

A synopsis of Convolvulaceae from the Upper Turi-Gurupi region in the Amazon of Maranhão, Brazil

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Abstract

A synopsis of Convolvulaceae species from the Upper Turi-Gurupi region, a strategic area for the conservation of Amazonian biodiversity in the Maranhão, is presented. Field samples and herbarium collections were analyzed to build a checklist, indicating the most representative taxa and providing data on growth habit, geographic distribution, occurrence in Brazilian phytogeographic domains, and distribution in the Upper Turi-Gurupi region. Twenty-one species and nine genera (*Aniseia* Choisy, *Bonamia* Thouars, *Camonea* Raf., *Distimake* Raf., *Evolvulus* L., *Ipomoea* L., *Maripa* Aubl., *Odonellia* K.R. Robertson, *Operculina* Silva Manso) were recorded. *Ipomoea* was the richest genus (10 species), and *I. asarifolia* was the most collected species. *Maripa scandens* is a new record for Maranhão and, in relation to the last taxonomic work of Convolvulaceae in the Amazon, which covered Maranhão, 10 species are new records for the state. A heterogeneous distribution of the species and sampling gaps were observed in the region, pointing to the need for further surveys. This study contributes to the knowledge of Convolvulaceae in the Amazon and stimulates the conservation of the Amazonian flora in Maranhão, since the study area is under risk of biodiversity loss due to environmental degradation and is one of the most threatened in the Amazon.

Keywords: Amazon Forest; Flora of Maranhão; *Ipomoea*; *Maripa*; Turiaçu Basin.

Sinopse de Convolvulaceae da região do Alto Turi-Gurupi na Amazônia do Maranhão, Brasil

Resumo

Foi elaborada uma sinopse para espécies de Convolvulaceae da região do Alto Turi-Gurupi, área estratégica em biodiversidade e conservação da Amazônia Maranhense. Foram realizadas coletas e análises em herbários para construção do checklist, indicando os táxons mais representativos e fornecendo dados sobre hábito de crescimento, distribuição geográfica, domínios fitogeográficos e distribuição das espécies para a região. Foram registradas 21 espécies e nove gêneros (*Aniseia* Choisy, *Bonamia* Thouars, *Camonea* Raf., *Distimake* Raf., *Evolvulus* L., *Ipomoea* L., *Maripa* Aubl., *Odonellia* K. R. Robertson e *Operculina* Silva Manso). *Ipomoea* foi o gênero mais representativo com 10 espécies, sendo *Ipomoea asarifolia* a mais coletada. *Maripa scandens* Aubl. é novo registro para o Maranhão e há 10 novos registros para o estado, em relação ao último trabalho taxonômico de Convolvulaceae na Amazônia com abrangência do Maranhão. Quanto a amostragem de Convolvulaceae na região, foi observada uma distribuição heterogênea das espécies e lacunas de coletas, evidenciando a necessidade de maior amostragem. O estudo colabora com o conhecimento dessa família botânica em território amazônico, além de estimular a conservação da flora amazônica maranhense, uma vez que, essa área está sob forte degradação ambiental, e uma das regiões mais ameaçadas em perda da biodiversidade de todo domínio amazônico.

Palavras-chave: Floresta Amazônica; Flora do Maranhão; *Ipomoea*; *Maripa*; Bacia do Turiaçu.

Introduction

Convolvulaceae Juss. is represented by about 1,900 species and 60 genera with a cosmopolitan distribution, with the largest number of records of species in the tropical region of the globe and few representatives in temperate areas (Mabberley, 1987; Austin, 1998; Staples & Brummitt, 2007; Simões & Staples,

2017; WCSP, 2020). Among the countries of South America, Brazil has a total of 422 species, including 192 endemics to the country, distributed in 25 genera (Simão-Bianchini *et al.*, 2020a).

The species of this family in Brazil occur in areas with

open vegetation, mainly in savannas such as Caatinga and Cerrado, forest edges and altered areas, but also in forested and ecotonal areas (Simão-Bianchini, 1998; Simão-Bianchini *et al.*, 2020a). More than 50% of the known species in the country (422 species of 25 genera) are recorded in the Northeast (230 species of 17 genera), where savanna physiognomies predominate (Simão-Bianchini *et al.*, 2020a).

Despite the predominance and relevance of Convolvulaceae species in Caatinga (149 spp.) and Cerrado (265 spp.), another rich and considerably promising domain for floristic studies of the family is the Amazon (129 spp.) (Simão-Bianchini *et al.*, 2020a). Some relevant works in this domain are those of Ducke (1922, 1925, 1932a, 1932b, 1935, 1938, 1939), in which several new species for the Amazon are published, including 11 of Convolvulaceae (seven of the genus *Dicranostyles* Benth. and four of the genus *Maripa* Aubl.). Falcão (1971) described the flora of the family in the state of Amazonas, cataloguing 40 species. Austin (1981), with the publication of novelties on Convolvulaceae for the Amazon flora, recognized a new name, two new species, and two new occurrences for the domain. Austin and Cavalcante (1982) produced a reference work on Convolvulaceae from the Brazilian Amazon, recognizing 132 taxa (125 species and seven varieties), demonstrating a high richness of species of the family. Also noteworthy are the identification guide of Convolvulaceae in the Ducke Reserve in the state of Amazonas (Ribeiro, & Simão-Bianchini, 1999) and the Flora of the cangas of Serra dos Carajás in the state of Pará (Simão-Bianchini, Vasconcelos, & Pastore, 2016).

