicos (www.tropicos.org), SpeciesLink (www.splink.org.br).

For the analysis of the Brazilian geographic distribution of the species, the information on the collection locations and coordinates were obtained based on Freitas, Lício and González (2013), Abreu, Giulietti (2016); Freitas; Alves-Araújo (2017); Freitas et al., (2019); Spinelli-Araújo et al., (2016), in addition to information from the SpeciesLink database (www.splink.org.br). After that, the data were grouped and the map was constructed using the QGIS software (QGIS Development Team 2015; <http://www.qgis.org/en/site/>). The exsiccate of the new records were incorporated into Federal University of Maranhão Herbarium (MAR).

Results

Aristolochia bahiensis F.González, Brittonia 50 (1): 8.1998.

Type: BRAZIL. Bahia: Una, Mico-Leão Biological Reserve (IBAMA), 46 km from the entrance of Highway BA-001 Ilhéus / Una, road that leads to Jaqueiral Farm, ca. 8 km from the entrance, 15°09'S, 39°05'W, 01.V.1996 (fl.), J. Jardim, S. C.

Santana & J. L. Paixão 809 (Holotype: CEPEC; Isotype: NY).

New Records. Brazil: Maranhão – Timon, Lat. 5°16'44,16" S; Long. 42°51'03,12"W, alt.59m asl, 01.I.2019, L.A. Moraes 832 (MAR).

Identification.

Voluble creeper; glabrous branches and cylinders, with suber; absent intrapeciolar profiles (Fig. 2A). Petiolated leaves; blade broad-oval to lanceolate, cardiac, apex attenuated to acuminate, base subcorded to truncated, adaxially glabrous, abaxially pubescent (Fig. 2B); 4 ribs from the dichotomization of the main lateral ribs at the base of the leaf. Intrapeciolar ripples; deltoid bracts, sessile, pubers. Glabrous perianth externally, beige with streaks and vinaceous macules (Fig. 2C), internally slightly vinaceous and pale yellow closest to the upper tube, with white trichomes (Fig. 2D); obovoid lower tube; cylindrical upper tube; inconspicuous or absent lower lip, revolute margin, obtuse apex; upper lip oval to elliptical, margin revolute, obtuse apex; gynostemium with pedicel and ovary puberules. Capsules and seeds not observed.

Figure 2. Leaf and flower morphology of *Aristolochia bahiensis*. **A.** General aspect of the branch (including phyllotaxis) with flower in terminal position. **B.** Detail of leaf blade variation: abaxial face (H) and adaxial face (B). H=higher; B=bottom. **C.** Side view of *A. bahiensis* flower. **D.** Details: glabrous perianth externally, beige with streaks and vinaceous macules, internally slightly vinaceous and pale yellow closest to the upper tube, with white trichomes.

Discussion and Conclusion

Aristolochia bahiensis is endemic to Brazil. According to Flora do Brasil (2020), the species occurs in the Atlantic Forest Domain in an Ombrophilous Forest environment, having already been registered in the States of Alagoas, Bahia and Espírito Santo.

There is no record of any species in the Aristolochiaceae family for areas studied most strongly in Maranhão (Almeida Jr. et al., 2017), but it is noticed that given the diversity of environments and the low number of studies that new occurrences have been relatively frequent to be registered for different regions of Maranhão (Diniz et al., 2017; Ferreira et al., 2017; Ferreira et al., 2018; Ferreira et al., 2019a.; Ferreira et al., 2019b.; Guarçoni et al., 2018a.; Guarçoni et al., 2018b.; Guarçoni et al., 2020; Koch and Araújo-Silva, 2014; Nascimento et al., 2018a.; Nascimento et al., 2018b.; Nascimento et al., 2019; Nascimento et al., 2020; Oliveira et al., 2018; Salazar-Ferreira et al., 2020; Silva et al., 2016; Silva et al., 2018a; Silva et al., 2018b.; Silva-Moraes et al., 2019).

