AQUATIC AND PALUSTRINE ANGIOSPERMS OF VIRUÁ NATIONAL PARK, BRAZILIAN AMAZON—NYMPHAEALES, ALISMATALES, DIOSCOREALES, AND ARECALES

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Abstract. The Viruá National Park (VNP) with its different plant formations (rainforest, white-sand savannas—"campinaranas," and "buritizais") is located in a region still lacking in botanical studies (Guiana Shield and Brazilian Amazon). Aiming to improve the knowledge of the region's flora, collections were conducted in VNP from 2010 to 2015. The present work provides a taxonomic treatment of the aquatic and palustrine members of Nymphaeales, Alismatales, Dioscoreales, and Arecales. It includes identification keys to species, as well as descriptions, illustrations, and comments on taxonomy, ecology and geographical distribution. A dichotomous key to all families with at least one aquatic or palustrine species found in VNP is also provided.

Keywords: Flora, Igapó; Guiana Shield, Macrophytes, Taxonomy

Resumo. O Parque Nacional do Viruá (VNP), com suas diferentes formações vegetais (floresta tropical, savanas de areia branca — campinaranas, e buritizais), está localizado em uma região ainda carente de estudos botânicos (Escudo das Guianas e Amazônia Brasileira). Com o objetivo de aprimorar o conhecimento sobre a flora da região, foram realizadas coletas no VNP de 2010 a 2015. O presente trabalho prove o tratamento taxonômico dos membros aquáticos e palustres de Nymphaeales, Alismatales, Dioscoreales e Arecales. São apresentadas chaves de identificação para espécies, bem como, descrições, ilustrações e comentários sobre taxonomia, ecologia e distribuição geográfica. Uma chave dicotômica para todas as famílias com pelo menos um representante aquático ou palustre encontrado no VNP também é apresentada.

Palavras-chave: Flora, Igapó, Escudo das Guianas, Macrófitas, Taxonomia

The Amazon covers about 7.590.000 km^2 distributed among eight countries of the northern region of South America. The Amazon Depression comprises the basins of the Amazon and Tocantins Rivers in the more central portion and on its borders comprises sub-Andean areas and Guiana and Brazilian Shields. (Eva et al., 2005).

The Guiana Shield has a varied topology, which includes sandstone tepuis, granite inselbergs, white sands, seasonally flooded tropical savannas, lowlands with numerous rivers, isolated mountain ranges, and coastal swamps, each supporting a characteristic vegetation (Huber, 1995; Huber et al., 1995). This variety accounts for a great deal of the high diversity and endemicity of the Shield's biota (Funk and Hollowell, 2007).

Located in the Brazilian portion of the Guiana Shield, the Viruá National Park (VNP) was object of a floristic survey, in which, we listed 207 species (distributed in 85 genera and in 37 families) of herbaceous and subshrubby aquatic and palustrine angiosperms (Costa et al., 2016).

The present work is the first of several other works to be published providing taxonomic treatments to the aquatic and palustrine taxa found in VNP. Here the families belonging to Nymphaeales (Cabombaceae and Nymphaeaceae), Alismatales (Alismataceae, Araceae and Hydrocharitaceae), Dioscoreales (Burmanniaceae) and Arecales (Arecaceae) are treated. We also provide a dichotomous key to all families in which at least one aquatic or palustrine species was found in VNP.

MATERIALS AND METHODS

Study Area

The Viruá National Park is located in the Caracaraí district, Roraima state, northern Brazil (01˚19'11"N, 61˚7'17"W DMS). The climate in the region is equatorial with the rainy season intercalated by a more or less short dry season, between October and March. This Conservation Unit presents igneous volcanic or metamorphic rocks in the hills and sandy soil of fluvial, aeolian or weathering sedimentary origin in the plains (Schaefer et al., 2009).

The VNP contains in its 227.011 ha different plant formations distributed in a mosaic (rainforest, white-sand savannas—"campinaranas," and "buritizais"—flooded areas dominated by *Mauritia* L. f. palms) (Gribel et al., 2009). The conservation unit has its western boundary at the Branco River, a line drawn a few kilometers from an abandoned fragment of the BR-174 road (known as "Estrada Perdida") as the northern and the eastern boundaries, and by the Anauá River in the southern limit (Schaefer et al., 2009).

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Collecting and Analyzing Data

We conducted expeditions in the Viruá National Park between February 2010 and January 2015. All plant formations in the VNP were sampled. The process of collecting and herborization followed Fidalgo and Bononi (1989); and only fertile individuals were sampled.

The collected materials are deposited in INPA herbarium. Duplicates were sent to UEC, UFP and UFRR (acronyms according to the Index Herbariorum: Thiers, continuously updated).

We identified the specimens through observation in nature; comparison with specimens deposited in K, INPA, MIRR, UEC and UFRR; consultation to original descriptions, revisions, regional floras and others specialized literature; whenever possible specialists were also consulted. We analyzed digital images of specimens deposited in K, F, MO, NY, P, and others *herbaria*, always taking into account the reliability of the identifications; with preference given to types, historical collections and specimens identified by specialists.

The families' classification followed APG IV (2016). We adapted the family and genera descriptions from specialized literature. Species descriptions and illustrations are based, predominantly, on the materials collected in VNP. When species' organ(s) was(were) not observed in VNP, its(their) description was(were) taken from literature and referenced. We based information on geographic distribution and species' authors on specialized literature, TROPICOS platform (last access june/2019) and Flora do Brasil 2020 (under construction). Comments on taxonomy and ecology considered field observations and specialized literature.

Results

Key to Aquatic and Palustrine Families of VNP

1a. Flowers achlamydeous, monochlamydeous or dichlamydeous and homochlamydeous 2
1b. Flowers dichlamydeous and heterochlamydous 10
2a. Perigone showy 3
2b. Perigone (when present) inconspicuous 7
3a. Leaves without sheath 4
3b. Leaves with sheath 5
4a. Amphibian herbs . . . . . Molluginaceae
4b. Submerged or floating herbs . . . . . Cabombaceae
5a. Palms . . . . . Arecaceae
5b. Herbs 6
6a. Floating or emergent herbs; leaves not equitant . . . . . Pontederiaceae
6b. Amphibian herbs; leaves equitant . . . . . Haemodoraceae
7a. Inflorescences of the spadix type . . . . . Araceae
7b. Inflorescences of another type 8
8a. Flowers grouped in heads . . . . . Eriocaulaceae
8b. Flowers grouped in spikelets 9
9a. Stems generally triangular; leaves spirally arranged, with a generally closed sheath . . . . . Cyperaceae
9b. Stems generally cylindrical or flattened; leaves distichous or rarely spirally arranged, with a generally open sheath . . . . . Poaceae
10a. Perianth 3-merous; leaves with sheath 11
10b. Perianth usually 4–5-merous (sometimes with less or more pieces); leaves without sheath 20
11a. Palms . . . . . Arecaceae
11b. Herbs 12
12a. Inflorescences capituliform 13
12b. Inflorescences of another type 15
13a. Anthers generally poricidal; base of leaves and inflorescences with mucilage . . . . . Rapateaceae
13b. Anthers dehiscing by slits; base of leaves and inflorescences without mucilage 14
14a. Heads generally whitish, rarely black; flowers with white or brown corollas . . . . . Eriocaulaceae
14b. Heads generally brown; flowers with yellow corolla . . . . . Xyridaceae
15a. Gynoecium dialycarpous . . . . . Alismataceae
15b. Gynoecium syncarpous 16
16a. Ovary superior 17
16b. Ovary inferior 18
17a. Leaves with conspicuously spiny margins . . . . . Bromeliaceae
17b. Leaves with non-spiny margins . . . . . Mayacaceae
18a. Androecium attached to the gynoecium forming a column . . . . . Orchidaceae
18b. Androecium and gynoecium free among themselves 19
19a. Submerged, floating or partially emerged herbs; leaves well developed, palmate or parallel veined . . . . . Hydrocharitaceae
19b. Palustrine herbs; leaves inconspicuous, 1-veined (rarely parallel veined), often scamiform . . . . . Burmanniaceae
20a. Flowers dialypetalous 21

20b. Flowers synpetalous 30
21a. Petals numerous, gradually becoming similar to stamens . . . . . Nymphaeaceae
21b. Petals 4–6, quite distinct from the stamens 22
22a. Flowers unisexual . . . . . Euphorbiaceae
22b. Flowers bisexual 23
23a. Ovary inferior 24
23b. Ovary superior 25
24a. Venation pinnate . . . . . Onagraceae
24b. Venation acrodromous . . . . . Melastomataceae
25a. Leaves compound . . . . . Fabaceae
25b. Leaves simple 26
26a. Stamens connate . . . . . Polygalaceae
26b. Stamens free 27
27a. Herbs with leaf indument formed by many glandular and sticky trichomes; insectivorous . . . . . Droseraceae
27b. Herbs, sub-shrubs or shrubs with leaf indument formed by non-glandular trichomes (if glandular, then non-sticky) or leaves glabrous; non-insectivorous 28
28a. Venation generally acrodromous; anthers falcate . . . . . Melastomataceae
28b. Venation pinnate; anthers other than falcate 29
29a. Leaves decussate or 3(4-)-whorled, rare partially alternate . . . . . Lythraceae
29b. Leaves alternate . . . . . Ochnaceae
30a. Unisexual flowers . . . . . Euphorbiaceae
30b. Bisexual flowers 31
31a. Plants with latex; stamens and stigmas fused (gynostegium) . . . . . Apocynaceae
31b. Plants without latex; stamens and stigmas free 32
32a. Flowers grouped in heads or glomerules 33
32b. Flowers grouped in racemes, spikes, panicles, etc 34
33a. Stipules interpeciolar, rarely absent or reduced to a line between leaves of the same node; fruit: capsule, schizocarp, or pyrene . . . . . Rubiaceae
33b. Stipules intrapeciolar; fruit: achene (cypsela) . . . . . Asteraceae
34a. Leaves compound . . . . . Fabaceae
34b. Leaves simple 35
35a. Ovary inferior . . . . . Rubiaceae
35b. Ovary superior 36
36a. Corolla bilabiate 37
36b. Corolla regular 40
37a. Herbs bearing utricles, or if utricles absent then leaves viscous . . . . . Lentibulariaceae
37b. Herbs without utricles and non-viscous leaves 38
38a. Inflorescences terminal, spiciform . . . . . Verbenaceae
38b. Inflorescences cymose, racemose or flowers solitary 39
39a. Stigma “thick”, bilobate . . . . . Plantaginaceae
39b. Stigma indistinct . . . . . Linderniaceae
40a. Petals’ lobes fimbriate . . . . . Menyanthaceae
40b. Petals’ lobes entire (not fimbriate) 41
41a. Aestivation contort . . . . . Gentianaceae
41b. Aestivation imbricate 42
42a. Stamens 3 . . . . . Plantaginaceae
42b. Stamens 4 . . . . . Linderniaceae