A recent note on *Ipomoea* from the Amazon (Wood, & Scotland, 2017) included the description of six new species, three of which occur in Brazil and were considered synonyms by Simão-Bianchini *et al.* (2020a). One of them was *I. pogonocalyx* J. R. I. Wood and Scotland, considered endemic to the state of Maranhão by Wood and Scotland (2017), found in Cerrado, and recognized as a synonym of *I. asplundii* O'Donnell by Simão-Bianchini *et al.* (2020a), occurring also in the states of Pará, Goiás and Mato Grosso.

The state of Maranhão has an extension of 331,937 km² (IMESC, 2008; IBGE, 2014) and is the only one in Northeast Brazil with areas of Amazon Forest. The state is geographically located in a transition zone between the Amazon (34.78%) and Cerrado (64.09%) – allowing the coexistence of species mainly from these two phytogeographic domains – and a small portion of Caatinga (1.13%) (Muniz, 2011; Civil, & Interinstitucional, 2011).

According to the taxonomic treatment of Convolvulaceae for the Flora do Brasil 2020 project (Simão-Bianchini *et al.* 2020a), 78 species are currently recognized for Maranhão. Floristic novelties for the family were recently published by Lourenço *et al.* (2020), who recorded the first occurrence of *Daustinia montana* (Morici.) Buriel and Simões in Maranhão, and Santos, Saraiva, Ferraz, Arruda, and Buriel (2020) who described *Ipomoea maranhensis* Santos and Buriel, endemic to the Cerrado of Maranhão, showing the floristic potential that the family has in the state.

Some regions of Maranhão have their flora still undersampled, as is the case of Upper Turi-Gurupi region in the western portion of the state. With an area of 25,605.93 km²,

this region comprises 18 municipalities and has potential for logging, fishing, agriculture, livestock, tourism and ecotourism activities, besides beekeeping and plant extraction (SEPLAN, 2008). It is also a strategic conservation area in the Amazon domain, with high floristic potential mainly because the Turiaçu River basin and the Gurupi Biological Reserve are within its territory. The Turiaçu River basin is the third largest in the Amazon, with a perimeter of 938.8km and an area of 14,394 km², corresponding to 12.7% of the total territory of this domain (Correia Filho, Gomes, Nunes, & Lopes Filho, 2011; Catunda, & Dias, 2019).

Deforestation and uncontrolled fragmentation in the Amazon of the state of Maranhão reach alarming rates: the original forest cover decreased from 25% (24,700 km²) in 2016 to 24% (23,967 km²) in 2019. This means that the remaining 6,038 km² of forest have been degraded by fires and/or illegal logging and present no core areas (outside legally protected areas) with the minimum size to ensure sustainable management practices (Silva-Junior *et al.*, 2020).

The objective of this study was to elaborate a synopsis of the Convolvulaceae species occurring in the Upper Turi-Gurupi region compiled through field sampling and analysis of materials previously collected in the area. Our goal is to investigate the floristic diversity of the family, contribute to the increase of botanical knowledge of the area and the state of Maranhão, and fill gaps in the floristic data of the Brazilian Amazon.

Materials and Methods

Collections were carried out in three forest fragments in the municipalities of Zé Doca, Nova Olinda and Centro Novo do Maranhão, within the Upper Turi-Gurupi region (Figure 1).

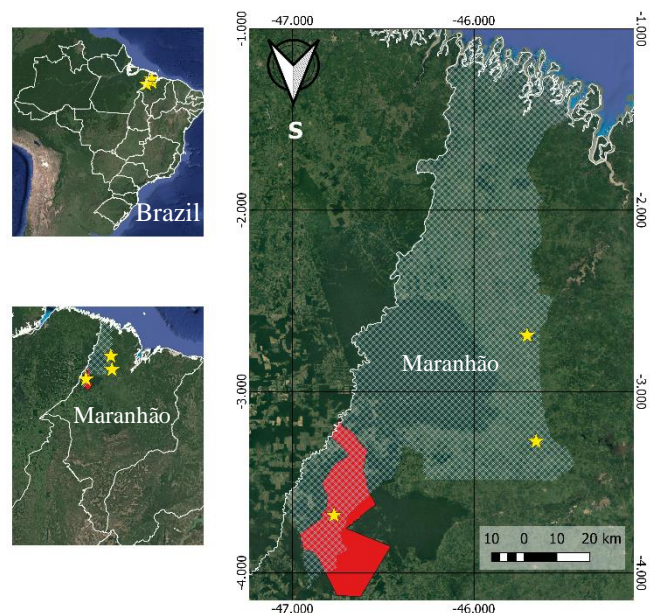


Figure 1. Location map of the Upper Turi-Gurupi region in the Amazon region of Maranhão, Brazil. Legend: Yellow star: collection locations; white: Upper Turi-Gurupi region and red: Gurupi Biological Reserve. Organization: Silva, G.S. 2022. Datum: SIRGAS 2000. Projection: Lat/long.

These municipalities have 2,138.981 km², 2,451.367 km² and 8.482,342 km², respectively, of Amazon Forest, corresponding to 9.4% of the total area of this biome in the state (Catunda, & Dias, 2019). Collections in Centro Novo do Maranhão were made within the Gurupi Biological Reserve, an integral protection conservation unit.

Seven field trips were held from May 2019 to October 2021. The random walking method (Filgueiras, Nogueira, Brochado and Guala II, 1994) was used in order to cover most of the phytophysionomies. Populations in the field were photographed and geographic coordinates and information on the habitat were recorded. The botanical materials of each species were herborized and deposited in the collection of the Prof. Aluísio Bittencourt Herbarium (HABIT) from the Center for Higher Studies of Caxias (CESC/UEMA) and the João Murça Pires Herbarium (MG) from the Emílio Goeldi Museum of Pará (MPEG).

