



Original Paper

Synopsis of Rubiaceae from the Iguaçu National Park, Paraná, Brazil

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Abstract

Iguaçu National Park represents the largest fragment of Inland Atlantic Rainforest of Paraná state. The vegetation is predominantly seasonal semideciduous forest, in the areas of Foz do Iguaçu and Capanema and a transition of this with *Araucaria* forest, in the Céu Azul area. This work aimed to recognize the genera and species of Rubiaceae occurring in the Park, through monthly collections from August 2013 to July 2014, supplemented with sporadic collections from May 2018 to April 2019. Thirty-five species were recorded, belonging to 19 genera. The most representative genera were *Palicourea* and *Psychotria* with five species, *Galianthe*, *Manettia*, *Borreria* with three, *Geophila* and *Coccocypselum* with two, and the other genera with only one species each. The areas with the major species richness were Foz do Iguaçu, with 24, of which four are exclusive to this area, followed by Céu Azul with 22 species, of which eight are exclusive. Of the 35 species recorded, seven occur in all areas and in both forest formations, seven occur only in the *Araucaria* forest area, and 20 occur only in the seasonal semideciduous forest. *Borreria orientalis* is highlighted due to its restricted distribution in Brazil, occurring only in Paraná, and *Manettia tweedieana* is considered endangered.

Palavras-chave: Seasonal Semideciduous forest, *Araucaria* Forest, taxonomy.

Resumo

O Parque Nacional do Iguaçu representa o maior fragmento de Mata Atlântica de Interior do estado do Paraná. Sua vegetação é predominantemente de Floresta Estacional Semidecidual, nas áreas de Foz do Iguaçu e Capanema e uma transição desta com Floresta Ombrófila Mista, na Área de Céu Azul. Este trabalho teve por objetivo reconhecer os gêneros e espécies de Rubiaceae com ocorrência no Parque, através de coletas mensais de agosto de 2013 a julho de 2014, complementadas com coletas esporádicas de maio de 2018 a abril 2019. Foram encontradas 35 espécies, pertencentes a 19 gêneros. Os gêneros mais representativos foram *Palicourea* e *Psychotria* com cinco espécies, *Galianthe*, *Manettia*, *Borreria* com três, *Geophila* e *Coccocypselum* com duas e os demais gêneros com apenas uma espécie cada. As áreas com maiores riquezas de espécies foram Foz do Iguaçu, com 24, sendo quatro exclusivas desta área, seguidas de Céu Azul com 22 espécies, das quais oito são exclusivas. Das 35 espécies encontradas sete ocorrem em todas as áreas e em ambas as formações florestais, sete ocorrem só na área de Floresta Ombrófila Mista e 20 ocorrem somente na Floresta Estacional Semidecidual. Destacam-se ainda *Borreria orientalis* por ter uma distribuição restrita no Brasil, apenas no Paraná e *Manettia tweedieana* por ser considerada “Em Perigo” de extinção.

Key words: Floresta Estacional Semidecidual, Floresta Ombrófila Mista, taxonomia.

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Introduction

Rubiaceae Juss. is considered the fourth richest botanical family, only behind Orchidaceae, Asteraceae and Leguminosae (Davis *et al.* 2009). The family has a cosmopolitan distribution, with greater diversity in the tropics, occurring in almost all forest formations (Souza & Lorenzi 2012). It has approximately 650 genera and 13,000 species (Delprete & Jardim 2012) being also the fourth most diverse family in Brazil, with 126 genera and 1,404 species, of which 731 are considered endemic (BFG 2018). Rubiaceae can be easily recognized in the vegetative stage, due to its simple leaves, opposite, rarely verticillate, leaf blade with entire margin, presence of interpetiolar (rare intrapetiolar) stipules, although in some cases they may be extremely small, but visible, rarely absent. When deciduous, they leave a linear scar at petiole height (Campos *et al.* 1999).

According to Delprete & Jardim (2012), for southern Brazil Rubiaceae has a satisfactory level of taxonomic studies, but this conclusion is based mainly on specimens from Santa Catarina (Delprete *et al.* 2004, 2005). In Paraná, only a floristic study of the arboreal and shrubby species of the Tibagi River basin (Ferreira Junior & Vieira 2015), a review of *Manettia* Mutis ex L. (Marinero *et al.* 2012), a Rubiaceae flora of riparian vegetation of a stretch of the upper Paraná River (Pereira 2007), and a floristic study of the Psychotriaceae, Coussareeae and Morindeae tribes in the region of Porto Rico, Upper Paraná River (Souza & Souza 1998) have been provided. In the Management Plan of the Iguaçu National Park only four species of Rubiaceae are mentioned, *Faramea cyanea* Müll. Arg., *Manettia* sp., *Palicourea marcgravi* A.St.-Hil., and *Psychotria* sp. (IBAMA 1999), and this low number is probably due to the predominance of herbaceous or shrubby species in the family, while management plans usually sample tree species.

For the Iguaçu National Park an epiphyte listing (Cervi & Borgo 2007), a study on ferns and lycophytes (Lautert *et al.* 2015) and tree species surveys (Gris & Temponi 2017; Souza *et al.* 2017) have been provided. In addition, floras or synopses of representative families of the shrub and herbaceous strata have also been monographed and are currently being published: Orchidaceae (Boff 2016), Acanthaceae, and Verbenaceae (Hammes 2017), Cyperaceae and Poaceae (Jesus 2017), and Bignoniaceae (Hentz Junior 2018). The Rubiaceae, being well represented in species richness and

abundance, is an important indicator for taxonomic, ecological, and conservation studies (Delprete & Jardim 2012), which confirms the need for a floristic survey for the family in Iguaçu National Park, contributing to the biodiversity assessment in this important conservation unit of Paraná.