1. CABOMBACEAE Rich. ex A. Rich. (**Nymphaeales)**

Aquatic *herbs* with creeping rhizomes rooting in substrate, and elongate, submerged, distally floating. *Submerged leaves* (*Cabomba* Aubl. only) opposite or whorled, short-petiolate, palmatisect. *Floating leaves*, alternate, sometimes opposite, short- to long-petiolate, simple, narrowly to broadly elliptic, peltate or occasionally with a basal sinus, entire. *Flowers* solitary, axillary, from distal nodes, long-pedicellate, floating in water or emerged (occasionally submerged), bisexual, actinomorphic; sepals (2–)3, free or connate only at the base; petals (2–)3, free, with nectariferous auricles near base; stamens 3–6 (*Cabomba*) or 12–36 rarely more (*Brasenia* Schreb.); carpels 1–4 (*Cabomba*) or 4–18 (*Brasenia*), free; ovary superior, each tapering toward a short style, stigma spherical and terminal (*Cabomba*), elongate, decurrent (*Brasenia*); ovules 1–5, placentation laminar. *Fruits* indehiscent, similar to achene or follicle. *Seeds* operculate (adapted from Ørgaard, 1991; Wiersema, 1997).

Cabombaceae are practically cosmopolitan, with two genera and six species (Wiersema, 1997). In Brazil, the family is represented only by *Cabomba*, with five species (Pellegrini, 2020). In VNP two species were found.

KEY TO CABOMBACEAE SPECIES

1a. Flowers yellow; floating leaves elliptic to ovate . . . . . *Cabomba schwartzii*
1b. Flowers pink; floating leaves ensiform . . . . . *Cabomba furcata*

1.a. *Cabomba* Aubl.

Perennial, submerged or floating. *Rhizome* branched or not. *Submerged leaves* decussate or ternate; dissected di- or trichotomically into filiform segments. *Floating leaves* alternate, peltate; blade oval, elliptic, linear to sagittate, margin entire. *Flowers* usually axillary; sepals imbricate, persistent, petaloid, obtuse-obovate to oblong; petals imbricate, persistent, of the same colour as the sepals, unguiculate, obtuse, base auriculate, nectaries 2, yellow, inserted in auricles; stamens 3–6, anthers yellow, longitudinally dehiscing; carpels 1–4, ovules 1–5; style short, stigma capitate. *Fruits* ovoid with elongated apex. *Seeds* ellipsoid-globose to oval (adapted from Ørgaard 1991; Wiersema, 1997).

Cabomba occurs from the eastern United States to northern Argentina; five species are registered (Wiersema, 1997). In Brazil, the genus is distributed throughout the national territory and counts on five species (Pellegrini, 2020).

1.a.1. *Cabomba furcata* Schult. & Schult. f., Syst. Veg., ed. 15 bis [Roemer & Schultes] 7(2): 1379. 1830. Fig. 1A–C.

Herbs with length varying according to the height of water level. *Submerged leaves* green, reddish when young; blade sparsely to densely setose, reniform to circular in outline, 31.5–37.0 × 17.0–34.0 mm, 3–5-splitted at base, with linear segments, 2–3-splitted, the first divisions often trifurcated and three-dimensional, the terminal ones bifurcated, two-dimensional, segments 3.7–7.7 mm long, 2–4 mucronate; petiole 6.5–20.0 mm length. *Floating leaves* ensiform, slightly involute, 14.5–15.0 × 0.5–0.8 mm, green, margins vinaceous, adaxial surface glabrous, abaxial surface sparsely setulose, punctate-glandulose; petiole 22.5–25.5 mm long. *Flowers* 6.3 mm length; peduncle 40.5 mm long, reddish, setulose; petals and sepals punctate-glandulose, lilac to pinkish with yellow base; sepals 3, 6.5–7.0 × 2.5–3.0 mm, apex obtuse; petals 3, ca. 6.0 × 2.5 mm, apex obtuse; stamens 6, filaments 2.5–3.0 mm length, anthers ca. 1.0 mm length; pistils 3, botuliform, punctate-glandulose, ca. 3.0 mm, style ca. 1/4 of the length of the pistil, ovary unilocular, ovules 3–5, some may be aborted, stigma whitish, ciliate. *Fruits* thin walled. *Seeds* globose to ellipsoid, ca. 1.5 mm length, echinate.

The flowers of *C. furcata* emerge from water around 10:00 a.m. and submerge around 4:00 p.m. During this time, they were seen being visited by bees and flies. *Cabomba furcata* co-occurs with populations of *C. schwartzii* in VNP. The species forms dense population aggregates, although these are smaller than those of *C. schwartzii*.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, Parque Nacional do Viruá, 01°24'03"N, 60°59'10"W, 25 January 2011, *S. M. Costa 763 & K. G. Cangani* (INPA, UEC); idem, 01°24'51"N, 60°59'12"W, 20 July 2010, *T. D. M. Barbosa 1201 & S. M. Costa* (INPA, UEC); idem, 01°24'00"N, 60°59'08"W, 22 July 2010, *T. D. M. Barbosa 1269 & S. M. Costa* (INPA, UEC); idem, Estrada perdida próximo a 1ª bueira, 16 September 2010, *S. M. Costa et al. 766* (INPA, UEC).

Additional specimens examined: BRAZIL. "Piauhy," July 1839, *Gardner 2478* (Isolectotype of *Cabomba piauhyensis* Gardner: [K000220408]).

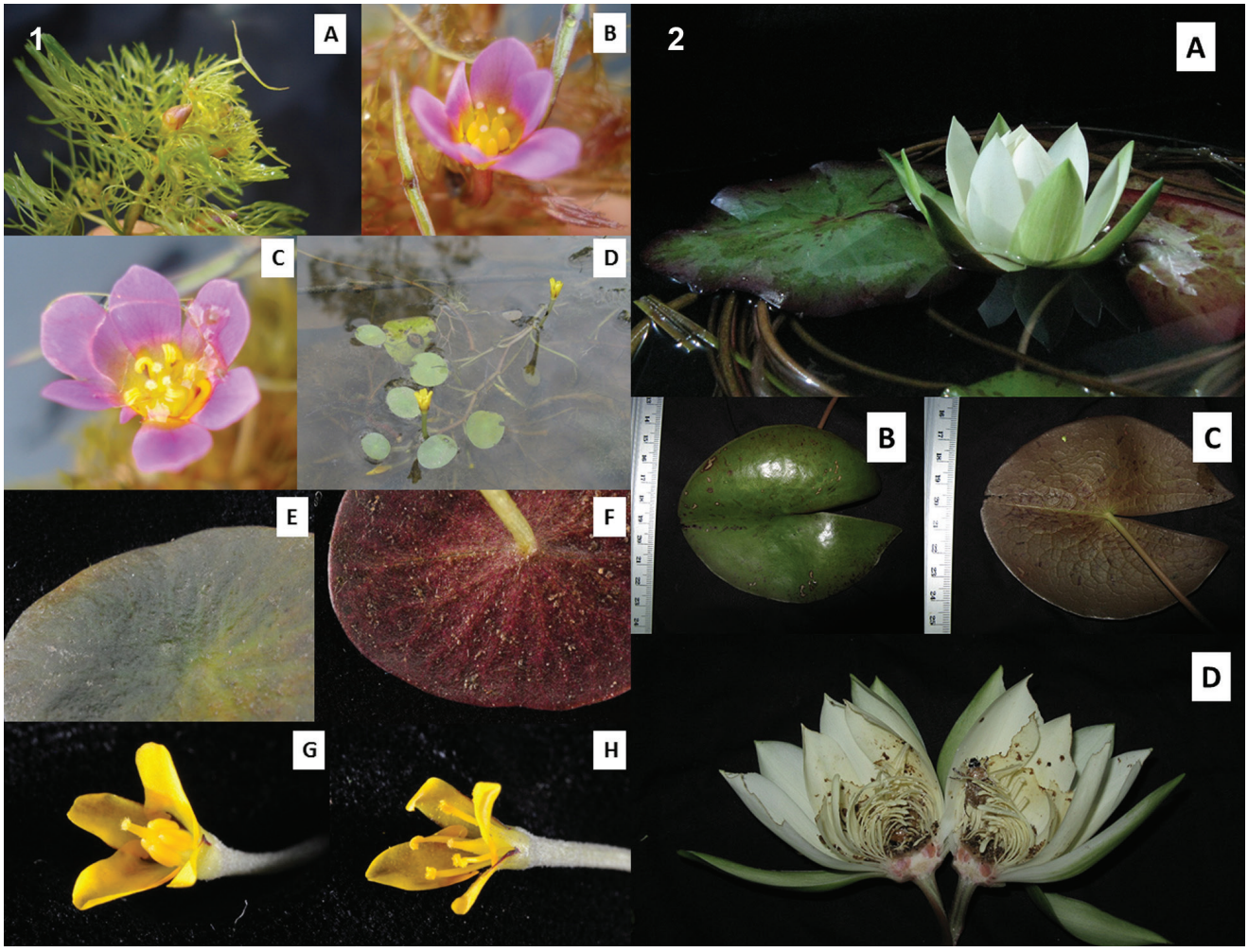
Geographical distribution and ecology: Herbs predominantly submerged; occur in ditches, lagoons, streams and along riverbanks, 50–400 m; Venezuela, Costa Rica, Cuba, eastern Colombia, Trinidad, Guyana, Suriname, French Guiana, Peru, Brazil and northern Bolivia (Wiersema, 1997). In Brazil, the species is found in the North (Amazonas, Pará, Rondônia, Roraima and Tocantins), Northeast (Bahia, Maranhão, Paraíba, Pernambuco and Piauí), Central-West (Distrito Federal, Goiás, Mato Grosso do Sul and Mato Grosso), Southeast (Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo) and South (Paraná, Rio Grande do Sul and Santa Catarina) regions (Pellegrini, 2020).