The discovery and registration of *A. bahiensis* in the Parnaíba River basin, but precisely in a forest with characteristics of the Cerrado adjacent to its riparian forest, in the territory of Maranhão, reinforces the discussion raised by several authors that the region is home to a large ecotonal area, because it brings together species that occur in very diverse areas, from areas of more humid seasonal forests, passing through Cerrado areas, to drier areas, such as the Caatinga, reinforcing the dispersing role of water bodies in the dissemination of seeds and propagules.

It is believed, therefore, that there is still an exceptionally large gap in relation to the *Aristolochia* species that actually occur in Maranhão and that further studies on the state's flora are needed. This is the first record of the species *Aristolochia bahiensis* in a forest area strongly influenced by the presence of plants from the Cerrado, in addition to its first occurrence in the state of Maranhão, which expands its area of distribution in the Brazilian territory. and in another biome in the country (Cerrado).

The new occurrence of *A. bahiensis* calls attention to the need for floristic surveys in areas not yet sampled in Maranhão, as well as in neighboring states, especially in places of forest remnants with many species typical of the Cerrado, before these habitats. destroyed by anthropic action. It is believed that one of the possible reasons for the lack of registration in the state is due to the scarcity of collections of species of the Aristolochiaceae Juss. family, this may be due to the great difficulty of finding them during collects, or even their identification in the field, because in the area only one individual of the species was found, therefore, of rare occurrence.

Finally, it is important to know the regional flora, as it contributes to indicate the degree of richness and diversity of plants in the region, in the case of the occurrence of the species *A. bahiensis* in a Cerrado fragment, it can enable projects of conservation, management and recovery of areas belonging to this phyto physiognomy. In addition, it extends the area of geographic distribution of the taxon, in addition to providing knowledge related to ecology and taxonomic data of the species.

Acknowledgements

The authors are grateful for the resources coming from CNPq (Universal Project N° 422747/2016-5) for funding.

References

- Abreu, I.S., Giulietti, A.M. 2016. Flora da Bahia: Aristolochiaceae. Sitientibus série Ciências Biológicas 16: 1-25. <http://dx.doi.org/10.13102/scb1059>
- Almeida Jr., E. B., Silva, A. N. F., Lima, G. P., Amorim, I. F. F., Serra, F. C. V., Correia, B. E. F., Machado, M. A., Almeida, R. A. G., Castro A. R. R., Figueiredo, N., Silva, R. M., Santos-Filho, F. S. 2017. Checklist of the flora of the restingas of Maranhão state, Northeast, Brazil. Indian Journal of Applied Research: 7 (6): 603-612. <https://doi.org/10.36106/ijar>
- Amorim, G. S., Amorim, I. F. F., Almeida Jr., E. B. 2016. Flora de uma área de dunas antropizadas na praia de Araçagi, Maranhão. Revista Biociências: 22 (2): 18-29.

<http://periodicos.unitau.br/ojs/index.php/biociencias/article/view/2232>

APG IV 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society, 181, 1–20. With 1 figure. <https://doi.org/10.1111/boj.12385>

Aristolochiaceae in Flora do Brasil 2020 em construção. Jardim Botânico do Rio de Janeiro. Disponível em: <<http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB15750>>. Acesso em: 20 jul. 2020.

Barros, F., Araújo, A.A.M., Freitas, J. 2015. *Aristolochiaceae* in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em: <<http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB15750>>. Acesso em: 20 jul. 2020.

Barroso, G.M., Guimarães, E.F., Ichaso, C.L.F., Costa, C.G., Peixoto, A.L. 2002. Sistemática de Angiospermas do Brasil. Vol. 1. 2ª ed., Viçosa (MG). Ed. UFV. 309p.

Cabral-Freire, M.C.C., Monteiro, R. 1993. Florística das praias da ilha de São Luis, Estado do Maranhão (Brasil): diversidade de espécies e suas ocorrências no litoral brasileiro. Acta Amazonica: 23 (2-3): 125-140. <https://www.scielo.br/pdf/aa/v23n2-3/1809-4392-aa-23-2-3-0125.pdf>

Camelo Jr., A. E., Silva, G. S., Conceição, G. M. 2017. Florística de um Fragmento Vegetacional da Área de Proteção Ambiental do Buriti do Meio, Caxias, Maranhão. Agraryan Academy: 4 (7): 269-279. DOI: 10.18677/Agrarian_Academy_2017a26.