Material and Methods

Study area

Due to its favorable soil for agricultural activities, the original vegetation of western region of Paraná state has been extremely devastated over the years, leaving only small portions of original formations (Maack 2012). Iguaçu National Park (Fig. 1) represents the largest of these fragments, although it corresponds to less than 4% of the original area. The Park is part of the Atlantic Forest biome, represented by the Submontane Semideciduous Seasonal Forests (SSF) and *Araucaria* Forest (AF) (IBAMA 1999; Roderjan *et al.* 2002; IBGE 2012), with a total area of 185,262.5 hectares and a perimeter of 420 km, at the coordinates 25°05' to 25°41' South and 53°40' to 54°38' West (IBAMA 1999). It is located in the subtropical climate region (Cfa) and the summers are hot and have a higher concentration of rainfall, but there is no defined dry season and the frequency of frost is low (IAPAR 2010).

For this study the Park was divided into three areas (Fig. 1): the Céu Azul Area, covering the trails located in the northern portion of the Park, the Capanema Area to the south and the Foz do Iguaçu Area in the southwest region. In the Area 1 (Céu Azul) there are the following trails: Fazenda Rio Butu, Nascentes do Jumelo, Araucárias, Cachoeira rio Azul, Manoel Gomes and Jacutinga (Fig. 1a-f). The trails are predominantly under Montane AF with transition to Submontane SSF, at altitudes ranging from 400 to 700 meters. In the Area 2 (Capanema) the trails were Iguaçu River Banks on the Brazilian side, Cachoeira Rio Silva-Jardim, and Ilha do Sol (Fig. 1). The predominant forest formation is Submontane SSF at altitudes of 150 to 250 meters. In order to have access to the trails, a motor boat was used, traveling along the Iguaçu River. Rubiaceae species seen along the river banks were also collected. In the Area 3 (Foz do Iguaçu) the trails were Poço Preto, Represa São João, Antiga Usina, Escola Parque, Macuco Safari, Bananeiras, Cataratas, and Hidrante (Fig. 1j-q). Its vegetation is predominantly Submontane SSF, with altitudes ranging between 100 and 270 meters.

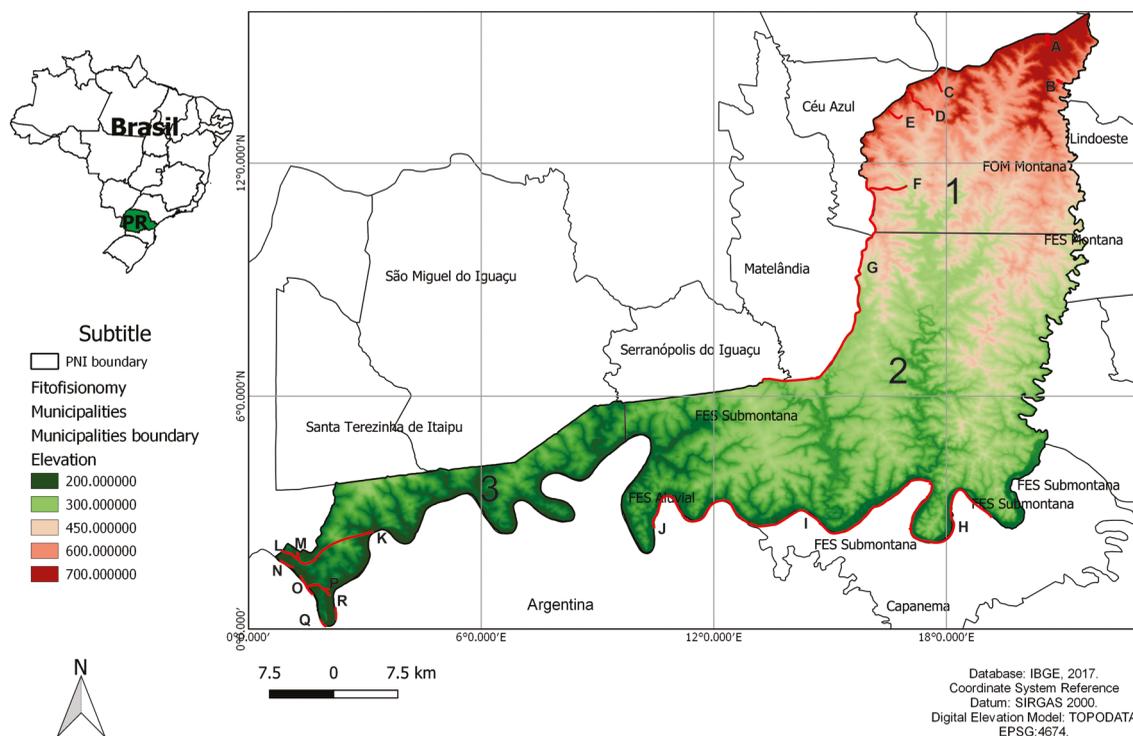


Figure 1 – Map of Iguacu National Park and respective trails – Three areas of ParNa: Céu Azul (area 1) – A. Fazenda Rio Butu; B. Nascentes do Jumelo; C. Araucárias; D. Cachoeira Rio Azul; E. Manoel Gomes; F. Jacutinga. Capanema (area 2): G. Matelândia H. Banks of Rio Iguacu on the Brazilian side; I. Cachoeira Rio Silva-Jardim; J. Ilha do Sol. Foz do Iguacu (area 3): K. Poço Preto; L. Represa São João; M. Antiga Usina; N. Escola Parque; O. Macuco Safari; P. Bananeiras; Q. Cataratas; R. Hidrante (Based on Hammes *et al.* 2021).