1.a.2. *Cabomba schwartzii* Rataj, Acta Amazon. 7: 143. 1977. Fig. 1D–H.

Herbs with length varying according to the height of water level. *Submerged leaves* green to reddish; blade sparsely to densely setose, reniform to circular, 53.0 × 50.5 mm, 3–5-splitted at the base, with linear segments, ditrichotomically splitted, the first divisions often trifurcated, three-dimensional, the terminal ones bifurcated, two-dimensional, segments 4.5–7.0 mm, 2–4 mucronate; petiole 9.0–12.5 mm long. *Floating leaves* broadly elliptic to oval, punctate-glandulose, 19.5–32.0 × 13.5–21.0 mm, adaxial surface olive green, sparsely tomentulose to glabrous, abaxial surface vinaceous, sparsely tomentulose, margin hyaline; petiole 23.0–30.0 mm length, hirsute. *Flowers* ca. 8.0 mm length; peduncle 30.5–37.0 mm long, hirsute; petals and sepals yellow; sepals 2, 6.5–7.5 × 2.5–3.0 mm, adaxial surface sparsely tomentose, sparsely punctate-glandulose, abaxial surface glabrous, not punctutate-glandulose, apex truncate, slightly obtuse, or retuse; petals 2, 6.5–7.5 × 2.5–3.0 mm, apex obtuse or retuse, adaxial surface sparsely tomentose, sparsely punctate-glandulose, abaxial surface glabrous, not punctate-glandulose, stamens 4, filaments ca. 4.0 mm length, anthers ca. 1.3 mm length; pistil 1, botuliform, tomentelous, sparsely punctate-glandulose, 6.0–6.5 mm length, style ca. 1/4 of the length of the pistil, glabrous, ovary unilocular, ovules 1–2, some may be aborted, stigma whitish, short ciliated. *Fruits* thin walled. *Seeds* ovoid, ellipsoid, 1.5–2.1 × ± 1.0 mm, verrucose.

The flowers of *Cabomba schwartzii* emerge from water around 10:00 a.m. and submerge around 4:00 p.m., during this time they are visited by bees and flies. The species occurs in large patches dominating the landscape.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, Parque Nacional do Viruá, 01°27'30"N, 60°58'26"W, 07 March 2010, *T. D. M. Barbosa et al. 1096*



FIGURES 1–2. **1.** Cabombaceae – *Cabomba furcata* Schult. & Schult. f. **A**, submerged and floating leaves (peltate narrowly lanceolate at the apex of the shoot); **B**, flower (first day); **C**, flower (second day). *Cabomba schwartzii* Rataj. **D**, habit; **E**, floating leaf (adaxial surface); **F**, floating leaf (abaxial surface); **G**, flower (first day); **H**, flower (second day). **2.** Nymphaeaceae – *Nymphaea gardneriana* Planch. **A**, habit; **B**, leaf (adaxial surface); **C**, leaf (abaxial surface); **D**, flower (longitudinal section).

(INPA, UEC); idem, 01°24'44"W, 60°13'00"W, 20 June 2010, *T. D. M. Barbosa 1230 & S. M. Costa* (INPA, UEC); idem, 01°24'03"N, 60°59'10"W, 25 January 2011, *S. M. Costa 894 & K. G. Cangani* (INPA, UEC); idem, Estrada perdida próxima a 1ª bueira, 16 September 2011, *S. M. Costa et al. 763,* (INPA, UEC).

Additional specimens examined: BRAZIL. Amazonas: Rio Negro, rio Itu, igarapé do Aduja, *Schwartz s/n* (Holotype [INPA53905]).

Geographical distribution and ecology: Submerged herbs; occur in ditches, lagoons, streams and along river-banks. Species known only to the states of Amazonas and Roraima in the Brazilian North region (Barbosa et al., 2018).

2. NYMPHAEACEAE Salisb. (**Nymphaeales)**

Herbs, rhizomatous, perennial, rooted in substrate. *Leaves* arising directly from the rhizome, simple, alternate, long-petiolate; blade ovate-lanceolate to orbicular, cordate to peltate. *Flowers* emerged, occasionally submerged, solitary, axillary, or extra-axillary, pedicel long, originating from the rhizome, bisexual, actinomorphic; sepals 4–6(–14), free or adnate to ovary; petals 4–70, free, spirally arranged or the external ones arranged in whorls of 4, hypogynous to perigynous, often transitional to stamens or staminodes; stamens 14–700, spirally arranged, usually grading from outer laminar forms to inner forms with more distinctive filament and anther, anthers 2-thecae, introrse, longitudinally dehiscing; ovary superior to inferior, carpels 3–50, 3–many locules and 2–many ovules per locule, totally or partially united, stigma sessile 3–50, in numbers equal to the carpels, ovules pendulous, laminar placentation. *Fruits* coriaceous, berry-like or capsule-like, with irregular dehiscence, usually retracted beneath the water surface. *Seeds* arillate or not, ovoid to globose, operculate, seed coat glabrous to pilose (adapted from Feres and Amaral, 2003; Wiersema, 2003).

Broad distribution in temperate and tropical zones, lakes and bays, from fresh to little brackish waters. The family consists of six genera; the largest of them, *Nymphaea* L.,

is cosmopolitan, with about 70 species, as well as several hybrids and varieties (Feres and Amaral, 2003). In Brazil, the family is found throughout the national territory with two genera (*Nymphaea* and *Victoria* Lindl.) and 23 species (Flora do Brasil, 2019d). In VNP only *Nymphaea* was found with two species.

Key to Nymphaeaceae Species

1a. Margins of leaf irregularly toothed; sepals reddish-green. . . . . *Nymphaea rudgeana*
1b. Margins of leaf repand; sepals green (never reddish) . . . . . *Nymphaea gardneriana*

2.a. *Nymphaea* L.

Rhizome erect or horizontal. *Leaves* usually floating; blade elliptic-ovate to orbicular, base cordate to sagittate, apex rounded to acute, margin entire to sinuous-toothed, venation palmate with a prominent central vein. *Flowers* with pedicels mostly stouter than petioles; sepals usually 4, hypogynous, imbricate, free, oblong to lanceolate; petals 7–40, showy, imbricate, free, hypogynous to perigynous, oblong to lanceolate, inserted in several series, transition from petals to stamens gradual or abrupt; stamens 20–700, multiseriate, peryginous to epigynous, free, the external ones petaloid, the internal ones filiform, connective with or without terminal appendage; ovary semi-inferior, syncarpous or apocarpous, carpels 5–50; stigmatic tissue radial terminated by triangular, linear, lingulate or clavate carpellary appendage. *Capsule* ripening under water, dehiscence irregular. *Seeds* with a floating membranous aril, often with ridges or hair-like papillae on outer surface (adapted from Feres and Amaral, 2003; Wiersema, 2003).

Distributed in tropical to temperate habitats on all continents except Antarctica, with ca. 45–50 species (Wiersema, 2003). In Brazil, *Nymphaea* is found throughout the national territory, with 21 species (Flora do Brasil, 2019d). The genus occurs in stagnant waters or waters with little movement (Feres and Amaral, 2003). In VNP two species were found.

2.a.1. *Nymphaea gardneriana* Planch., Fl. Serres Jard. Eur. 8: 120. 1853. Fig. 2A–D.

Leaves with greenish petiole, glabrescent, without ring of trichomes at apex, blade chartaceous, elliptic to suborbicular, apex round to mucronate, margin repand, adaxial surface green or reddish, with longitudinal striae caused by the acicular sclereids of the mesophill, abaxial surface green or reddish, with spider web-like veins, central and major veins sulcate, 7.2–11.2 × 4.5–8.7 cm. *Flowers* with greenish pedicel, ca. 6.1 mm diam.; sepals 4, cymbiform, base white, other parts green, white longitudinal striae, ca. 60.0 × 20.0 mm, narrow-elliptic, oblanceolate, apex cucullate, acute or rounded; petals 17, cymbiform, whitish, the outermost narrowly elliptical, 55.2 × 21.7 mm, the inner most narrowly elliptic to oblanceolate, 44.4 × 14.5 mm; gradual transition to stamens, apex mucronate; stamens 79, white, the most external ones ca. 36.3 × 4.7 mm, the most internal ca. 16.3 × 2.0 mm; external and internal apical extensions absent; external anthers ca. 20.1 × 3.1 mm, the innermost 9.6 × 2.1 cm; carpels 24, carpellary appendages 14.3 × 1.8 mm, white, fusiform. *Fruits* not seen.

According to Wiersema (2003) most of the species of *Nymphaea* of Venezuela are nocturnal species apparently exclusively pollinated by beetles *Cyclocephala* Latreille. In Viruá, we also found beetles pollinating the flowers of *N. gardneriana*, and they probably belong to *Cyclocephala* as well. *Nymphaea gardneriana* is very common in the area; its flowers begin the anthesis in the late afternoon exuding a scent that dominates the environment. The species was seen mostly in open areas, but it was also collected in flooded areas in the interior of forest, where it is less frequent.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, 20 July 2010, 01°24'44"N, 60°13'00"W, *T. D. M. Barbosa 1229 & S. M. Costa* (INPA, UEC); idem, grade PPBio L1/N6, 12 September 2010, *S. M. Costa 694 & T. D. M. Barbosa* (INPA, UEC).

Additional specimens examined: BRAZIL. "in prov. Piauhy," Jul-Sep, 1839, *Gardner 2476* (Isolectotype [K000220394]); Goiás, 1840, *Gardner 3568* (Isolectotype of *Nymphaea stenaspidota* [K000220395]).

Geographic distribution and ecology: Venezuela, Guyana, Brazil, eastern Bolivia, Paraguay, northeastern Argentina (Wiersema, 2003). In Brazil, the species is found in the North (Acre, Pará, Roraima and Tocantins), Northeast (Paraíba and Piauí), Central-West (Distrito Federal, Goiás, Mato Grosso do Sul and Mato Grosso), Southeast (Minas Gerais and São Paulo) and South (Paraná) regions (Flora do Brasil, 2019d).