Cardoso, J. A., Aquino, C. M. S. 2014. Problemas ambientais decorrentes do padrão de uso e cobertura das terras da microbacia do Riacho Roncador em Timon (MA). Geografia em Questão: 07 (1): 104-122. <http://saber.unioeste.br/index.php/geoemquestao/article/viewFile/8564/7071>

CLIMATEMPO. 2020. Disponível: <https://pt.climate-data.org/america-do-sul/brasil/maranhao/timon-31932/> Accessed on: 06 jun.2020.

Conceição, G.M., Castro, A.A.J.F. 2009. Fitossociologia de uma área de cerrado marginal, Parque Estadual do Mirador, Maranhão. Scientia Plena. 5 (5):1-16. <https://www.scienciaplena.org.br/sp/article/view/643/305>

Conceição, G.M., Zarate, E.L.P., Ruggieri, A.C., Silva, E.O., Silva, M.F. 2015. Pteridoflora e seus aspectos ecológicos no município de Timon, Maranhão, Brasil. Brazilian Geographical Journal: Geosciences and Humanities research medium 6 (1): 74-81. <http://www.seer.ufu.br/index.php/brazilangeojournal/article/view/24876>

Correia Filho, F. L. 2011. Projeto Cadastro de Fontes de Abastecimento por Água Subterrânea, estado do Maranhão: relatório diagnóstico do município de Timon. Teresina: CPRM - Serviço Geológico do Brasil. 31 p. http://rigeo.cprm.gov.br/xmlui/bitstream/handle/doc/15662/rel_timon.pdf?sequence=1

Diniz, M. R., Silva, G. S., Conceição, G. M. 2017. Novas ocorrências para o Maranhão de espécies de Papilionoideae, depositadas no Herbário HABIT, do Centro de Estudos Superiores de Caxias, Maranhão. Biota Amazônia 7(4): 57-59. <https://periodicos.unifap.br/index.php/biota/article/view/3713>

EMBRAPA. 2006. Solos do Nordeste. Recife, 2006. Disponível: <www.uep.cnps.embrapa.br/>. Accessed on: 2020-6-26.

Ferreira, A. W. C., Calió, M. F., Silva-Júnior, W. R., Silva, M. J. C., Oliveira, M. S., Silva, E. O.; Guarçoni, E. A. E., Carvalho, A. K. C., Figueiredo, N. 2018. First record of *Voyria caerulea* Aubl. (Gentianaceae), a mycoheterotrophic plant, in Maranhão state, northeastern Brazil. Check List 14 (5): 833-837. <https://doi.org/10.15560/14.5.833>

Ferreira, A. W. C., Lima, G. P., Silva, M. J. C., Almeida Jr., E. B. 2019a. Geographic range extension of *Rapatea paludosa* Aubl.