Data collection and analysis

Field work was made monthly to several trails in Iguacu National Park (Fig. 1) between August 2013 and July 2014. Complementary collections were performed sporadically between May 2018 and April 2019, using the walking method described by Filgueiras *et al.* (1994). After being collected, photographed, analyzed and herborized using standard techniques (Bridson & Forman 2004), the specimens were identified through specific literature (Delprete *et al.* 2004; 2005; Jung-Mendaçolli 2007) and by comparison with herbarium collections from other institutions: CTES, EVB, FUEL, HUEM, MBM, and UPCB (Thiers, continuously updated). And the specimens were deposited in the UNOP herbarium and their duplicates are in CTES, EVB, HCF, and MBM.

Morphological studies of vegetative and reproductive characteristics were made with a stereomicroscope. These characteristics were used for the elaboration of identification keys

and illustrations. The morphological terms follow Radford *et al.* (1974), Stearn (1992) and the spellings of the scientific names and their authors were verified in The International Plant Names Index (IPNI 2019) and BFG (2018). Data on flowering, fruiting, and geographic distribution of the species were obtained from the specimens collected and from those deposited in the herbaria cited above, as well as in specific literature (Delprete *et al.* 2004, 2005).

Results and Discussion

In the Iguazu National Park 35 species were recorded, belonging to 19 genera. The most representative genera were *Palicourea* Aubl. and *Psychotria* L. with five species each, followed by *Borreria* G. Mey., *Galianthe* Griseb. ex Lorentz, and *Manettia* Mutis ex L., with three species, and *Coccocypselum* P.Browne and *Geophila* D.Don with two species each. The other genera, *Cephalanthus* L., *Chomelia* Jacq., *Cordia* A.Rich. ex DC., *Coussarea* Aubl.,

Diodia L., *Faramea* Aubl., *Galium* L., *Guettarda* L., *Hamelia* Jacq., *Ixora* L., *Richardia* L., and

Spermacoce L., were represented by only one species each.

Identification key for the genera of Rubiaceae from the Iguaçu National Park

1. Herbs, scandent subshrubs or vines.
 2. Vines, winged seeds 15. *Manettia*
 - 2'. Herbs or scandent subshrubs, wingless seeds.
 3. Leaves and stipules equal in size and shape, calyx absent 10. *Galium*
 - 3'. Leaves and stipules different in size and shape, calyx present.
 4. Stipules entire.
 5. Fruit baccate, blue or purple, seeds numerous 4. *Coccocypselum*
 - 5'. Fruit drupaceous, orange and dark purple, seeds two 11. *Geophila*
 - 4'. Stipules fimbriate, rarely 1 fimbria (*Diodia saponariifolia*).
 6. Inflorescences with 1–2 flowers, always axillary; hypanthium and fruit hidden by stipular sheath; fruit indehiscent 7. *Diodia*
 - 6'. Inflorescences multiflorous, terminal and axillary; hypanthium and fruit not hidden by stipular sheath; fruit dehiscent
 7. Inflorescence thyrsoid; flowers pedicellate, distylous 9. *Galianthe*
 - 7'. Inflorescence glomeruliform, flowers sessile, homostylous.
 8. Calyx caducous; stigma 3-fid; fruit schizocarpic, separating into three mericarps 18. *Richardia*
 - 8'. Calyx persistent; stigma 2-fid or 2-lobed; fruit capsular, separating into two mericarps or indehiscent.
 9. Inflorescence pseudoaxillary (unilateral position); flowers with stamens and stigma included; fruit indehiscent or tardily apically dehiscent into two indehiscent mericarps 19. *Spermacoce*
 - 9'. Inflorescences apical and axillary, flowers with stamens and stigma exerted; fruit with both mericarps dehiscent 1. *Borreria*
 - 1'. Trees and erect shrubs.
 10. Fruit baccate.
 11. Stipules aristate 14. *Ixora*
 - 11'. Stipules triangular.
 12. Leaf domatia in crypt; flowers unisexual, white, pleasantly fragrant 5. *Cordia*
 - 12'. Leaf domatia absent; flowers bisexual, orange-reddish, without fragrance 13. *Hamelia*
 - 10'. Fruit drupaceous or capsules.
 13. Corolla externally white.
 14. Inflorescence glomeriform; corolla with a black colleter at interlobular sinuses; capsular fruit; seeds with a white spongy aril 2. *Cephalanthus*
 - 14'. Inflorescence not glomeriform; corolla without colletes; drupaceous fruits; seeds without aril.
 15. Fruit with one seed 6. *Coussarea*
 - 15'. Fruit with more than one seed.
 16. Calyx and hypanthium up to 0.5 mm long 16. *Palicourea* (*P. brevicollis*)
 - 16'. Calyx and hypanthium longer than 1 mm 17. *Psychotria*
 - 13'. Corolla never white (yellow, orange, pinkish, lilac, vinaceous or bluish).
 17. Stipules bilobate 16. *Palicourea*
 - 17'. Stipules entire.
 18. Inflorescence terminal 8. *Faramea*
 - 18'. Inflorescence axillary.
 19. Stigma bifid 3. *Chomelia*
 - 19'. Stigma capitate 12. *Guettarda*

1. *Borreria* G.F.W. Mey., Prim. Fl. Esseq. 79. 1818.
nom. cons.

Key to species of *Borreria* in Iguazu National Park

1. Inflorescence terminal and one subterminal; bracts 4; stigma 2-lobate..... 1.2. *Borreria orientalis*
- 1'. Inflorescence terminal and axillary; bracts 2; stigma bifid, before anthesis.
 2. Margin of the stipular sheath truncate, at the same height as the base of leaf blade 1.1. *Borreria latifolia*
 - 2'. Margin of the stipular sheath tubular, extending beyond the base of the leaf blade 1.3 *Borreria schumannii*

1.1. *Borreria latifolia* (Aubl.) K.Schum., *Fl. bras.* (Martius) 6, pt. 6: 61, pl. 80. 1888. Figs. 2a-b; 3a
Supplementary Bibliography: Jung-Mendaçolli (2007), Oliveira *et al.* (2014).