In addition to the samples collected in the field, the herbaria PEUFR, INPA, IAN, MAR, MG, NY, P and RB (acronyms according to Thiers, 2021), which have collections from the study area, were also consulted. The herbaria SP and MO were consulted, but no records of collections for the study

area were found. The accepted names and their correct authorities are in accordance with IPNI (2021) and Flora do Brasil (2020). Data on growth habits, geographic distribution, occurrence in Brazilian phytogeographic domains, and taxa endemic to Brazil based on data from Flora do Brasil (2020) are provided, as well as an identification key for the species. The distribution of taxa in the Upper Turi-Gurupi region was prepared based on geographic information obtained from the collections, noted in the labels of the studied specimens, and maps were generated in the Quantum GIS 3.6 software (Qgis, 2015).

Results and Discussion

Fourty-two specimens of 21 species distributed in nine genera (*Aniseia* Choisy, *Bonamia* Thouars, *Camonea* Raf., *Distimake* Raf., *Evolvulus* L., *Ipomoea* L., *Maripa* Aubl., *Odonellia* K. R. Robertson, *Operculina* Silva Manso) of Convolvulaceae were recorded. *Ipomoea* was the richest genus, with 10 species (Figure 2) followed by *Distimake*, *Evolvulus* and *Maripa* with two species each; the other genera had only one species (Figure 3). *Maripa scandens* Aubl. is a new record for the state of Maranhão.

Key to genera of Convolvulaceae from the Upper Turi-Gurupi region

1. Woody climbers (lianas); leaves coriaceous; fruits indehiscent 7. *Maripa*
1. Herbaceous climbers, subwoody climbers, erect herbs or decumbent herbs; leaves chartaceous; fruits dehiscent.
 2. Erect herbs with ascending or decumbent stem, stem never twiner; corolla blue, < 1 cm long; stigma filiform..... 5. *Evolvulus*
 2. Herbaceous or subwoody climbers (decumbent herbs in *Ipomoea asarifolia* and *I. batatas*); corolla pink, white, yellow or red, ≥ 2 cm long; stigma globose.
 3. Corolla pink or red, occasionally white in some individuals or flowers, pollen with spiny exine..... 6. *Ipomoea*
 3. Corolla yellow or white, pollen rugose or spinulose.
 4. Leaves compound, leaflets 5..... 4. *Distimake*
 4. Leaves simple.
 5. Corolla yellow; anthers spirally twisted after anthesis.
 6. Stems and peduncles alate, lacking auricles; fruits operculate capsule..... 9. *Operculina*
 6. Stems smooth, with two paired auricles at nodes; fruits 4-valved capsule..... 3. *Camonea*
 5. Corolla white, anthers straight after anthesis.
 7. Style bifid; fruits 8-valved capsule 2. *Bonamia*
 7. Style entire; fruits 4-valved capsule.
 8. Leaves linear to narrow-elliptical; outer sepals foliaceous, bigger than the inner ones, base subcordate 1. *Aniseia*
 8. Leaves ovate; sepals not foliaceous, unequal, base rounded to truncate.. 8. *Odonellia*

1. *Aniseia* Choisy

Aniseia is represented by herbaceous vines with simple trichomes, entire leaves, commonly with a wedged to attenuate base, axillary summits with up to three flowers, and unequal sepals, the outer one being much bigger and foliaceous (Simão-Bianchini, Ferreira, & Delgado-Junior, 2020). Three species are currently recognized to comprise the genus, but other 30 names have already been considered and then segregated to

other genera (Athiê-Souza, Staples, Zickel & Buriel, 2017). Recently, the genus *Iseia* O'Donell was included in *Aniseia* and *Aniseia martinicensis* var. *ambigua* Hallier f. and *A. cernua* Moric. recognized as synonyms of *A. martinicensis* (Athiê-Souza *et al.*, 2017). However, these changes are not well accepted by some authors and, in Brazil, the three species - *A. martinicensis*, *A. cernua*, and *Iseia luxurians* (Moric.) O'Donell - are recognized, observed in fields or forest edges (Simão-Bianchini *et al.*, 2020c). Here we

recognize *A. cernua* as synonym of *A. martinecensis*. In Maranhão and in the Brazilian Amazon, *Aniseia* is represented by one species (Athiê-Souza, Staples, Zickel, & Buril, 2017).

1.1 *Aniseia martinicensis* (Jacq.) Choisy

Habit: Herbaceous climber, twiner.

Distribution: Throughout the tropics, usually along waterways; Mexico, West Indies, Central America, and South America (Austin, 1999; Athiê-Souza *et al.*, 2017). The species is widely distributed in Brazil (except in the South Region), in the phytogeographic domains of the Amazon, Caatinga, Cerrado, Atlantic Forest, and Pantanal (Simão-Bianchini *et al.*, 2020c).

Specimens examined: *Jangoux, I.J.* 832 (UFRPE), 1022 (INPA).

2. *Bonamia* Thouars

Bonamia is represented by subshrubs, herbs or climbers with axillary or less common terminal inflorescences, white or pink corolla, two free or half fused styles, terminal globose stigmas, dehiscent fruits, mostly opening by 4 to 8 valves (Moreira, Simão-Bianchini, & Cavalcanti 2019; Moreira, & Simão-Bianchini, 2020). *Bonamia* occurs throughout the Americas, Africa, Madagascar, Southeast Asia, and Australia, with approximately 65 species (Myint, & Ward, 1968; Moreira *et al.*, 2019). In Brazil, there are 16 species, 10 of which are endemic to the country. Five species are recorded in the Brazilian Amazon, two in Maranhão (Moreira, & Simão-Bianchini, 2020), and one in the Upper Turi-Gurupi region.