- (Rapateaceae) to Maranhão state, northeastern Brazil. Check List: 15 (5): 921–925. <https://doi.org/10.15560/15.5.911>
- Ferreira, A. W. C., Oliveira, M. S., Silva-Júnior, W. R., Andrade, I. M., Coelho, M. A. N., Oliveira, H. C., Mayo, S. J. 2019b. New occurrences of small aquatic duckweeds (Araceae, Lemnoideae) in Maranhão state, northeastern Brazil. Check List: 15 (6): 1153–1160. <https://doi.org/10.15560/15.6.1153>
- Ferreira, A. W. C., Oliveira, M. S., Silva, E. M., Campos, D. O. S., Pansarin, E. R., Guarçoni, E. A. E. 2017. *Vanilla bahiana* Hoehne and *Vanilla pompona* Schiede (Orchidaceae, Vanilloideae): two new records from Maranhão state, Brazil. Check List: 13 (6): 1131–1137. <https://doi.org/10.15560/13.6.1131>.
- Freitas, J., Lírio, E. J., González, F. 2013a. *Aristolochia bahiensis* (Aristolochiaceae) reaches Espírito Santo: range extension and first description of capsules and seeds. Boletim do Museu de Biologia Mello Leitão: 32: 5–11. http://boletim.sambio.org.br/pdf/32_01.pdf
- Freitas, J.; Lírio, E. J.; González, F. 2013b. A new cauliflorous species of *Aristolochia* (Aristolochiaceae) from Espírito Santo, Brazil. Phytotaxa: 124 (1): 51–59. <https://www.biotaxa.org/Phytotaxa/article/view/phytotaxa.124.1.2>
- Freitas, J., Alves-Araújo, A. 2017. Flora do Espírito Santo: Aristolochiaceae. Rodriguésia: 68 (5): 1505–1539. <https://doi.org/10.1590/2175-7860201768501>
- Freitas, J., Delírio, E. J., Guimarães, E. F., Alves-Araújo, A. 2019. Two new records and morphological discussions of *Aristolochia* (Aristolochiaceae) from Rio de Janeiro State, Brazil. Journal of the Botanical Research Institute of Texas: 13 (1): 235–240. https://www.researchgate.net/publication/335320799_TWO_NEW_RECORDS_AND_MORPHOLOGICAL_DISCUSSIONS_OF_ARISTOLOCHIA_ARISTOLOCHIACEAE_FROM_RIO_DE_JANEIRO_STATE_BRAZIL
- González, F. 1990. Aristolochiaceae. - In: Rangel, J. O., Cadena, A., Correal, G. and Bernal, R. (ed.), Flora de Colômbia. Instituto de Ciências Naturales, pp. 1–184.
- González, F. 1998. Two new species of *Aristolochia* from Brazil and Peru. Brittonia: 50 (1): 5–10. <https://doi.org/10.2307/2807710>.
- González, F. 2011. A new pseudostipule-bearing species of *Aristolochia* (Aristolochiaceae) from Bahia and Espírito Santo, Brazil. – Brittonia: 63(4): 430–435.
- González F. 2012. Florística y sistemática filogenética innecesariamente disyuntas: el caso de *Aristolochia*, *Euglypha* y *Holostylis*. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales 36: 193–202.
- Guarçoni, A. E., Saraiva, R. V. C., Ferraz, T. M. 2020. *Dyckia maranhensis* (Bromeliaceae, Pitcairnioideae), a New Species from the Cerrado of Maranhão, Northeastern Brazil. Systematic Botany: 45 (1): 47–52. <https://doi.org/10.1600/036364420X15801369352289>
- Guarçoni, E. A. E., Bastian, R. E., Silva, E. O., Ferreira, A. W. C. 2018a. First record of the rare *Dyckia racemosa* Baker (Bromeliaceae) in Maranhão State (Northeastern Brazil), with an update on the species description, geographic distribution, and conservation status. Phytotaxa: 349: 273–280. <https://doi.org/10.11646/phytotaxa.349.3.8>
- Guarçoni, E. A. E., Costa, A. F., Silva, E. O., Ferreira, A. W. C., Oliveira, M. S. 2018b. New records of *Tillandsia* L. (Bromeliaceae, Tillandsioideae) for Maranhão State, Brazil. Check List: 14 (6): 951–959. <https://doi.org/10.15560/14.6.951>
- Harris, J. G., Harris, M. W. 2001. Plant identification terminology: An illustrated glossary. 2nd ed. Spring Lake: Spring Lake Publishing. 206p.
- IBGE (Instituto Brasileiro de Geografia e Estatística). 2014. Perfil dos estados online. <https://www.ibge.gov.br/cidades-e-estados/ma.html>. Accessed on: 2020-7-06.
- Koch, A. K., Araújo-Silva, L. E. 2014. Primeiro registro de *Voyria tenella* Guild. ex. Hook. (Gentianaceae) para o estado do Maranhão, Brasil. Biota Amazônia: 4 (3): 132–134. <http://dx.doi.org/10.18561/2179-5746/biotaamazonia.v4n3p132-134>