Selected specimen: Area 1, Santa Tereza do Oeste, 3.V.2013, fl. and fr., *M.L. Toderke et al.* 70 (UNOP).

It is distributed in Central and South America and as an introduced species into Africa, Asia and Australia. In Brazil, occurs in almost the entire country except Rio Grande do Sul and in almost all vegetation types (Cabral *et al.* 2011; BFG 2018). In Iguazu National Park, it was found only at municipality of Santa Tereza do Oeste, in the Céu Azul area (AF).

The species can be observed flowering and fruiting through the year (Cabral *et al.* 2011). In the Park it was found in both flower and fruit in May.

This species is characterized by having inflorescences with numerous axillar glomeruli, each one with two bracts, yellowish leaves when dry, bifid stigma, and corolla lobes internally pilose.

1.2. *Borreria orientalis* E.L. Cabral, R.M. Salas & L.M. Miguel, Bol. Soc. Argent. Bot. 47(3-4): 430. 2012. Figs. 2c-d; 3b

Supplementary Bibliography: Cabral *et al.* (2012).

Selected specimen: Area 3, Foz do Iguazu, 17.XII.2013, fl. and fr., *M.L. Toderke et al.* 140 (UNOP).

It is distributed in Northern Argentina, eastern Paraguay, and southern Brazil. In Brazil it only occurs in the state of Paraná (Cabral *et al.* 2012). In the Park it was found only in the “Foz do Iguazu” area.

In the Park the species was collected with flowers and fruits between August and December.

The species is characterized by only one terminal glomerulus and a subterminal one, it has four foliaceous bracts that are three times longer than the inflorescence, and ruminant seeds.

1.3. *Borreria schumannii* (Standl. ex Bacigalupo) E.L. Cabral & Sobrado, Acta Bot. Brasil. 25(2): 266. 2011. Figs. 2e-f; 3c

Supplementary Bibliography: Delprete *et al.* (2005) as *Spermacoce schumannii*; Zappi *et al.* (2014).

Selected specimens: Area 1, Céu Azul, 12.XII.2018, fl., *C.R. Rauber et al.* 248 (UNOP); Area 2, Capanema, 20.III.2014, fl. and fr., *M.L. Toderke et al.* 173 (UNOP); Area 3, Foz do Iguazu, 22.V.2018, fl., *C.R. Rauber et al.* 18 (UNOP).

It is distributed in Northeast Argentina, Paraguay, and Brazil, where it is widely distributed in several vegetation types (BFG 2018). In the Park the species was found in all areas.

Flowers and fruits all year long (Cabral *et al.* 2011). In the Park the species was found flowering and fruiting in February and March.

The species is characterized as being a scandent subshrub (Silveira 2010) with a tubular margin of the stipular sheath, extending beyond the base of the leaf blade. As *B. latifolia*, when dry its leaves are also yellowish.

2. *Cephalanthus* L., Sp. Pl. 1: 95. 1753; Gen. Pl. ed. 5, 42. 1754.

2.1. *Cephalanthus glabratus* (Spreng.) K.Schum, *Fl. bras.* 6(6): 128, t. 94. 1889. Fig. 3d

Supplementary Bibliography: Pereira & Kinoshita (2013).

Selected specimen: Area 3, Foz do Iguazu, 27.X.2018, fl., *C.R. Rauber et al.* 202 (UNOP).

It is distributed throughout the River Plate Basin, Paraguay, Argentina, and Uruguay. In Brazil, it occurs in the southern states, as well as São Paulo, Mato Grosso, and Mato Grosso do Sul (Delprete *et al.* 2004; BFG 2018). In the Park the species was found only in the Foz do Iguazu Area.

According to Delprete *et al.* (2004), this species flowers between November and December.