2.a.2. *Nymphaea rudgeana* G. Mey., Prim. Fl. Esseq. 198. 1818. Figure in *Flora Brasiliensis*. Vol. IV, Part II. Fasc. 77, plate 35. 1878.

Leaves with reddish petiole, glabrescent, without ring of trichomes at apex, blade subcoriaceous, broadly elliptic, apex truncate to rounded, margin irregularly toothed with repand apex, adaxial surface green or reddish, abaxial surface green or red, pleated, with central and main veins strongly prominent, radial, other veins irregularly reticulated, 25.0–31.2 × 28.0–32.0 cm. *Flowers* with reddish pedicel, ca. 7.0 mm diam.; sepals 4, cymbiform, reddish-green or pinkish, sometimes with reddish spots, 4.5–5.7 × 1.9–2.2 cm, elliptic, apex cucullate, acute or rounded; petals 17, cymbiform, white to pinkish, the outermost elliptic, 4.8 × 2.1 cm, the most internal ones narrowly elliptic, 3.8–4.1 × 1.2–1.4 cm; gradual transition to stamens, apex rounded; stamens 50–54, the most external ones ca. 3.5 × 1.2 cm, the most internal ca. 1.7 × 2.8 cm; filaments white, apical extensions yellowish-white, the outermost ca. 1.0 mm length, the most internal absent; anthers yellowish-white, the outermost ca. 1.2 × 0.4 cm, the innermost 8.2 × 2.6 cm; carpels 16, carpellary appendages 1.0 × 0.2 cm, yellowish-white, clavate, pink. *Fruits* 2.5–4 × 3.2–5.3 cm. *Seeds* oval, 1.4–2.0 × 1.0–1.5 mm, seed coat smooth, with trichomes arranged in longitudinal rows.

Flowers with nocturnal anthesis, flower buds emerge and close during the day. Among the strictly aquatic plants from Viruá it can be easily recognized by its large leaves, with irregularly toothed margin and repand apex.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, 20 January 2011, 01°24'50"N, 60°59'17"W, *M. C. E. Amaral 2011/33 & C. F. Silva* (INPA, UEC); idem, 21 September 2010, 01°16'46"N, 60°59'20"W, *S. M. Costa et al. 815* (INPA, UEC).

Additional specimens examined: BRAZIL. Pará, December, 1849, *Spruce 479* (Lectotype of *Nymphaea sinuata* Salzman ex Lehmann [K000220402]).

Geographic distribution and ecology: Venezuela, Cuba, Jamaica, Guadaloupe, Martinique, northeastern Colombia, Trinidad, Guyana, Suriname, French Guiana, Brazil (Wiersema, 2003). In Brazil, the species is found in the North (Amazonas, Amapá, Pará, Rondônia, Roraima and Tocantins), Northeast (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe), Southeast (Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo) and South (Paraná) regions (Flora do Brasil, 2019d).

3. ALISMATACEAE Vent. (**Alismatales)**

Herbs rooted in substrate, annual or perennial, cormose, stoloniferous, often rhizomatous. *Leaves* emerged, submerged or floating, basal, sessile or petiolate; petioles cylindrical to trigonal, with open and non-auriculate sheaths; blades linear, lanceolate, sagittate, ovate to rhomboid, sometimes marked by pellucid dots or lines, venation acrodromous. *Inflorescences* erect, rarely floating, scapose, racemose, paniculate, rarely umbellate, spathe absent; bracts whorled, linear, entire. *Flowers* hypogynous, actinomorphic, bisexual or unisexual (hermaphroditic, monoecious, or rarely dioecious plants), subsessile to long-pedicellate; sepals 3, green, persistent in fruit; petals 3, white (yellow base in *Sagittaria* Rupp. ex L.); stamens 6, 9 or many, free, yellow; anthers 2-thecae, basifixed or versatile, longitudinal dehiscence, extrorse; pistils 6–many, free, yellow, 1 whorled or spiraled, 1-locular, each with 1(2) ovules, placentation basal; styles terminal or lateral, persistent; stigma linear. *Fruits* usually achenes compressed or cylindrical, often winged, with longitudinal ribs or ribs absent, glands present or absent (adapted from Haynes and Holm-Nielsen, 1995).

Cosmopolitan family, with ten genera and about 80 species (Haynes and Holm-Nielsen, 1995). In Brazil, Alismataceae are recorded in all regions and states, with five genera and 37 species (Matias, 2019). In VNP two genera and three species were found.

Key to Alismataceae Species

1a. Flowers bisexual; fruits almost cylindrical, predominantly ribbed . . . . . *Helanthium tenellum*
1b. Flowers, at least the most basal, unisexual; fruits conspicuously compressed, not ribbed 2
2a. Leaves floating, sagittate . . . . . *Sagittaria guayanensis*
2b. Leaves emerged, linear, ovate-lanceolate or elliptic . . . . . *Sagittaria rhombifolia*

3.a. *Helanthium* (Benth. & Hook. f.) Engelm. ex J.G. Sm.

Scapose *herbs*, pseudostoloniferous. *Emerged leaves* petiolate, blades narrow to elliptic, 1–5-veined, pellucid marks absent or present in the form of lines; submerged leaves sessile, blade linear. *Inflorescences* umbellate or racemose composed of 2–3-whorls of flowers; bracts ovoid. *Flowers* bisexual, pedicellate; sepals ovate; petals unguiculate; stamens (6–)9; anthers globulose; pistils 10–20. *Fruits* turgid, obovate, 3–4-ribbed, not carinate, beak erect (adapted from Lehtonen and Myllys, 2008).

Helanthium is a genus with broad phenotypic plasticity. According to Haynes and Holm-Nielsen (1994), the genus has two species and is distributed from the northeastern United States of America to southern Brazil and Argentina.

3.a.1. *Helanthium tenellum* (Mart. ex Schult. f.) Britton, Man. Fl. N. States [Britton], ed, 2. 54. 1905. Fig. 3A–B.

Herbs palustrine or submerged, up to 25 cm, stoloniferous. *Emerged leaves* lanceolate, apex acute, base acute to attenuate, 3–5 veins, pellucid marks absent; submerged leaves oblanceolate, ca. 30.0 × 1.8 mm, apex acute, base attenuate, 1–3 veins. *Inflorescences* umbellate, with 1 whorl, or racemose with 2 whorls; scape erect, cylindrical, glabrous, ca. 52.0 × 0.55 mm, whorls 5-flowered; peduncle ca. 31.5 mm length; bracts smaller than the pedicel, connate till ca. 1/2 of the length, 2.20 × 1.40 mm, conduplicate, apex acute; pedicel ca. 11.0 × 0.2 mm. *Flowers* ca. 4.2 mm diam.; sepals ca. 1.80 × 1.40 mm, appressed to patent, 4-veined, veins without papillae; petals ca. 3.6 × 2.6 mm, apex rounded to emarginate; stamens 9–10; pistils 15–20. *Fruits* ca. 1.0 × 0.7 mm.

No emergent leaves were seen (description according to Amaral et al., 2008). The specimens were collected in campinaranas, in floodplain areas, preferably in sunny locations. Species found in abundance where it occurs.

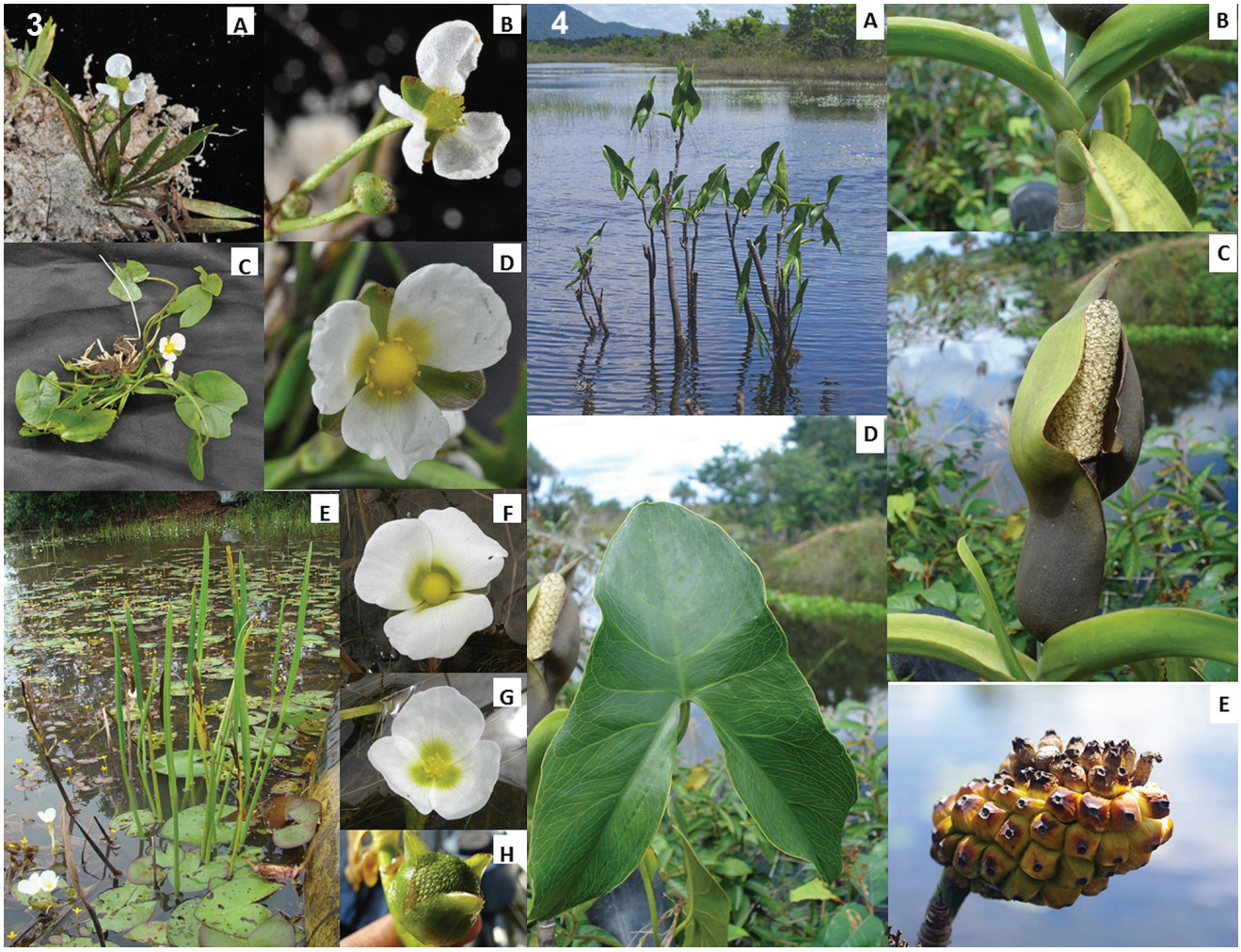
Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, 07 March 2010, 01°25'15"N, 60°59'08"W, *T. D. M. Barbosa et al. 1094* (INPA, UEC); idem, Estrada Perdida, 16 September 2010, *S. M. Costa et al. 754* (INPA, UEC).