- Lima, G. P., Almeida Jr., E. B. 2018. Diversidade e similaridade florística de uma restinga ecotonal no Maranhão, nordeste do Brasil. *Rev. Interciência*: 13 (4): 275-282. <https://www.interciencia.net/wp-content/uploads/2018/05/275-6142-ALMEIDA-43-04.pdf>
- Loch, V. C., Muniz, F.H. 2016. Estrutura da vegetação de cerrado stricto sensu com extração do Bacuri (*Platonia insignis* Mart.) em uma reserva extrativista, na região meio-norte do Brasil. *Rev. Biol. Neotrop.* 13 (1): 20-30. DOI: <https://doi.org/10.5216/rbn.v13i1.35082>
- Medeiros, M.B., Walter, B.M.T., Silva, G.P. 2008. Fitossociologia no cerrado stricto sensu no município de Carolina, MA, Brasil. *Cerne* 14 (4): 285-294.
- Muniz, F. H., Cesar, O., Monteiro, R. 1994. Fitossociologia da Vegetação arbórea da Reserva Florestal do Sacavém, São Luís, Maranhão (Brasil). *Acta Amazônica*: 24 (4): 219-236. <https://www.scielo.br/pdf/aa/v24n3-4/1809-4392-aa-24-3-4-0219.pdf>
- Nascimento, J. M., Gomes, G. S., Silva, G. S., Santos-Silva, D. L., Araújo, M. F. V., Conceição, G. M. 2019. New occurrence of *Prestonia bahiensis* Müll. Arg. (Apocynaceae) for the vegetation of the State University of Maranhão, Brazil. *International Journal of Development Research*: 9 (3): 26392-26395. <http://doi.org/10.37118>.
- Nascimento, J. M., Gomes, G. S., Silva, G. S., Santos-Silva, D. L. S., Araújo, M. F. V., Conceição, G. M. 2020. Expanding the Occurrence of Malvaceae to Maranhão, Brazil. *Research, Society and Development*: 9 (4): 1-11. DOI: <http://dx.doi.org/10.33448/rsd-v9i4.2612>
- Nascimento, J. M., Silva, G. S., Silva, D. L. S., Oliveira, R. R., Silva, A. M., Gomes, G. S., Oliveira, R. F., Conceição, G. M. 2018a. Ocorrência de *Connarus suberosus* Planch (Connaraceae) para o Parque Estadual do Mirador, Maranhão, Brasil. *Revista Arquivos Científicos (IMMES)*: 1 (2): 69-72, <https://doi.org/10.5935/2595-4407/rac.immes.v1n2p69-72>
- Nascimento, J. M., Viana, D. R., Silva, A. M., Oliveira, R. R., Conceição, G. M. 2018b. Novas Ocorrências de Rubiaceae Mantidas em Coleção Botânica: Caracterização Morfológica e Distribuição Geográfica. *Revista Arquivos Científicos (IMMES)*: 1 (2): 14-20. <https://doi.org/10.5935/2595-4407/rac.immes.v1n2p14-20>
- Neres, L. P., Conceição, G. M. 2010. Florística e Fitossociologia da Área de Proteção Ambiental Municipal do Inhamum, Caxias, Maranhão, Brasil. *Cadernos de Geociências*: 7 (2): 122-130. <https://portalseer.ufba.br/index.php/cadgeoc/article/view/4531/3550>
- Oliveira, R. R., Silva, G. S., Santos-Silva, D. L., Martins, P. R. P., Conceição, G. M. 2018. Primeiro registro da planta carnívora *Drosera sessilifolia* A. St.-Hil. (Droseraceae) no Parque Nacional Chapada das Mesas, Maranhão, Brasil. *Biota amazônica*: 8 (2): 60-62. <http://dx.doi.org/10.18561/2179-5746/biotaamazonia.v8n2p60-62>
- Rodrigues, M. L., Mota, N. F. O., Viana, P. L., Kocha, A. K., Secco, R. S. 2019. Vascular flora of Lençóis Maranhenses National Park, Maranhão State, Brazil: checklist, floristic affinities and phyto physiognomies of restingas in the municipality of Barreirinhas. *Acta Botanica Brasilica*: 33 (3): 498-516. <https://doi.org/10.1590/0102-33062018abb0421>
- Salazar-Ferreira, M., Gonella, P. M., Guarçoni, E. A. E. 2020. New records of *Utricularia* (Lentibulariaceae) for the state of Maranhão, Brazil. *Check List*: 16 (1): 121-125. <https://doi.org/10.15560/16.1.121>
- Santos, C. R., Amorim, I. F. F., Almeida Jr., E. B. 2019. Caracterização fitossociológica do componente halófilo-psamófilo em uma área de dunas, São Luís, Maranhão, Brasil. *Bol. Lab. Hidrobiol*: 29 (1): 1-8. <http://www.periodicoseletronicos.ufma.br/index.php/blabohidro/article/view/11112/6874>