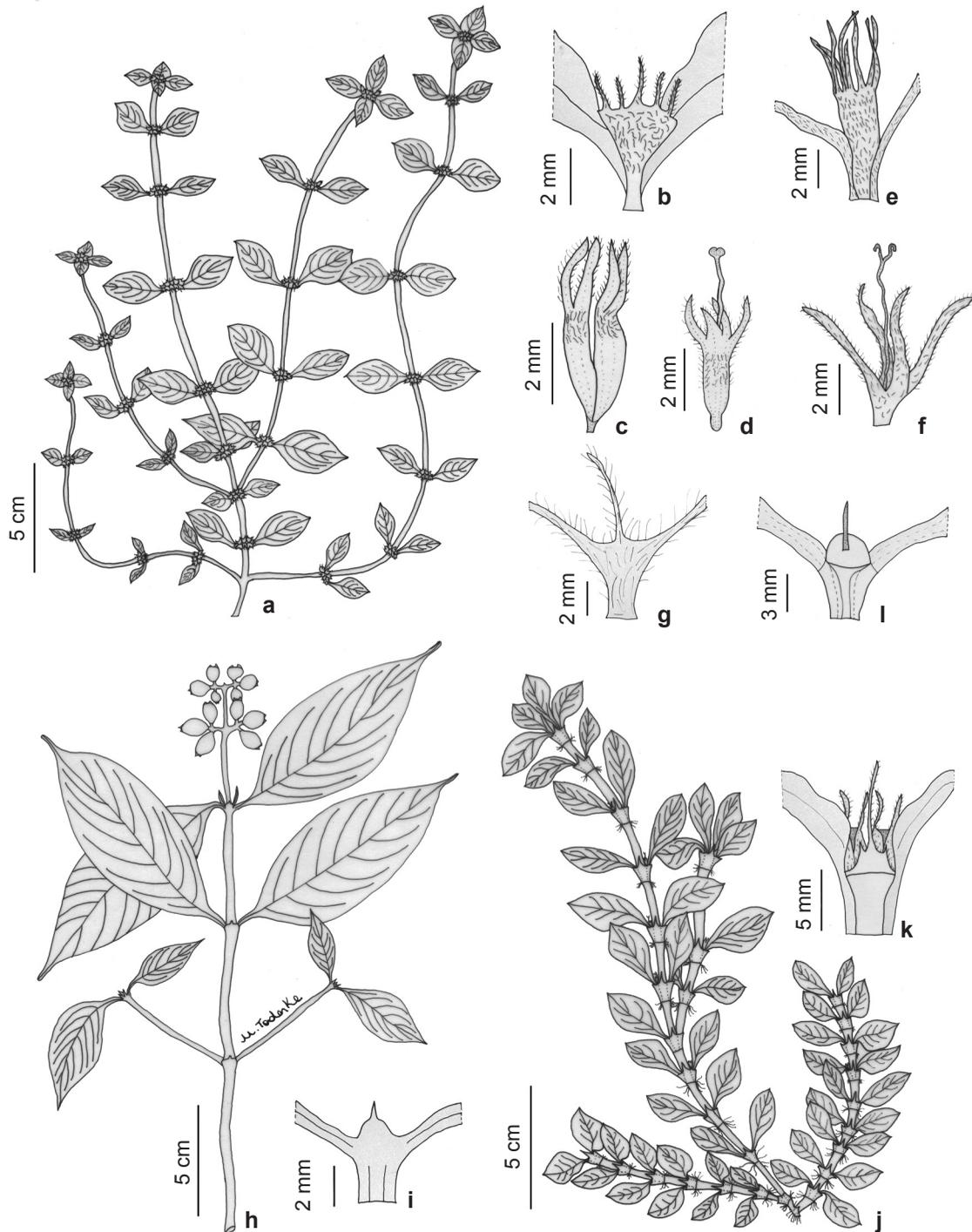


Figure 2 – a-b. *Borreria latifolia* – a. habit; b. stipule sheath. c-d. *Borreria orientalis* – c. fruit with two dehiscent mericarps; d. calyx and capitate stigma. e-f. *Borreria schumannii* – e. stipule sheath; f. calyx and bifid stigma. g. *Coccocypselum hasslerianum* – stipule sheath. h-i. *Coussarea contracta* – h. habit; i. stipule sheath. j-k. *Diodia saponariifolia* – j. habit; k. fruit hidden by stipule sheath. l. *Faramaea hyacinthina* – stipule sheath. (a-b. Toderke 70 (UNOP); c. Toderke 140 (UNOP); d. Toderke 77 (UNOP); e-f. Toderke 163 (UNOP); g. Toderke 216 (UNOP); h-i. Toderke 162 (UNOP); j. Labiak 3822 (MBM); k. Ribas 6050 (MBM); l. Toderke 73 (UNOP)).