2.1 *Bonamia maripoides* Hallier f.

Habit: Subwoody climber, twiner.

Distribution: *Bonamia maripoides* is known in the Guianas, Venezuela and Brazil (Austin, & Cavalcante, 1982). In Brazil, it occurs in the North, Northeast and Southeast regions and in the phytogeographic domains of the Amazon and Atlantic Forest (Moreira, & Simão-Bianchini, 2020).

Specimens examined: *Fróes, R.L.* 34498 (IAN)

3. *Camonea* Raf.

Camonea is represented by climbing or prostrate herbs with two paired auricles at base of the petioles, yellow or cream corollas, glabrous midpetaline bands, generally spirally twisted anthers, single styles, biglobed stigmas, and 4-valved capsules (Simões, & Staples, 2017; Simão-Bianchini, Petrongari, & Simões, 2020). *Camonea* is centered in tropical Asia with one species (*C. umbellata*) widespread in tropical America and Africa (Simões, & Staples, 2017). Five species are described worldwide and only one is reported for Brazil, which has been found in Maranhão (Simões, & Staples, 2017; Simão-Bianchini *et al.*, 2020d), and in the present survey in the Upper Turi-Gurupi region.

3.1 *Camonea umbellata* (L.) A.R. Simões & Staples (Fig. 3M)

Habit: Herbaceous climber, twiner.

Distribution: Widely distributed in the Americas and Asia

(Simões, & Staples, 2017). In Brazil, it is found throughout the country, in all phytogeographic domains except Pampa (Simão-Bianchini *et al.*, 2020d).

Specimens examined: *Nascimento, J.S.* 2 (HABIT).

4. *Distimake* Raf.

Distimake is characterized by climbing, rarely erect or prostrate subshrubby habit, simple or compound leaves, white or yellow entirely glabrous corollas, stamens with twisted anthers after anthesis, entire styles, globose stigmas, and generally 4-valved capsules with greatly accrescent calyx (Simões, & Staples, 2017). *Distimake* is widespread in tropical America and tropical Africa, with disjunct species in Asia and northern Australia (Simões, & Staples, 2017). In Brazil, there are 18 species, nine of which are endemic (Petrongari, & Simões, 2020). Five species are reported for the Brazilian Amazon and four for Maranhão (Petrongari, & Simões, 2020). Two species were found in the the Upper Turi-Gurupi region.

Key to species of *Distimake* from the Upper Turi-Gurupi region

1. Plants hirsute; corolla < 3 cm long.....4.1 *Distimake aegyptius*
1. Plants glabrous to pubescent; corolla > 3.5 cm long4.2 *Distimake macrocalyx*

4.1 *Distimake aegyptius* (L.) A.R. Simões & Staples (Fig. 3J)

Habit: Herbaceous climber, twiner.

Distribution: Widely distributed in the Tropics of the world (O'Donell, 1941; Austin, & Cavalcante, 1982). In Brazil, it is found throughout the country and all phytogeographic domains, except in the South and in Pampa (Petrongari & Simões, 2020).

Specimens examined: *Nascimento, J.S.* 6, 8, 14 (HABIT)

4.2 *Distimake macrocalyx* (Ruiz & Pav.) A.R. Simões & Staples (Fig. 3I.)

Habit: Subwoody climber, twiner.

Distribution: It occurs from the Guianas to Argentina (O'Donell, 1941; Simão-Bianchini *et al.*, 2016), and it is widely distributed in Brazil, in all regions and phytogeographic domains except Pampa (Petrongari, & Simões, 2020).

Specimens examined: *Jangoux, I.J.* 113 (P); *Nascimento, J.S.* 16 (HABIT); *Rosa, N.A.* 2902 (MG).

5. *Evolvulus* L.

Evolvulus is characterized by prostrate or erect herbaceous or subshrubby habit, malpighiaceus trichomes, simple leaves, blue or white corollas, two free or partially united styles, two filiform stigmas, and 4-valved capsules (Ooststroom, 1934; Simão-Bianchini, & Silva, 2020).



Figure 2. Diversity of Convolvulaceae collected in the Upper Turi-Gurupi region. A and B. *Ipomoea asarifolia*; C and D. *Ipomoea carnea* subsp. *fistulosa*; E and F. *Ipomoea ramosissima*; G and H. *Ipomoea bahiensis*; I and J. *Ipomoea quamoclit*; K and L. *Ipomoea batatas*; M and N. *Ipomoea acanthocarpa*. O and P. *Odonellia hirtiflora*; Q and R. *Distimake macrocalyx*; S and T. *Distimake aegyptius*; U and V. *Evolvulus alsinoides*; W and X. *Evolvulus glomeratus*; Y and Z. *Camonea umbellata*; AI and BI. *Operculina hamiltonii*. Photos: Authors.

Evolvulus includes about 100 species distributed predominantly in the Americas, with two pantropical species (Ooststroom, 1934; Santos, & Buriel, 2020). In Brazil, 72 species are recognized, including 49 endemic to the country. Eleven species are reported for the Brazilian Amazon, 15 for Maranhão (Simão-Bianchini, & Silva, 2020), and two for the Upper Turi-Gurupi region.