- Santos-Filho, F.S., Almeida Jr., E.B., Soares, C.J.R.S. 2013. Cocais: zona ecotonal natural ou artificial? *Revista Equador (UFPI)*, 1(1), 02 - 13.
<https://revistas.ufpi.br/index.php/equador/article/view/1043>.
- Serra, F. C. V., Lima, P. B., Almeida Jr., E. B. 2016. Species richness in restinga vegetation on the eastern Maranhão State, Northeastern Brazil. *Acta Amazonica*: 46 (3): 271-280.
<https://doi.org/10.1590/1809-4392201504704>
- Silva, E. O., Guarçoni, E. A. E., Ferreira, A. W. C., Oliveira, M. S., Júnior-OLiveira, C. N. 2016. First record of *Passiflora pedata* L. (Passifloraceae) from Maranhão state, northeastern Brazil, *Check List*: 12 (5): 1-4.
<https://doi.org/10.15560/12.5.1958>
- Silva, E. O., Milward-de-Azevedo, M. A., Sá, N. A. S., Sousa, D. A., Conceição, G. M. 2018a. New records of *Passiflora* L. (Passifloraceae) species from Maranhão state and northeastern Brazil, *Check List*: 14 (2): 347-352.
<https://doi.org/10.15560/14.2.347>
- Silva, H.G., Figueiredo, N., Andrade, G.V. 2008. Estrutura da vegetação de um cerradão e a heterogeneidade regional do cerrado no Maranhão, Brasil. *Revista Árvore*. 32 (5): 921-930.
<https://doi.org/10.1590/S0100-67622008000500017>
- Silva, J. A. S., Fernandes, R. S., Costa, D. P. 2018b. Species diversity of the genus *Riccia* L. (Marchantiales, Ricciaceae) in Maranhão state, Brazil. *Check List*: 14 (5): 763–769.
<https://doi.org/10.15560/14.5.763>
- Silva-Moraes, H.C.I., Cordeiro, I., Figueiredo, N. 2019. Flora and floristic affinities of the Cerrados of Maranhão state, Brazil. *Edinburgh journal of botany*: 76, p.1- 21, 2019.
<https://doi.org/10.1017/S0960428618000215>.
- Souza, V.C., Lorenzi, H. 2012. Botânica sistemática: guia ilustrado para identificação das famílias de fanerógamas nativas e exóticas no Brasil, baseado em APG III. 3rd ed. Nova Odessa (SP): Instituto Plantarum. 768p.
- Spinelli-Araújo, L., Bayma-Silva, G., Torresan, F. E., Victoria, D., Vicente, L. E., Bolfe, E. L., Manzatto, C. 2016. Conservação da biodiversidade do estado do Maranhão: cenário atual em dados geoespaciais / Luciana Spinelli-Araújo... [et al.]. Jaguariúna: Embrapa Meio Ambiente. 28p.
- Wanke, S., González, F., Neinhuis, C. 2006a. Systematics of pipevines: combining morphological and fast-evolving molecular characters to investigate the relationships within subfamily Aristolochioideae (Aristolochiaceae). *International Journal of Plant Sciences* 167: 1215–1227.
- Wanke, S., Samain, M.S., Vanderschaeve, L., Mathieu, G., Goetghebeur, P., Neinhuis, C. 2006b. Phylogeny of the genus *Peperomia* (Piperaceae) inferred from the trnK/matK region (cpDNA). *Plant Biology* 8: 93-102.