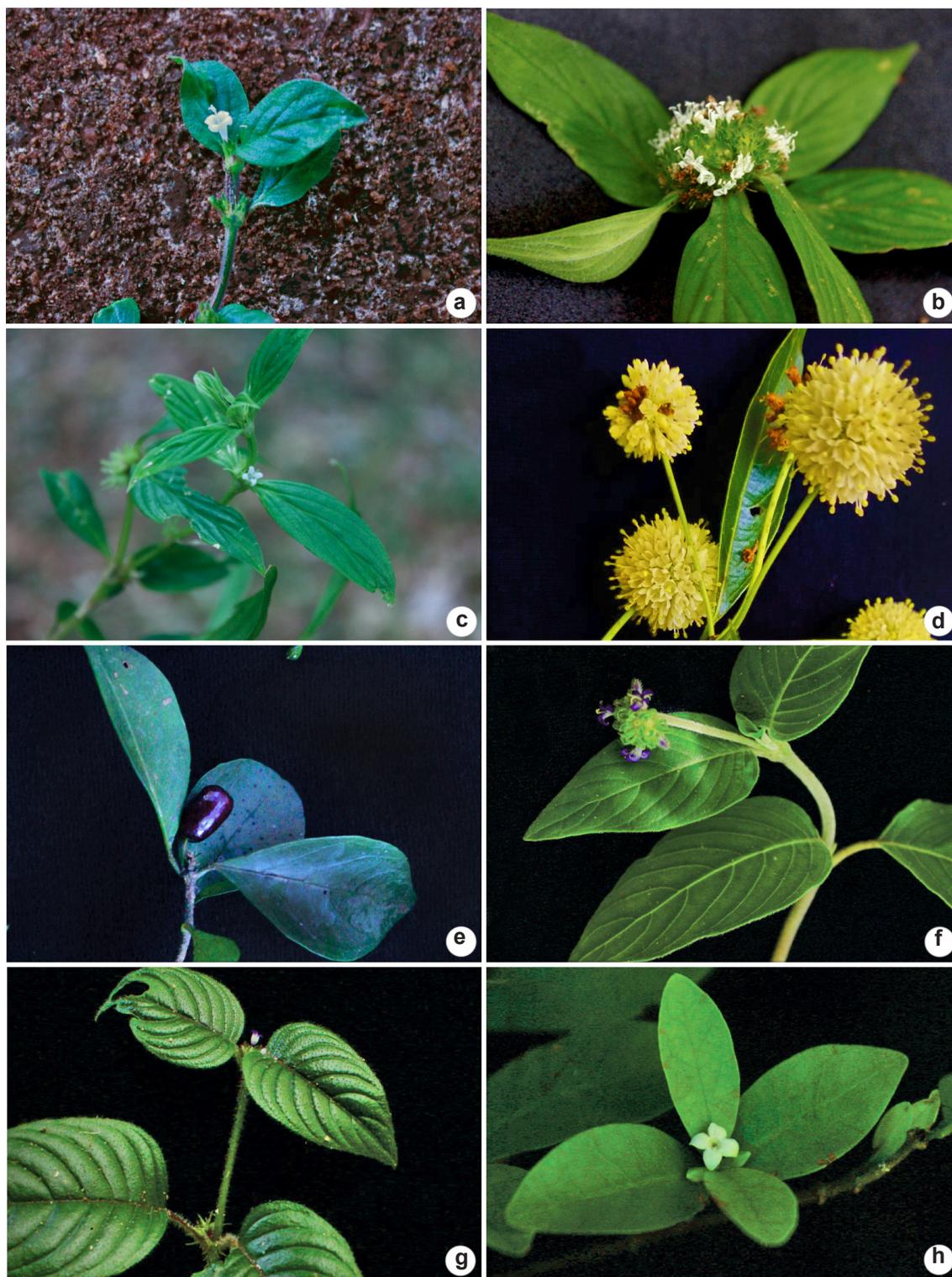


Figure 3 – a. *Borreria latifolia* – flower. b. *Borreria orientalis* – inflorescence. c. *Borreria schumannii* – flower. d. *Cephalanthus glabratus* – inflorescence. e. *Chomelia obtusa* – fruit. f. *Coccocypselum condalia* – inflorescence. g. *Coccocypselum hasslerianum* – inflorescence. h. *Cordiera concolor* – flower. (Photos: a-c, g. Zini AS, 2014; d-f,h. Rauber CR, 2018).

In the Park it was found flowering in October and November.

This species is characterized by its verticillate leaves, white flowers in glomeriform, cymose inflorescence, and seeds with a white spongy aril.

3. *Chomelia* Jacq., Opera Var. 210. 1758.

3.1. *Chomelia obtusa* Cham. & Schltdl., *Linnaea* 4(2): 185. 1829. Fig. 3e

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015).
Selected specimens: Area 1, Céu Azul, 7.II.2019, fl. and fr., M.G. Caxambu 8880 (HCF); Area 3: Foz do Iguaçú, 18.V.2019, fr., L.H.S.M. Conceição 106 (UNOP).

The species occurs in almost all states in Brazil, except in the northern region, and it extends

to Argentina throughout the River Plate Basin (Delprete *et al.* 2004; BFG 2018). In the Park the species was found in the areas of Foz do Iguaçú and Céu Azul.

The flowering of this species begins in October according Delprete *et al.* (2004), although in the Park it was found flowering between December and February, and fruiting in February through March.

The species differs from remaining species of *Chomelia* inhabiting South Brazil by having leaves with tertiary veins obscure (BFG 2018) and domatia in crypt (Romero *et al.* 2015).

4. *Coccocypselum* P.Browne, Civ. Nat. Hist. Jamaica 144. 1756.

Key to species of *Coccocypselum* in Iguaçú National Park

1. Leaf blade with attenuate or truncate base, glabrous; pedunculate inflorescences..... 4.1. *Coccocypselum condalia*
- 1'. Leaf blade with cordate base, hirsute; sessile inflorescences..... 4.2. *Coccocypselum hasslerianum*

4.1. *Coccocypselum condalia* Pers., Syn. Pl. 1: 132. 1805. Fig. 3f

Supplementary Bibliography: Jung-Mendaçolli (2007); Oliveira *et al.* (2014); Zappi *et al.* (2014).

Selected specimen: Area 1, Céu Azul, 7.II.2019, fl., C.R. Rauber *et al.* 250 (UNOP).

The species is distributed in Guyana, Peru, Paraguay, and Brazil, where it occurs in states (Delprete *et al.* 2004; BFG 2018). In the Park, it occurs only in the Céu Azul area (AF).

Flowers from October to February (Delprete *et al.* 2004). In the Park the species was found flowering from December through February.

This species is characterized by the absence of indumentum on vegetative parts and by pedunculate inflorescences.

4.2. *Coccocypselum hasslerianum* Chodat, Bull. Herb. Boissier ser. 2, 4: 169. 1904. Figs. 2g; 3g

Supplementary Bibliography: Jung-Mendaçolli (2007); Oliveira *et al.* (2014); Zappi *et al.* (2014).

Selected specimen: Area 1, Céu Azul, 12.XII.2018, fl., C.R. Rauber *et al.* 235 (UNOP).

The species is distributed in northern Argentina (Misiones), eastern Paraguay and, in Brazil in almost all regions of the country, except the northern (Costa & Mamede 2002; Cabral &

Salas 2007). In the Park, it occurs only in the Céu Azul area (AF).

Flowers and fruits through the year (Cabral & Salas 2007). In the Park, it was found fruiting in June and July.

This species is characterized by its dense hirsute indumentum, with long erect trichomes and sessile inflorescences (Costa & Mamede 2002).

5. *Cordia* A.Rich. ex DC., Prodr. 4: 445. 1830.

5.1. *Cordia concolor* (Cham.), Kuntze Revis. Gen. Pl. 1: 279. 1891. Fig. 3h

Supplementary Bibliography: Delprete *et al.* (2004); Ferreira Junior & Vieira (2015).

Selected specimen: Area 1, Santa Tereza do Oeste, 30.I.2019, fr., C.R. Rauber *et al.* 302 (UNOP).

This species occurs in Argentina, Paraguay, and Brazil, where it occurs in all regions (Delprete *et al.* 2004; BFG 2018). In the Park, it was found in municipality of Santa Tereza do Oeste in the area of Céu Azul (AF).