Additional specimens examined: BOLIVIA. Reyes, 25 October 1921, *White 1540* (Isolectotype of *Helanthium bolivianum* (Rusby) Lehtonen & Myllys [K000061663]).

Geographical distribution and ecology: In sandy and soaked soils. From the Northeastern United States, to Mexico, Nicaragua, Cuba, Jamaica, Dominican Republic, Colombia, Guyana, Bolivia, Argentina and Brazil (Haynes and Holm-Nielsen, 1995). In Brazil, the species is found in all regions and states (except Acre) (Matias, 2019).

3.b. *Sagittaria* Rupp. ex L.

Rhizomatous *herbs*, the rhizomes occasionally terminated by tubers, or cormose. *Emerged* or *floating leaves* petiolate, blades sagittate, rhombiform to linear; submerged leaves sessile, blades linear. *Inflorescences* usually a raceme or



FIGURES 3–4. **3.** Alismataceae – *Helanthium tenellum* (Mart. ex Schult. f.) Britton. **A**, habit; **B**, flower and flower bud. *Sagittaria guayanensis* Kunth. **C**, habit; **D**, flower. *Sagittaria rhombifolia* Cham.. **E**, habit; **F**, pistillate flower; **G**, staminate flower; **H**, fruit. **4.** Araceae – *Montrichardia arborescens* (L.) Schott. **A**, habit; **B**, leaves' basis; **C**, inflorescence; **D**, leaf (adaxial surface); **E**, infructescence.

panicle, whorls 1–17 with 2 or 3 flowers; bracts obtuse to acute. *Flowers* at least the lower ones unisexual; pedicellate; sepals elliptic (staminate flowers) or ovate to almost deltoids (pistillate flowers); petals obovate; staminate flowers with 7–numerous stamens, anthers linear to sagittate, pistillode rarely present; pistillate flowers with numerous pistils, arranged spirally, surrounded by a whorl of staminodes (sometimes absent). *Fruits* laterally compressed, usually with thin and curved margin, winged, with apical or lateral keel (adapted from Haynes and Holm-Nielsen, 1995; Pansarin and Amaral, 2005).

Genus with approximately 30 species distributed in temperate and tropical regions of the globe, from the temperate north to tropical America, extending to Patagonia. Of these species, 14 occur in the neotropics, six occur in Brazil (Haynes and Holm-Nielsen, 1994; Matias, 2019; Pansarin and Amaral, 2005).

3.b.1. ***Sagittaria guayanensis*** Kunth, Nov. Gen. Sp. (quarto ed.) 1: 250. 1815[1816]. Fig. 3C–D.

Emerged or floating-fixed *herbs*, cormose, up to ca. 15 cm tall. *Emerged* or *floating leaves* sagittate, ca. 30.0–45.0 × 25.0–36.5 mm, apex acute-rounded, base sagittate to cordate, venation actinodromous, 10–11-veined. *Submerged leaves* linear, apex rounded to obtuse, 3–5-veined, base acute to attenuate. *Inflorescences* scape with 1–7 whorls, ca. 56.0 × 1.55 mm; bracts of staminate and pistillate flowers ovate. *Staminate flowers* with pedicel 19.5 × 0.5 mm, glabrous; sepals ca. 6.0 × 3.0 mm; petals ca. 6.5 × 5.0 mm; stamens 7, pistillodes ca. 40; *pistillate flowers* with ring of staminodes; pedicel ca. 9.75 × 0.80 mm, pubescent; sepals erect in flowers and fruits. *Fruits* ca. 2.0 × 1.5 mm, with lateral keel horizontal to ascending, face tuberculate.

No submerged leaves were observed in VNP (description according to Amaral et al., 2008). The species was collected in a shallow lake, with clay soil, in a sunny area.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, 01°27'30"N, 60°58'26"W, 07 March 2010, *T. D. M. Barbosa et al. 1097* (INPA, UEC).

Geographic distribution and ecology: In lakes, canals and flooded areas. From the southeastern United States, passing through Jamaica, the Dominican Republic, and Mexico, Central America and South America to Paraguay and northern Argentina (Amaral et al., 2008; Haynes and

Holm-Nielsen, 1994). In Brazil, the species is found in the North (Acre, Amazonas, Pará, Roraima and Tocantins), Northeast (Alagoas, Bahia, Ceará, Maranhão, Pernambuco, Piauí, Rio Grande do Norte, Sergipe), Central-West (Goiás, Mato Grosso do Sul and Mato Grosso) and Southeast (Minas Gerais) reagions (Matias, 2019).

3.b.2. ***Sagittaria rhombifolia*** Cham., Linnaea 10: 219. 1835. Fig. 3E–H.

Emerged *herbs*, rhizomatous or cormose, up to 1.0 m tall. *Emerged leaves* linear, lanceolate-ovate, less often narrow-elliptic, often conduplicate, 12.0–15.0 × 1.0–2.0 cm, apex and base acute, parallel-bowed venation, 5–8-veined. *Submerged leaves* linear, apex rounded to acute, 1–3-veined. *Inflorescences* scape with 1–12 whorls, ca. 100.0 × 0.5 cm; bracts of staminate flowers ovate to deltoid; bracts of the pistillate flowers deltoid. *Staminate flowers* with pedicel 24.0 × 1.5 mm, glabrous; sepals ca. 11.75 × 7.0 mm; petals ca. 21.0 × 20.5 mm; stamens 9–12, pistillodes ca. 20; *pistillate flowers* with or without staminodes ring; pedicel 11.5 × 3.0 mm, glabrous; sepals appressed on flowers and fruits. *Fruits* ca. 4.0 × 1.5 mm, with lateral or horizontal keel, face non-tuberculate.

The inflorescence can be found both above and below the water. In both cases, the flowers open around 11:00 a.m. Apparently in cases where the axis is below the water only the flowers' pedicel rises causing the flowers to emerge. Bees and flies were seen visiting *S. rhombifolia* flowers in VNP.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, Estrada Perdida, 19 September 2010, *S. M. Costa et al. 770b* (INPA, UEC); idem, 14 October 2011, *C. T. Pedrollo et al. 140* (INPA, UEC); idem, 01°25'15"N, 60°59'06"W, 16 July 2010, *T. D. M. Barbosa 1110 & S. M. Costa* (INPA, UEC).

Additional specimens examined: BRAZIL. *s.d.*, *Sellow s.n.* (Isolectotype [K000587167]); idem, August 1839, *Gardner 2737* (Lectotype of *Sagittaria pugioniformis* var. *platyphylla* Micheli [K000587168]); idem, 1841, *Gardner 2737* (Isolectotype of *Sagittaria pugioniformis* var. *platyphylla* Micheli [K000587169]).

Geographic distribution and ecology: In palustrine and shallow lagoon environments (Amaral et al., 2008). From Costa Rica to Argentina (Haynes and Holm-Nielsen, 1994). In Brazil, it is found in the North (Acre, Pará, Rondônia, Roraima and Tocantins), Northeast (Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Piauí and Sergipe), Central-West (Goiás, Mato Grosso do Sul and Mato Grosso), Southeast (Minas Gerais and São Paulo) and South (Paraná, Rio Grande do Sul and Santa Catarina) regions (Matias, 2019).

4. ARACEAE Juss. (**Alismatales**)

Herbs sometimes latisciferous. *Stems* subterranean and rhizomatous or cormose, or aerial and erect, creeping or climbing. *Leaves* alternate, sometimes distichous, basal or cauline; petiole with a sheath, often geniculate; blade usually simple, entire or variously dissected, primary lateral veins often radiate or pinnate. *Inflorescences* spadix subtended by a free spathe or partially adnate to it. *Spathe* patent, reflexed, or convolute, sometimes differentiated into a basal tube and an apical limb. *Spadix* generally cylindrical. *Flowers* sessile, ebracteate, bisexual or unisexual (monoecious plants, rarely dioecious), often the most basal flowers pistillate and the most apical flowers staminate; perianth absent or generally with 4–6 tepals (monochlamydeous flowers), usually free; stamens 2–6(–9), free or synandria, anthers often subsessile, extrorse, longitudinal, or poricidal, when sterile then the staminodes free or synandrodia; pistils generally free; ovary usually superior, 1–many loculate, each with 1–many ovules, placentation parietal, axillary or apical; style usually absent or short; stigma rounded to linear. *Fruits* usually an infructescence composed of separate indehiscent berries with 1–many seeds (adapted from Buntig, 1995).

Family with approximately 110 genera and about 3500 species. Araceae are distributed throughout the world except for polar regions and drier deserts, mainly in tropical and subtropical regions (Li et al., 2010). In Brazil Araceae are found in all regions and states, 511 species are registered in 38 genera (Flora do Brasil, 2019a). In VNP two genera and two species were found.

Key to Araceae Species

1a. Free floating plants; leaves arranged in rosette . . . . . *Pistia stratiotes*
1b. Emergent plants, rooted in the substrate; leaves alternate. . . . . *Montrichardia arborescens*

4.a. ***Montrichardia*** Crueg.