Key to species of *Evolvulus* from the Upper Turi-Gurupi region

1. Leaves lanceolate, apex acute; inflorescence axillary, peduncle long; corolla rotate.....5.1 *Evolvulus alsinoides*
1. Leaves oblong to elliptical, apex rounded; inflorescence terminal, sessile; corolla hypocrateriform.....5.2 *Evolvulus glomeratus*

5.1 *Evolvulus alsinoides* (L.) L. Fig. 3K.

Habit: Erect herb with virgate stem.

Distribution: The species has a pantropical distribution and it is cultivated in almost all continents (Ooststroom, 1934). In Brazil, it occurs in all regions (except in the South) and in the Amazon and Cerrado phytogeographic domains (Simão-Bianchini, & Silva, 2020).

Specimens examined: *Nascimento, J.S. 3* (HABIT)

5.2 *Evolvulus glomeratus* Nees & Mart. Fig. 3L.

Habit: Erect to decumbent herb.

Distribution: From the Guianas to Argentina (Ooststroom, 1934; Santos, & Buriel, 2020). In Brazil, it occurs in all regions and phytogeographic domains (Simão-Bianchini, & Silva, 2020).

Specimens examined: *Nascimento, J.S. 18* (HABIT)

6. *Ipomoea* L.

Ipomoea includes mainly climbers, herbs or subshrubs, rarely shrubs or trees, with generally simple trichomes, simple or compound leaves, corollas with varied colors, entire styles, usually two globose stigmas, pantoporate pollen with spinous exine, and generally 4-valved capsules (Wood, Muñoz-Rodríguez, Williams, & Scotland, 2020). *Ipomoea* has 650 to 900 species widely distributed in the tropics and subtropics (Eserman *et al.*, 2020). It is the largest and most important genus of Convolvulaceae recorded for Brazil, with 159 species (63 endemics to the country) occurring in all regions and phytogeographic domains (Simão-Bianchini, Ferreira, & Vasconcelos, 2020). Fifty-three species are reported for the Brazilian Amazon, 40 for Maranhão (Simão-Bianchini *et al.*, 2020b), and 10 for the Upper Turi-Gurupi region.

Key to species of *Ipomoea* from the Upper Turi-Gurupi region

1. Sepals rostrate; corolla hypocrateriform, red; stamens exerted.
 2. Leaves pinnatisect *Ipomoea quamoclit*
 2. Leaves entire, ovate *Ipomoea hederifolia*
1. Sepals lacking rostrum; corolla infundibulliform-campanulate, pink; stamens inserted.
 3. Shrubs; leaves lanceolate *Ipomoea carnea* subsp. *fistulosa*
 3. Stem twiners or decumbent herbs; leaves ovate, reniform, suborbiculate to 3-5-lobate.
 4. Leaves reniform to suborbiculate; sepal unequal, outer shorter than inner *Ipomoea asarifolia*
 4. Leaves ovate; sepal equal to subequal.
 5. Subwoody climbers (stem woody at the base); sepals concave, coriaceous *Ipomoea goyazensis*
 5. Herbaceous climbers or decumbent herbs; sepals flat, carthaceous.
 6. Corolla pink with white tube; sepals with hirsute base *Ipomoea purpurea*
 6. Corolla entirely pink or with darker tube; sepals glabrous or only ciliate
 7. Sepals with a prominent appendage near the apex.....*Ipomoea bahiensis*
 7. Sepals lacking a prominent appendage.
 8. Decumbent herbs; leaves entire to 3-5-7-lobate; sepals with acute apex..... *Ipomoea batatas*
 8. Climbing twiners; leaves generally entire or shallowly 3-lobate; sepals with obtuse to rounded apex
 9. Corolla > 5 cm long; sepals muricate, margin hyaline..... *Ipomoea acanthocarpa*
 9. Corolla < 2.5 cm long; sepals smooth, margin dim *Ipomoea ramosissima*

6.1 *Ipomoea acanthocarpa* (Choisy) Aschers., & Schweinf.

Habit: Herbaceous climber, twiner.

Distribution: Bolivia, Peru, Colombia, Guyana, and Brazil (Wood *et al.*, 2020). In Brazil, it occurs the North and Northeast regions, in the Amazon, Caatinga and Atlantic Forest (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Nascimento, J.S. 11* (HABIT).

6.2 *Ipomoea asarifolia* (Desr.) Roem., & Schult Fig. 3A and 3B

Habit: Decumbent herb.

Distribution: *Ipomoea asarifolia* has a Pantropical distribution and is common in altered areas (Austin, & Cavalcante, 1982; Wood *et al.*, 2020). In Brazil, it is widely distributed in the North and Northeast regions, in the Amazon, Caatinga and Atlantic Forest (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Nascimento*, J.S. 4, 5, 7, 15 (HABIT); *Pastore*, M. 1500 (MG); *Rosa*, N.A. 2881 (NY); *Silva*, W.C. 96 (MAR).

6.3 *Ipomoea bahiensis* Willd. ex Roem., & Schult. Fig. 3E

Habit: Herbaceous climber, twiner.

Distribution: It is distributed only in Bolivia and Brazil (Wood *et al.*, 2020). In Brazil, it is widely distributed in all regions (except the South), in open fields and altered areas of the Amazon, Cerrado, Caatinga, and Atlantic Forest (Simão-Bianchini *et al.* 2020b).

Specimens examined: *Nascimento*, J.S. 10 (HABIT); *Pastore*, M. 1491, 1519 (MG).

6.4 *Ipomoea batatas* (L.) Lam. Fig. 3G.

Habit: Decumbent herb.