Flowers from November to March (Delprete *et al.* 2004). In the Park, the species was found flowering in December and January.

This species is characterized by its subsessile to shortly petiolate leaves, with elliptical, oblong to lanceolate blades, usually chartaceous to subcoriaceous, and leaf domatia in crypt.

6. *Coussarea* Aubl., Hist. Pl. Guiane 98. 1775.

6.1. *Coussarea contracta* (Walpert) Müll.Arg., Flora 58(30): 467. 1875. Fig. 2h-i

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015).

Selected specimens: Area 2, Serranópolis do Iguacu, 13.X.2016, fl., *M.G. Caxambu 7624* (HCF); Area 3, Foz do Iguacu, 22.V.2018, fr., *C.R. Rauber et al. 2* (UNOP).

It is distributed throughout Argentina, Paraguay, and Brazil, where it has a wide distribution, except in the northern region (Gomes 2003). In the Park, it was found in the Foz do Iguacu and Capanema areas.

The species has marked flowering in October and November, and its fruits ripen in May and June (Gomes 2003). In the Park, it was found flowering in October and with unripe fruits in February.

This species is characterized by its unbranched inflorescences axes and markedly compressed fruits (Gomes 2003).

7. *Diodia* L., Species Plantarum. 2. 1753.

7.1. *Diodia saponariifolia* (Cham. & Schltdl.) K.Schum., *Fl. bras.* 6, pt. 6: 16. 1888.

Figs. 2j-k; 4a

Supplementary Bibliography: Jung-Mendaçolli (2007); Oliveira *et al.* (2014).

Selected specimens: Area 2: Capanema, 30.II.2016, fl., *M.L. Toderke et al. 230* (UNOP); Area 3, Foz do Iguacu, 30.X.2006, fl. and fr., *P.H. Labiak et al. 3822* (MBM).

It is distributed in South America in Brazil, Argentina, and Paraguay (Bacigalupo & Cabral 1999). In Brazil, it occurs in the Central-west, Southeast, South and in the state of Bahia in the Northeast region (BFG 2018), and in the Park

it was found in the areas of Foz do Iguacu and Capanema.

Flowering from October to March (Delprete *et al.* 2004). In the Park it was found flowering in October and February.

This species is characterized by the corolla rising over the foliage close to the ground (Bacigalupo & Cabral 1999; Jung-Mendaçolli 2007), style bifid with stigmatic spreading branches, corolla lobes internally pilose, and by presenting fruits hidden by the stipular sheath, indehiscent.

8. *Faramea* Aubl., Hist. Pl. Guiane 102. 1775.

8.1. *Faramea hyacinthina* Mart., Flora 24(2): 73. 1841. Figs. 2l; 4b

Supplementary Bibliography: Gomes (2003); Jung-Mendaçolli (2007).

Selected specimen: Area 3, Foz do Iguacu, 4.VII.2018, fl., *C.R. Rauber et al. 109* (UNOP).

The species is distributed in South America in Brazil, Argentina, and Paraguay. In Brazil, it occurs in the states of Sergipe and Bahia, throughout southeastern region unto the state of Paraná (Gomes 2003; BFG 2018). In the Park, the was found only in the Foz do Iguacu area.

Flowers in September and October, and fruits in February (Gomes 2003). In the Park, the was found flowering and fruiting from June to February.

This species is characterized by the translucent dots of the leaves, which have a sharp-cuneate base and abruptly cuspidate apex and by its blue flowers (Gomes 2003).

9. *Galianthe* Griseb., Abh. Königl. Ges. Wiss. Göttingen 24: 156. 1879.

Key to species of *Galianthe* in Iguacu National Park

1. Leaf blade elliptical to lanceolate, 8–25 × 1.8–4 mm, only the primary vein visible, both faces scabrous.....9.1. *Galianthe brasiliensis*
- 1'. Leaf blade elliptical, 35–75 × 12–28 mm, with 4–6 pairs of secondary veins, both faces glabrous, puberulous or pubescent.
 2. Plants stoloniferous, radicant at the nodes, inflorescences terminal, cymose, partial inflorescences short pedunculate, pauciflorous; fruits dehiscing into two indehiscent mericarps 9.2. *Galianthe hispidula*
 - 2'. Plant usually erect; inflorescence in the main and lateral branches, thyrsoid, lax, long pedunculate; fruits dehiscing into two dehiscent mericarps..... 9.3. *Galianthe laxa*

9.1. *Galianthe brasiliensis* (Spreng.) E.L. Cabral & Bacigalupo, Ann. Missouri Bot. Gard. 84(4): 861. 1998. Fig. 4c

Supplementary Bibliography: Jung-Mendaçolli (2007); Florentín *et al.* (2017).

Selected specimens: Area 2, Capanema, 8.XI.2013, fl.