Herbs erect. *Stems* unbranched, spiny or not. *Leaves* mostly terminal, apparently resupinate with posterior lobes held toward the ground and the adaxial surface outward; petioles sheathed up to middle or beyond, wings ending in a ligule; blades sagittate or ovate, posterior lobes of approximately the same length as the anterior lobe, primary lateral veins confluent into a collective vein close to margin, veins of higher orders reticulate. *Inflorescences* with solitary and short peduncles. *Spathe* slightly convolute and constrict, entirely deciduous, limb partially opening. *Spadix* shorter than spathe, pistillate portion 2–3 times shorter than staminate portion and contiguous to it. *Flowers* unisexual, achlamydeous; *staminate flowers* with 3–6 stamens, free, prismatic, thecae oblong, lateral and dehiscent by an apical slit; *pistillate flowers* with 1-loculate ovary, 1–2 ovules, placentation basal; apical portion of the style subtruncate with a central concavity; stigma discoid. *Infructescences* ellipsoid or ovoid. *Fruits* bacaceous, spongy, 1-seeded (adapted from Bunting, 1995).

Genus distributed in the neotropics, with two species: *M. arborescens* and *M. linifera* (Arruda) Schott (Bunting, 1995). In Brazil, the genus is distributed in the North (Acre, Amazonas, Amapá, Pará, Rondônia and Roraima), Northeast (Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe), Central-West (Mato Grosso) and Southeast (Espírito Santo, Minas Gerais and Rio de Janeiro) regions (Mayo and Andrade, 2019). In VNP one species was found.

4.a.1. ***Montrichardia arborescens*** (L.) Schott, Arac. Betreff. 1: 4. 1854. Fig. 4A–E.

Herbs emerged, amphibians, ca. 2.0 m tall. *Stems* with internodes ca. 4.0–5.0 × 6.5–9.0 mm. *Leaves* with petiolate sheath 89.0 × 10.5 mm; petiole 45.5 × 2.0 mm; not geniculate; blade chartaceous, discolor, sagittate, 15.5–18.5 × 8.5–10.0 cm, apex obtuse, margin wavy; venation colocasioid, 3 primary lateral veins, 2 acroscopic, 0–1 basiscopic, slightly prominent on both surfaces. *Inflorescences* 1 per leaf axil; peduncle 23.0–35.0 × 3.5–5.0 mm, green. *Spathe* 10.0 × 18.0 mm, green externally, internally white with red base. *Spadix* ca. 83.5 × 33.5 mm, stipite 1.5 mm length, cream, pistillate area 26.5 mm, staminate area 56.5 mm. *Infructescences* erect, ellipsoid, ca. 10.0 × 6.0 cm. *Fruits* green, or brown, apex convex, 2–3 cm long, 1-seeded. *Seeds* up to 1.5 cm long.

Herbs with whitish latex turning reddish over time. Species collected in grassy campinaranas, occurring more or less isolated, or in forested areas (mainly in the forest edges of the Iruá river), where it occurs in dense populations.

According to Bunting (1995), the distinction between *M. arborescens* and *M. linifera*, both occurring in the Brazilian Amazon, is difficult. Many plants have intermediate characteristics between them, making it difficult to identify, particularly in the Amazon. One of the characteristics that distinguish the two species is that in *M. arborescens* the primary lateral veins are in number of 3 or 4, whereas in *M. linifera* the veins are 5 to 7. The specimens collected in Viruá present 3 primary veins and were thus identified as *M. arborescens*.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, Estrada Perdida, 16 September 2010, *S. M. Costa et al. 768* (INPA, UEC).

Additional specimens examined: PANAMA. February, 1850, *Fendler 432* (Type of *Montrichardia fendleri* Schott [K000434763] - image), idem, February 1850, *Fendler 433* (Type of *Montrichardia fendleri* Schott [K000434764] - image).

Geographic distribution and ecology: occurs in river banks, lagoons and in forests with seasonal flooding. Often forming large colonies in sunny or partially shaded areas. Species widely distributed in Central America, Puerto Rico, the Caribbean, Trinidad and Tobago and South America (Bunting, 1995). In Brazil, the species is found in the North (Acre, Amazonas, Pará, Rondônia and Roraima), Central-West (Mato Grosso) and Southeast (Minas Gerais) regions (adapted from Mayo and Andrade, 2019).

4.b. ***Pistia*** L.

The genus is monotypic, so the descriptions is as follows.

4.b.1. ***Pistia stratiotes*** L., Sp. Pl. 2: 963. 1753. Figure in *Flora Brasiliensis*. Vol. III, Part II, Fasc. 76, plate 52. 1878.

Floating aquatic *herbs*, perennial, stoloniferous, acaulescent, with feathery roots. *Leaves* rosulate, densely pubescent; petiole ca. 2.5 mm long, externally pilose, internally glabrous; sheath ligulate, ca. 4.5 mm long, scarious, punctate-glandulose, surrounding the petiole, apex irregular; blade ca. 19.5 × 19.0 mm, obovate-cuneate to obovate-oblong, slightly spongy, apex rounded, truncate to retuse, cuneate towards the base, veins 5, subparallel, emerging from the base, slightly divergent and approaching the margins near apex, strongly prominent abaxially, venation of higher orders reticulate. *Inflorescences* solitary, ca. 1.0 cm length; peduncle pubescent. *Spathe* white, slightly constricted in the middle, pubescent externally, glabrous internally, proximal margins connate and adnate to the ovary's wall forming a tube, the free margins between the tube and lamina folded forming a partition between a staminate distal chamber and a pistillate proximal chamber. *Spadix* mostly adnate to spathe, shorter than this, only the staminate apical portion free, pistillate zone with a single gynoecium at the base. *Flowers* unisexual, glabrous; *staminate flowers* a synandrium, consisting of 2 connate stamens, dehiscing by an apical slit; *pistillate flowers* with gynoecium adnate to the axis of the spadix, ovary ovoid, 1-loculate, ovules numerous, placentation apparently parietal, style region attenuate, bending towards the staminate flowers, stigma discoid, subcapitate. *Fruits* thin walled, utricular, many-seeded, berry ellipsoid, marcescent. *Seeds* ellipsoid, seed coat reticulate-alveolate.

Collected floating in white water (igarapé do Cobra), among dense populations of *Eichhornia* Kunth.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, 00°57'53"N, 61°21'30"W, 26 March 2011, *T. D. M. Barbosa 1403 & S. M. Costa* (INPA, UEC).

Geographic distribution and ecology: Pantropical species occuring in river banks and lagoons. It is widely distributed in the tropics and subtropics (Amaral et al., 2008). In Brazil, the species is recorded in all regions and states (except Rondônia and Tocantins) (adapted from Mayo and Andrade, 2019).

5. HYDROCHARITACEAE Juss. (**Alismatales)**

Annual or perennial *herbs*, submerged, floating, or emerged, usually glabrous. *Stems* rhizomatous or erect. *Leaves* basal or caulinar, alternate, opposite, or whorled, entire or serrate, sessile or petiolate, 1–many-veined; stipules when present forming a tubular sheath around the stem; parallel-veined. *Inflorescences* axillary, terminal, or scapose, solitary or cymose, 1–multi-flowered, subtended by a bifid bract or a pair of opposite, sessile or pedunculate bracts. *Flowers* unisexual or bisexual (monoecious, dioecious or hermaphroditic plants), usually actinomorphic and dichlamydeous; sepals free, valvate; petals free, imbricate or convolute; stamens absent or 2–many in 1–more whorls, the inner often staminodal, free or connate, anthers basifixed, 2-thecae, dehiscing via short slits; carpels absent or 2–5, connate; ovary inferior, 1-locular, placentation parietal or laminar; ovules numerous; style 2–5; stigma usually bifid. *Fruits* capsule similar to berry. *Seeds* fusiform, ellipsoid, ovoid, or globose (adapted from Haynes and Holm-Nielsen, 1999).

Native mainly to tropical and subtropical waters of the world, but also in temperate areas. Hydrocharitaceae has

16 genera and ca. 100 species (Haynes and Holm-Nielsen, 1999). In Brazil, 14 species are recorded in seven genera. The family is found in all regions and states (except Acre) (Lourenço and Bove, 2019). In VNP one species was found.

5.a. *Elodea* Michx.

Herbs submerged, perennial, glabrous, dioecious or hermaphrodite. *Stems* erect, branched or not. *Leaves* simple, sessile, linear to narrow-elliptical, in whorls of 3–7, or rarely opposite, 1-veined, serrate, vein without dorsal prickle. *Inflorescences* solitary, axillary; spathes sessile, usually narrowed towards the base, cylindrical to elliptic-spatulate, 1-flowered. *Flowers* bisexual or unisexual, usually projected to water's surface by the elongating hypanthium base; sepals 3, herbaceous, green; petals 3, membranaceous, white to pale blue, free, elliptic, unguiculate; stamens 3–9, or reduced to 3 staminodes, anthers oblong to ellipsoid, filaments subulate to lanceolate, free or the 3 inner connate halfway to apex; carpels 3, 1-locular, placentation parietal; styles 3, stigmas 3, bifid. *Fruits* ovoid to lanceolate-ellipsoid, corniculate. *Seeds* 3–8, cylindrical to fusiform (adapted from Haynes and Holm-Nielsen, 1999).

Genus distributed in the western hemisphere. *Elodea* has six species (Haynes and Holm-Nielsen, 1999), only one in VNP. The six species of *Elodea* are separated into two subgenera: *Elodea* and *Apalanthe* Planch. The subgenera can be separated into subgenus *Elodea* with five species, with unisexual flowers, staminate flowers with 6–9 stamens and some filaments connate; and subgenus *Apalanthae* with *Elodea granatensis* only, with bisexual flowers, with 3 free stamens and filaments (adapted from Haynes and Holm-Nielsen, 1999).

Due to such discrepant features commonly the subgenus *Apalanthe* has been treated as a genus apart from *Elodea*. In this case, the only species belonging to this taxon would be *Apalanthe granatensis* (Humb. & Bonpl.) Planch. (Haynes and Holm-Nielsen, 1999).

5.a.1. *Elodea granatensis* Bonpl. in Humb. & Bonpl., Pl. Aequinoct. 2(16): 150. 1809 [1813]. Figure in Hall and Gil (2016) under the name *Apalanthe granatensis* (Humb. & Bonpl.) Planch.