Distribution: Pantropical species widely cultivated for food use (Austin, & Cavalcante, 1982). In Brazil, it is distributed in all regions and phytogeographic domains (Simão-Bianchini *et al.* 2020b).

Specimens examined: *Balée*, W.L. 3482 (NY); *Nascimento*, J.S. 12 (HABIT).

6.5 *Ipomoea carnea* subsp. *fistulosa* (Mart. ex Choisy) D.F.Austin Fig. 3C.

Habit: Erect shrub.

Distribution: Probably native to eastern Bolivia, northern Argentina, eastern Paraguay and southern Brazil, widely cultivated and naturalized from the United States to Argentina (Austin, 1977; Wood *et al.*, 2020). In Brazil, it is distributed in all regions and phytogeographic domains (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Nascimento*, J.S. 1, 17 (HABIT).

6.6 *Ipomoea goyazensis* Gardner

Habit: Subwoody climber, twiner.

Distribution: Restricted to Bolivia and Brazil (Wood *et al.*, 2020). In Brazil, it occurs in all regions, in the phytogeographic domains of the Amazon, Cerrado and Atlantic Forest (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Jangoux*, I.J. 674 (NY).

6.7 *Ipomoea hederifolia* L.

Habit: Herbaceous climbers.

Distribution: Native to tropical America, occurring from the south of the United States to Argentina, being widely cultivated as an ornamental plant worldwide (Wood *et al.*, 2020). In Brazil, it occurs in all regions and phytogeographic domains, frequent along roadsides and as a ruderal species (Simão-

Bianchini *et al.*, 2020b).

Specimens examined: *Fróes*, R.L. 1847 (NY)

6.8 *Ipomoea purpurea* (L.) Roth

Habit: Herbaceous climbers.

Distribution: Pantropical, widely cultivated (Wood *et al.*, 2020). In Brazil, it occurs in all regions and phytogeographic domains (except in the Pantanal) (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Fróes*, R.L. 34043 (IAN)

6.9 *Ipomoea quamoclit* L. Fig. 3F.

Habit: Herbaceous climber, twiner.

Distribution: Pantropical, widely cultivated as an ornamental plant (Austin, & Cavalcante, 1982; Austin, & Huáman, 1996). In Brazil, it occurs in all regions and phytogeographic domains (except in the Pantanal) (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Jangoux*, I.J. 408 (RB); *Nascimento*, J.S. 19 (HABIT).

6.10 *Ipomoea ramosissima* (Poir.) Choisy Fig. 3D.

Habit: Herbaceous climber, twiner.

Distribution: It occurs throughout tropical America, in sandbanks, forest edges, pastures, cultivated fields, and vacant lots (Wood *et al.*, 2020). In Brazil, it occurs in all regions and phytogeographic domains (except in the Pantanal) (Simão-Bianchini *et al.*, 2020b).

Specimens examined: *Nascimento*, J.S. 13 (HABIT).

7. *Maripa* Aubl.

Maripa is represented by lianas reaching up to 40 m in height, with simple, generally coriaceous leaves, white, pink or purple corolla, simple or less frequently bifid style, globose stigma, and indehiscent and ligneous fruits (Austin, 1973; Pastore, 2020). This genus includes 20 species with distribution from Central America to northern South America, predominately in the Amazon Forest (Austin, 1973). Twelve species are recognized in Brazil, found in the North, part of the Midwest and the Northeast regions, in the Amazon and less frequently in Cerrado. Two species were reported for Maranhão (Pastore, 2020), and of the two species found in the Upper Turi-Gurupi region, one is a new record for Maranhão, thus raising to three the number of species known from the state.

Key to species of *Maripa* from the Upper Turi-Gurupi region

1. Outer sepals sparsely lepidote to glabrous, ciliate; fruits < 1.4 mm long, sepal loosely adpressed to the base of the fruit *Maripa glabra*
1. Outer sepals sericeous; fruits > 1.4 mm long, sepal adpressed to the base of the fruit *Maripa scandens*

7.1 *Maripa glabra* Choisy

Habit: Woody climber (liana), twiner.

Distribution: Suriname, French Guiana and Brazil (Austin, & Cavalcante, 1982). In Brazil, it occurs in the North and Northeast, restricted to the state of Maranhão in the latter, and it is an exclusively Amazonian species (Pastore, 2020). In Maranhão, *M. glabra* is known from only two samples collected in the Upper Turi-Gurupi region in 1978 and 1985.

Specimens examined: *Balée, W.L. 1070* (UFRPE); *Rosa, N.A. 2737* (NY)

7.2 *Maripa scandens* Aubl.

Habit: Woody climber (liana), twiner.

Distribution: Venezuela, Guyana, French Guiana, and Brazil (Austin, & Cavalcante, 1982). In Brazil, it is recorded in the North and only in the state Mato Grosso in the Midwest, and it is an exclusively Amazonian species (Pastore, 2020). In this study, *M. scandens* is a new record for the state of Maranhão.

Specimens examined: *Pastore, M. 1499* (MG)

8. *Odonellia* K. R. Robertson

Odonellia is characterized by climbing habit, simple trichomes, simple leaves, glomeruliform or capituliform inflorescences, white corollas, sericeous midpetaline bands, entire style, globose stigma, and 4-valved capsules (Robertson, 1982). *Odonellia* has only two species, one of which is restricted to the Brazilian territory and the other is widely distributed from southern Mexico to northern South America (Robertson, 1982; Austin, & Cavalcante, 1982). Both species occur in Brazil and only one was registered for Maranhão by Simão-Bianchini (2020) and was found in the Upper Turi-Gurupi region in the present study.