Stems irregularly branched. *Prophylls* paired, oblique, almost triangular, gradually attenuated to an acute apex, ca. 1.9 × 0.4 mm. *Leaves* 5–6-whorled, imbricate, linear to narrowly elliptic, 6.7–7.8 × 1.6–1.8 mm, apex acute, margins serrate. *Spathe* tubular, ca. 8.25 × 2.40 mm, apex bifid. *Flowers* bisexual, sessile; hypanthium ca. 40.0 × 1.5 mm, cylindrical; sepals oblong to narrowly oblong, ca. 1.70 × 0.60 mm, reflexed, apex rounded; petals patent, oblong, ca. 4.0 × 1.0 mm; stamens 3, antisepalous, yellow or white, filaments ca. 1.2 mm, anthers ca. 0.5 × 0.4 mm; styles antipetalous, ca. 2.0 mm, slightly flattened, irregularly divided into 3 lobes, divisions almost to the base, stigmatic lobes white, flat, papillose, base of styles thickened. *Fruits* thin walled, irregularly dehiscent, botuliform, ca. 5.6 × 2.0 mm, bearing remnants of the hypanthium. *Seeds* 6–7 per fruit, fusiform, 2–3 × 0.4–0.5 mm, bearing a persistent micropylar projection ca. 0.4 mm length, seed coat covered by trichomes, ca. 0.6 mm, straight, ascending.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, Estrada Perdida, 20 January 2011, *M. C. E. Amaral 2011/34 & C. F. Silva* (INPA, UEC); idem, 16 September 2010, *S. M. Costa et al. 762* (INPA, UEC).

Additional specimens examined: BRAZIL. *Spruce 1991* (Type of *Elodea guyannensis* var. *dicranioides* Spruce ex Caspary [K000587176] - image).

Geographical distribution and ecology: Venezuela, Colombia, Guyana, Suriname, Brazil and Bolivia. It is found mainly in low altitude areas, however it is recorded up to 1500 m in Colombia (Cook, 1985). In Brazil, the species is found in the North (Amazonas, Pará, Roraima and Tocantins), Northeast (Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe), Central-West (Goiás, Mato Grosso do Sul and Mato Grosso) and Southeast (Minas Gerais, Rio de Janeiro and São Paulo) regions (Lourenço and Bove, 2019).

6. BURMANNIACEAE Blume (**Discoreales**)

Herbs annual or perennial, saprophytic or autotrophic, glabrous, usually rhizomatous. *Stems* usually not branched. *Leaves* alternate, often rosulate, simple, entire, sessile, without stipules. *Inflorescences* usually terminal cyme, bearing bracts, often bifurcate, 1–many-flowered. *Flowers* usually pedicellate, bisexual, syntepalous; floral tube usually persistent, sometimes provided with longitudinal wings or ribs; tepals 6, the three outer ones often much larger than the inner ones, usually valvate to induplicate; stamens 3 or 6, inserted in the floral tube, anthers 2-thecae, introrse, transversely dehiscent, connective dilated, and generally with basal and/or apical appendages; ovary inferior, 3-carpelar, 1- or 3-locular, placentation parietal or axillary, often with septal nectaries or with nectaries on top of the ovary, ovules numerous; style 3-branched at the apex, each branch with 3-apical stigma, sometimes provided with appendages, or stigma capitate. *Fruits* capsules, dehiscing longitudinally or transversely through slits or valves, or irregularly dehiscing. *Seeds* usually fusiform to subglobose (adapted from Kamer and Maas, 2003; Maas and Maas, 1997).

Family with about 150 species, distributed in 15 genera that occur in all tropical and subtropical regions of the old and new world; some outside the tropics (Kamer and Maas, 2003; Maas and Maas, 1997). In Brazil, the family is distributed throughout all the national territory, with 26 species distributed in eight genera (Flora do Brasil, 2019c). In VNP one genus with two species was found.

Key to Burmanniaceae Species

1a. Inflorescences 1–6 flowered; flowers blue-purplish with yellow tepals . . . . . *Burmannia bicolor*
1b. Inflorescences multi-flowered; flowers white to yellowish-white, sometimes green or purplish . . . . . *Burmannia capitata*

6.a. *Burmannia* L.

Herbs erect, usually autotrophic. *Rhizome* absent. *Stems* branched or not. *Leaves* spirally arranged, small and scale-like, sometimes relatively large especially near the base of the stem, sometimes rosulate. *Inflorescences* a terminal cyme, bifurcate, lax to capitate, or just a single terminal flower; bracts sometimes imbricate. *Flowers* sessile to short pedicelate; inner tepals smaller than external ones; floral tube cylindrical to trigonous, wings absent to largely 3-winged, wings running from the top of the floral tube down to the ovary, sometimes continuing as a crest over the outer tepals; anthers 3, sessile, inserted just below the inner tepals, connective with 2 apical and 1 basal appendage; ovary 3-locular, placentation axillary, septal nectaries 3; style 3-branched at apex, each branch with a bilabiate stigma, upper lip erect and usually clavate, lower lip flat and patent. *Capsules* crowned by persistent perianth, transversely dehiscent by several slits in the membranous wall, or irregularly dehiscent through the membranous and marcescent wall between the ribs. *Seeds* usually ellipsoid (adapted from Kamer and Maas, 2003; Maas and Maas, 1997).

Pantropical genus with about 60 species (Maas and Maas, 1997). About 20 Neotropical species, distributed from the southern United States, Mexico, Central America and the Antilles, to Peru, Paraguay, Argentina and Brazil (Maas et al., 1986). In Brazil, the genus is represented by 12 species, of which four are endemic to the country. It occurs in all regions and all states (Flora do Brasil, 2019c). In VNP two species were found.

6.a.1. *Burmannia bicolor* Mart., Nov. Gen. Sp. Pl. (Martius) 1(1): 10, t. 5. 1824. Fig. 5A–C.

Amphibian *herbs*, up to ca. 35 cm tall, glabrous. *Stems* angular, ca. 0.5 mm diam., green, sometimes the apical part purplish, predominantly unbranched. *Leaves* green, narrowly triangular-ovate to subulate, 4.0–13.0 × 1.0–2.0 mm, parallel-veined, apex acuminate, basal leaves rosulate. *Inflorescences* generally a single terminal flower, less often a bifurcate cincinnus, 2–6-flowered, each cincinnus ca. 8.0 mm length; bracts narrowly ovate, elliptic to subulate, 2.5–3.0 × 0.4–0.5 mm, apex acute to acuminate. *Flowers* blue-purplish with yellow tepals, ca. 13.0 mm length; outer tepals oval-triangular, ca. 2.0 × 1.5 mm, margins involute, 1-ribbed; inner tepals narrowly triangular to narrowly elliptic, almost columnar, 1.0 × 0.5 mm, sometimes margins involute; floral tube ca. 5.5 × 2.0 mm; wings semi-elliptic, 10.5 × 3.0 mm; style ca. 5.0 mm length; branches 1.0 mm length; ovary largely ovoid to obconical, 4.0 × 1.5 mm. *Capsules* purple, obovate to obconical, sometimes narrow, 2.5–5.5 × 1.5–3.0 mm. *Seeds* 0.2–0.7 × 0.1–0.2 mm.

The capsules were not seen in the specimens collected in Viruá—description from Maas et al. (1986). In VNP, the species is found in waterlogged areas, both in the grassy campinaranas of "Estrada Perdida" and in the "spots" of campinaranas encrusted in the forested areas of the PPBio grid.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, PARNA Viruá, 15 September 2010, *S. M. Costa et al. 742* (INPA, UEC); idem, 01°28'56"N, 61°01'13"W, 24 January 2011, *S. M. Costa 870 & K. G. Cangani* (INPA, UEC).

Additional specimens examined: BRAZIL. Minas Gerais, *s.d.*, *Martius 1196 p.p* (probable Isotype [K000524564] - image).

Geographic distribution and ecology: Cuba and South America except in the Andean parts; predominantly in sandy savannas or swamps, and in gallery forests; predominantly at low altitudes, but up to 1500 m (Maas et al., 1986). In Brazil, the species is found in the North (Amazonas, Amapá, Pará, Rondônia and Roraima), Northeast (Bahia and Maranhão), Central-West (Distrito Federal, Goiás and Mato Grosso), Southeast (Minas Gerais, Rio de Janeiro and São Paulo) and South (Paraná) regions (Flora do Brasil, 2019c).

6.a.2. *Burmannia capitata* (Walter ex J.F. Gmelin) Mart., Nov. Gen. Sp. Pl. (Martius) 1(1): 12. 1824. Figure in Giulietti (2016).

Amphibian *herbs*, up to ca. 14.0 cm tall, glabrous. *Stems* almost cylindrical, ca. 0.5 mm diam., yellowish or greenish, predominantly unbranched. *Leaves* subulate to narrowly ovate, 2.5–8.5 × ± 1.0 mm, parallel-veined, apex acute to predominantly acuminate, basal leaves rosulate. *Inflorescences* multi-flowered, capitate, consisting of 2 contracted and recurved cincinnus, or cincinnus less contracted and facing upward, 6.0 × 9.0 mm; bracts ovate to elliptic, imbricate, 2.0–2.5 × 1.0–1.5 mm, apex acute. *Flowers* white to yellowish-white, sometimes purple to greenish, ca. 3.5 × 1.0 mm; external tepals deltoid, 0.45 × 0.40 mm, margins involute; inner tepals ovate to triangular, 0.1 × 0.1 mm, sometimes absent; floral tube 1.5 × 1.0 mm; wings reduced to ribs; style 0.75 mm length; branches 0.2 mm length; ovary obovoid to ellipsoid, 2.0 × 1.0 mm. *Capsules* white to yellow, obovoid to ellipsoid, sometimes globose, 1.3–2.9 × 0.9–2.0 mm. *Seeds* 0.2–0.4 × 0.1 mm.