8.1 *Odonellia hirtiflora* (M.Martens & Galeotti) K.R.Robertson Fig. 3H.

Habit: Subwoody climber, twiner.

Distribution: *Odonellia hirtiflora* is fairly widespread in tropical America, occurring from southern Mexico through Central America to Colombia, Venezuela, Peru, and Brazil (Robertson, 1982; Austin, & Cavalcante, 1982). In Brazil, the species occurs only in the Amazon and Cerrado (Simão-Bianchini, 2020).

Specimens examined: *Jangoux, I.J. 868* (RB)

9. *Operculina* Silva Manso

Operculina is characterized by climbing habit, angular or grooved usually winged petioles and pedicles, simple (entire or lobbed) or rarely compound leaves, sepals usually accrescent in fruit, white, yellow or reddened corollas with usually pubescent midpetaline bands, spirally twisted anthers after anthesis, entire styles, globose stigmas, and operculate capsules (Staples, Simões, & Austin, 2020). *Operculina* is distributed throughout the tropics of the world (Staples *et al.*, 2020). Four species occur in Brazil, three in the Brazilian Amazon, and two in Maranhão (Simões, & Petrongari, 2020). In the Upper Turi-Gurupi region, it is represented by one

species.

9.1 *Operculina hamiltonii* (G. Don) D.F. Austin, & Staples. Fig. 3N

Habit: Herbaceous climber, twiner.

Distribution: Southern Mexico, Central and South America (Staples *et al.*, 2020). In Brazil, it occurs in all regions, except in the South, and in all phytogeographic domains, except Pampa (Simões, & Petrongari, 2020).

Specimens examined: *Balick, M.J. 1983* (RB); *Fróes, R.L. 1764* (UFRPE); *Jangoux, I.J. 958* (RB); *Nascimento, J.S. 9* (HABIT); *Rosa, N.A. 2565* (RB).

The great diversity of *Ipomoea* in the present study is due to the wide distribution and high richness of this genus – the largest of Convolvulaceae – in the tropics and subtropics (Eserman *et al.*, 2020). Conceição, Silva, and Rodrigues (2014) also indicated *Ipomoea* as the most representative genus in a survey of Convolvulaceae from a Cerrado fragment in Maranhão, demonstrating that the genus is diverse in the state.

In the Upper Turi-Gurupi region, *I. asarifolia* had the largest number (16%) of specimens in the survey. This species has a Pantropical distribution (Austin, & Cavalcante, 1982; Wood *et al.*, 2020) and is common in altered areas. It was collected in large populations during this study, and presented a decumbent growth habit and large and showy flowers, often with intense pink-colored corollas (Figure 2A and B) and, less frequently, white corollas.

Color variation of the corollas from pink or lilac to white has been observed in some species of Convolvulaceae (Simão-Bianchini *et al.*, 2016; Wood *et al.*, 2020). Colors may vary even within the same individual. The color of the corolla is an important visual cue to attract pollinators, and variable color patterns can influence the frequency of visitation (Paz, 2011). It is also a key strategy when the species occur in environments with few floral visitors that act as potential pollinators or where pollination can be uncertain or occasional, such as in anthropized areas (Paz, 2011), as it is the case of environments where *I. asarifolia* occurs.

Most species found in this study have pink- to lilac-colored corollas with nectar guides, landing platforms, and nectariferous discs at the base of the ovary. Based on these attributes, these species can be classified as mellitophilous (Faegri, & van der Pijl, 1979). On the other hand, *I. hederifolia* and *I. quamoclit*, also included in this study, present red-colored hypocrateriform corollas, indicating pollination by hummingbirds (Streisfeld, & Rausher, 2009).

Most of the recorded species (15 spp.) have climbing habit, growing on plants, fences and other supporting structures, with Herbaceous, subwoody or woody branches. Only *M. glabra* and *M. scandens* have woody branches throughout their length, being lianas of larger size. Regarding the climbing mechanism, the voluble habit was found in the species studied here, bearing in mind that the climbing habit and the voluble mechanism are predominant in the family (Austin, 2015). The branches that wrap around

a supporting structure normally present unidirectional growth (Hegarty, 1991; Vargas, Araújo, Schiavini, Rosa, & Hattori, 2013) and in the case of Convolvulaceae, the voluble branches are sinistrorse (Simão-Bianchini, & Pirani, 1997).

The other types of habits found in the species in this study were decumbent herb in *I. asarifolia*, *I. batatas*, and *E. glomeratus*; erect herb with decumbent branches in *E. alsinoides*; and erect shrub in *I. carnea* subsp. *fistulosa*.

Regarding the distribution of collections and species in the Upper Turi-Gurupi region, it is clear that despite the contribution of the present study, systematic collections of Convolvulaceae are still needed because much of the area remains unexplored (Figure 4).

Maripa scandens, found in this survey, is a new record for

the state of Maranhão, and an important addition to the Amazonian flora of the state. Some species of *Maripa* are probably still undocumented in the state of Maranhão due to undersampling in Amazon Forest areas. In relation to the taxonomic treatment of Convolvulaceae in the Brazilian Amazon of Austin and Cavalcante (1982), 10 species are new records for Maranhão: *Distimake aegyptius*, *Evolvulus alsinoides*, *E. glomeratus*, *Ipomoea acanthocarpa*, *I. bahiensis*, *I. batatas*, *I. quamoclit*, *I. ramosissima*, *Maripa glabra*, and *M. scandens*. This is especially relevant in view of the current alterations in plant composition caused by climate change (Esquivel-Muelbert *et al.*, 2018) and anthropization processes such as deforestation and fires (Ferrante, & Fearnside, 2019) in the Amazon Forest of Maranhão.

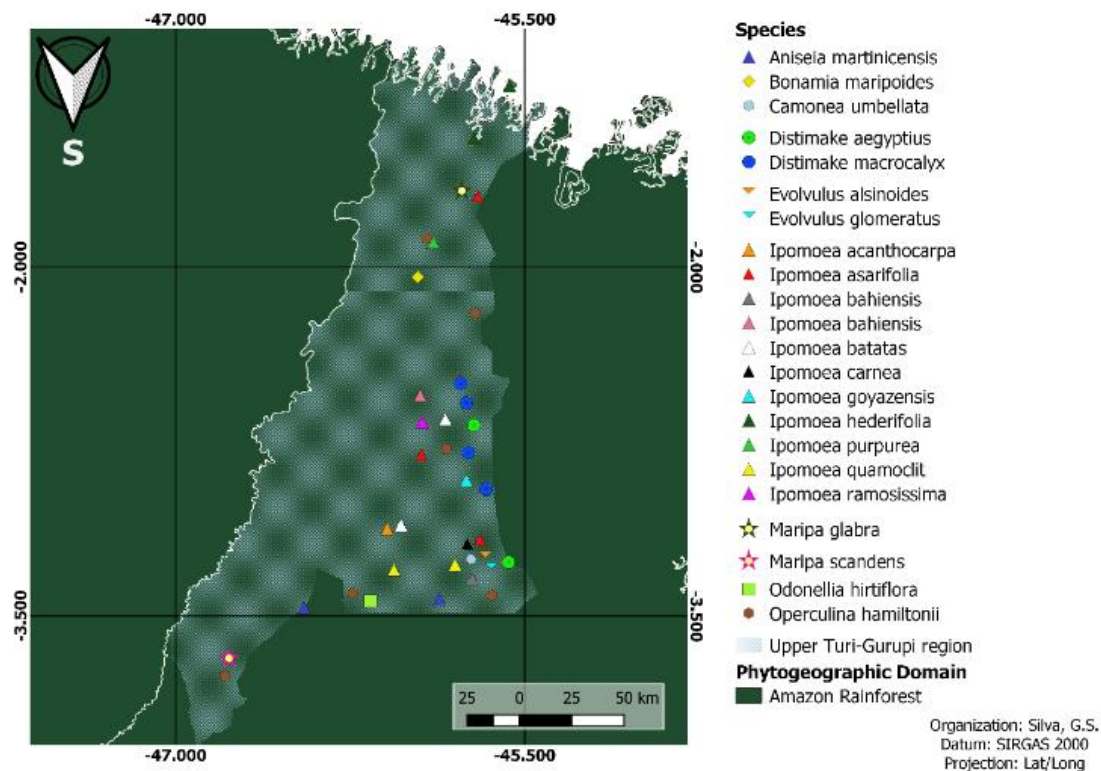


Figure 4. Distribution of collections of Convolvulaceae in the Upper Turi-Gurupi region. Organization: Silva, G.S. 2022. Datum: SIRGAS 2000. Projection: Lat/long.

The number of collections and cataloged species reflects the few floristic studies conducted in the area over time. It is a consensus among researchers that the diversity of plants in the Amazon is undersampled: the current sampling density corresponds to ten collections per 100 km². There is, therefore, a void of information resulting from lack of collections and a shortage of taxonomists in certain botanical groups (Maldonado *et al.*, 2015).

The little investment in collections in the Upper Turi-Gurupi region is a reflection of the low number of fragments suitable for botanical excursions, taking into account that only 17.6% of the total area of Amazon Forest in Maranhão lies within protected areas. These protected areas are two conservation units – the Baixada Maranhense Environmental

Preservation Area and the Gurupi Biological Reserve (Silva, Rylands, & Fonseca, 2005; Almeida, & Vieira, 2010) – and the Indigenous Lands integrating the so-called “Gurupi Mosaic” (Silva Junior *et al.*, 2020). Despite being an integral protection conservation unit and one of the last protected remnants of Amazon Forest in the state of Maranhão, the Gurupi Biological Reserve has only 23% of primary forest preserved (Silva *et al.*, 2005; Almeida, & Vieira, 2010). The vegetation in these legally protected areas is also degraded by fires and illegal logging, which had high rates registered between 2007 and 2019 (Silva Junior *et al.*, 2020).

It is important to emphasize that the species were collected in Amazon Forest fragments that are under strong anthropogenic pressure, mainly due to deforestation, fires

and agricultural activities. Such activities reduce the size of these fragments and affect the preservation of plant species. The fact that most species of Convolvulaceae sampled here are common in altered areas corroborate that a large part of the study area undergoes the impacts of deforestation and many fragments present anthropogenic influences and pioneer vegetation (Barbosa *et al.*, 2007; Vital, 2009).

Conclusion

The results presented here contribute to increase the knowledge about the distribution and floristic diversity of Convolvulaceae in the Amazon region of Maranhão, since most of the studies published so far in the Northeast of Brazil were conducted in Caatinga and in the semiarid region. The record of a new Amazonian species for Maranhão in this survey and the observed sampling gap indicate that new records may still be documented and new species to science may still be described, highlighting the importance of this area for conservation. Moreover, the identification key and data about local species provided in the present study support future technical work for conservation and land use policies. The data obtained here encourage the conservation of the Amazonian flora of Maranhão since this area is under strong risk of environmental degradation and is one of the most threatened in terms of biodiversity loss in the Amazon domain, with continued devastation even within protected areas.

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