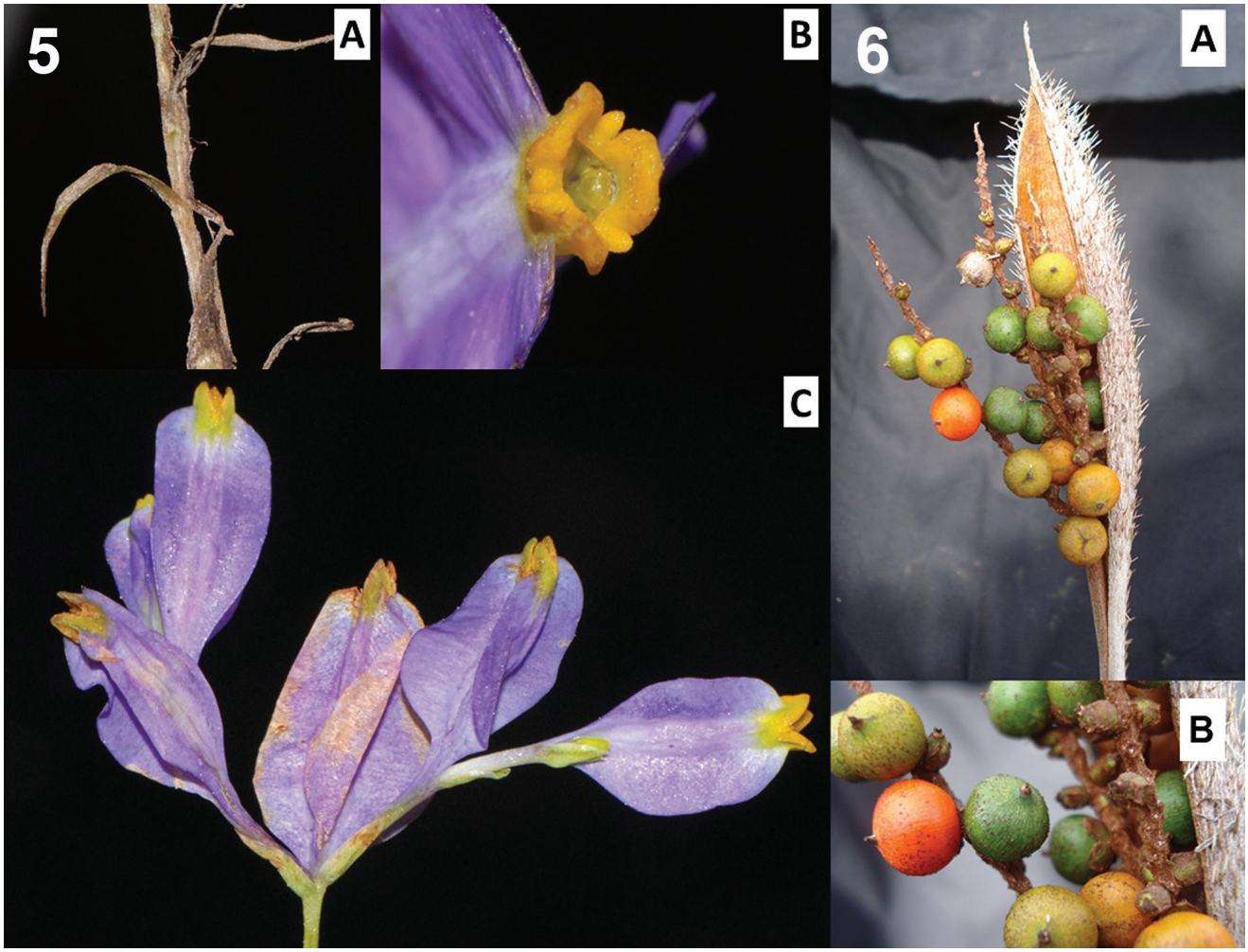
The capsules were not seen in the materials collected in Viruá—description from Maas et al. (1986).

Specimens examined from VNP: BRAZIL. Roraima: PARNA Viruá, 01°16'46"N, 60°59'20"W, 20 September 2010, *S. M. Costa et al. 792* (INPA, UEC).

Geographic distribution and ecology: from the south of the United States and Caribbean to northern Argentina, Paraguay and southern Brazil in the south; in savannas or swamps, in sandy or clayey soils (Maas et al., 1986). In Brazil, the species is found in all regions and states (except Acre) (Flora do Brasil, 2019c).

7. ARECACEAE Bercht. & J. Presl (**Arecales**)

Palm trees solitary or cespitose, spiny or not. *Stems* woody, aerial or subterranean. *Leaves* spirally or distichously arranged, palmate, costapalmate, pinnate, or entire with pinnate venation; usually petiolate; rachis conspicuous or very small; sheaths open or closed. *Inflorescences* inter or intrafoliar, usually solitary, spicate or branched; peduncle usually bearing a prophyll and 1–many bracts. *Flowers* usually 3-merous, heterochlamydeous, bisexual or unisexual (monoecious plants), sessile or pedicellate, often solitary or in triads, dyads or forming small fascicles;



FIGURES 5–6. **5.** Burmanniaceae – *Burmannia bicolor* Mart. **A**, leaves; **B**, flower (apex); **C**, inflorescence. **6.** Arecaceae – *Bactris campestris* Poepp. **A**, infructescence; **B**, fruit.

sepals generally 3, free or connate; petals generally 3, free or connate; stamens (3–)6–many, free or connate or adnate to the corolla base, staminodes present or absent; anthers basifixed or dorsifixed, 2-thecae; gynoecium apocarpous (1–)3(4) carpels or variously syncarpous generally 3-locular, or with 1 fertile locule, pistillode rudimentary or absent; style generally absent or short; stigma 3; ovule 1 per locule. *Fruits* more or less subtended by the persistent perianth, dry or drupaceous, sometimes covered by overlapping scales. *Seeds* generally one (adapted from Henderson, 1997).

Arecaceae are distributed in the tropics and subtropics of the world, few species occur in warmer temperate areas. The family has approximately 200 genera and about 2,000 species (Henderson, 1997). In the neotropics, palms are found in a wide variety of environments, from semi-deserts to savannas, mangroves, and lowland or mountain forests (Henderson, 1990). In Brazil, 37 genera and 300 species are recorded in all regions and states (Flora do Brasil, 2019b).

In this article, we chose to describe only *Bactris campestris* Poepp., because it is frequently encountered in the campinaranas of the VNP alongside other aquatic and palustrine herbs, subshrubs and shrubs. Nevertheless, it is worth mentioning that *Mauritia* sp. also occurs in VNP.

7.a. *Bactris* Jacq. ex Scop.

Monoecious *palm trees*, spiny. *Stems* solitary or cespitose. *Leaves* pinnate, entire with pinnate venation; sheaths open or close; pinnae regularly spaced or clustered, in 1 to several planes, or ± fused and then leaves entire, 1-veined. *Inflorescences* one order branched or spiciform, interfoliar; peduncles short; bract 1, much larger than the prophyll; rachillae glabrous or tomentose. *Flowers* unisexual, in triads; *staminate flowers* with (3–)6(–12) stamens, anthers linear, basifixed, pistillode minute or absent; *pistillate flowers* with varied calyx, corolla larger than the calyx or of the same length; staminodes absent or small, fused into a staminodal ring; gynoecium 3-locular and 3-ovulate, stigmas 3, sessile. *Fruits* globose to ovoid, or oblong, with apical stigmatic remnant, 1-seeded. *Seeds* with homogeneous endosperm, coriaceous (adapted from Henderson, 1997, 2000).

Bactris has a neotropical distribution and has about 100 species (Henderson, 1997). In Brazil, there are 45 species in

all regions and all states (except Ceará, Rio Grande do Norte and Paraíba in Northeast region) (Flora do Brasil, 2019b). In VNP one species was found.

7.a.1. ***Bactris campestris*** Poepp., ex Mart., Hist. Nat. Palm. 2: 146. 1837. Fig. 6A–B.

Amphibious, cespitose, 1.0–2.0 m tall. *Stems* 2.5 cm diam.; spines at the base of the leaf flattened and black, ca. 20.0 × 1.0 mm. *Leaves* densely villose, trichomes whitish-gray, pinnas spirally arranged, ensiform, ca. 22.5–29.0 × 1.0–1.5 cm, both surfaces glabrous, abaxial surface slightly lighter; peduncle 16.0 × 5.0 cm, grayish; rachilla 14.5 × 0.5 cm, densely rusty. *Fruits* depressed-globose, 6.0 × 7.0 mm, green when unripe, yellow or red when ripe.

In VNP, *Bactris campestris* is found in woody-grassy campinaranas where it occurs very frequently.

Specimens examined from VNP: BRAZIL. Roraima: Caracaraí, Parque Nacional do Viruá, N1-N2/L3, 22 January 2011, *S. M. Costa 840* (INPA, UEC); idem, 01°24'09"N, 60°59'11"W, 25 July 2010, *T. D. M. Barbosa 1343 & S. M. Costa* (INPA, UEC).

Additional specimens examined: GUYANA. January 1880, *E.F. im Thurm* (probable type of *Bactris leptocarpa* Trail ex im Thurm [K000584792] - image).

Geographic distribution and ecology: Colombian Amazon, Trinidad, Guyana, Suriname, French Guiana, Brazilian Amazon [in the North (Amazonas, Amapá, Pará and Roraima) and Northeast (Maranhão) regions] (Flora do Brasil, 2019b; Henderson, 1997).

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Appendix
Index to Numbered Collections

Amaral, M.C.E. 2011/33 & Silva, C.F. (**2.a.2**); *2011/34* (**5.a.1**)

Barbosa, T.D.M. 1201 & Costa S.M. (**1.a.1**); *1269* (**1.a.1**); *1230* (**1.a.2**); *1229* (**2.a.1**); *1110* (**3.b.2**); *1403* (**4.b.1**); *1343* (**7.a.1**)

Barbosa, T.D.M. et al. 1096 (**1.a.2**); *1094* (**3.a.1**); *1097* (**3.b.1**)

Costa, S.M. 840 (**7.a.1**)

Costa, S.M. 694 & Barbosa, T.D.M. (**2.a.1**)

Costa, S.M. 763 & Cangani, K.G. (**1.a.1**); *894* (**1.a.2**); *870* (**6.a.1**)

Costa, S.M. et al. 766 (**1.a.1**); *763* (**1.a.2**); *815* (**2.a.2**); *754* (**3.a.1**); *770b* (**3.b.2**); *768* (**4.a.1**); *762* (**5.a.1**); *742* (**6.a.1**); *792* (**6.a.2**)

Pedrollo, C.T. et al. 140 (**3.b.2**)