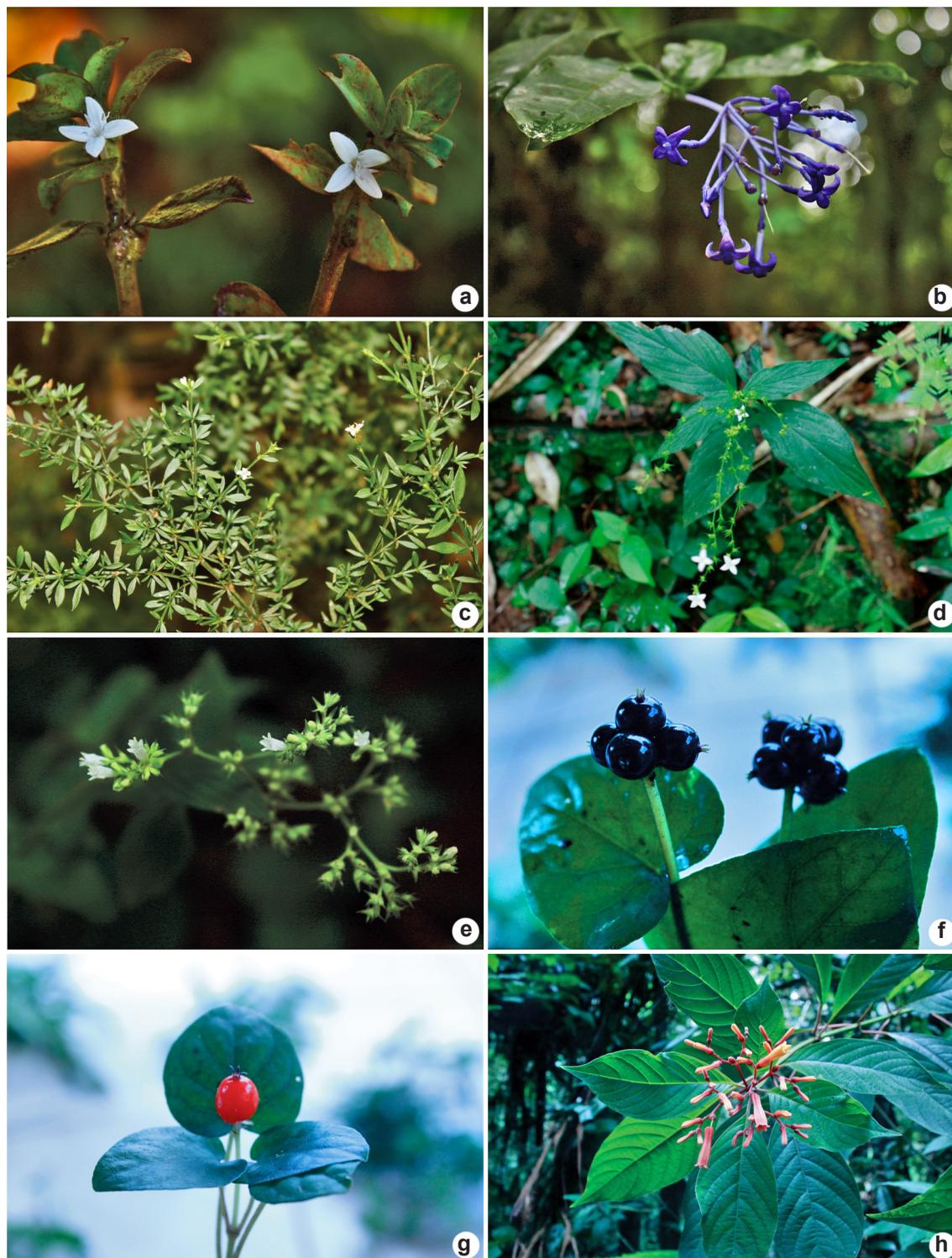


Figure 4 – a. *Diodia saponariifolia* – habit. b. *Faramaea hyacinthina* – inflorescence. c. *Galianthe brasiliensis* – habit. d. *Galianthe hispidula* – inflorescence; e. *Galianthe laxa* – inflorescence. f. *Geophila macropoda* – fruit. g. *Geophila repens* – fruit. h. *Hamelia patens* – inflorescence. (Photos: f-g. Zini AS, 2014; a-b, e. Rauber CR, 2018; c-d, h. Toderke ML, 2013).

and fr., *M.L. Toderke et al.* 124 (UNOP); Area 3, Foz do Iguazu, 10.XII.2018, fl., *C.R. Rauber et al.* 231 (UNOP).

The species is distributed in South America, in Brazil, Paraguay, Uruguay and Argentina (Cabral & Bacigalupo 1997). In Brazil it is present throughout the South and Southeast, in the Central-west in Mato Grosso do Sul and in the Northeast in Bahia (BFG 2018); in the Park the was found in the Foz do Iguazu and Capanema areas.

Flowers and fruits through the year, with predominance from December to March (Delprete *et al.* 2004). In the Park it was found flowering and fruiting in May, and from October to December.

This species is characterized by its subshrubby habit, abundant branching and small leaves compared to other species of *Galianthe* studied and with only the primary vein visible. In addition, it has thyrsoid, monochasial and dichasial inflorescences, short pedunculate, and fruits dehiscing into two indehiscent mericarps.

9.2. *Galianthe hispidula* (A.Rich. ex DC.) E.L.Cabral & Bacigalupo, Ann. Missouri Bot. Gard. 84: 870. 1998. Fig. 4d

Supplementary Bibliography: Jung-Mendaçolli (2007); Florentín *et al.* (2017).

Selected specimens: Area 1, Céu Azul, 14.I.2014, fl. and fr., *M.L. Toderke et al.* 151 (UNOP); Area 2, Capanema, 7.XI.2013, fl. and fr., *M.L. Toderke et al.* 117 (UNOP); Area 3, Foz do Iguazu, 4.VII.2018, fr., *C.R. Rauber et al.* 90 (UNOP).

The species is distributed in South America, in Paraguay and northeastern Argentina, besides Brazil (Cabral & Bacigalupo 1997), where it occurs in the South and Southeast of the country (BFG 2018). In the Park it was found in all areas.

Flowers and fruits from spring to early fall (Cabral & Bacigalupo 1997). In the Park, the was found flowering and fruiting in July and from October to March.

This species is characterized by its stoloniferous habit, radican at the nodes, and fruits splitting into two indehiscent mericarps (Cabral & Bacigalupo 1997).

9.3. *Galianthe laxa* (Cham. & Schltdl.) E.L.Cabral, Bol. Soc. Argent. Bot. 27(3-4): 244. 1992.

Fig. 4e

Supplementary Bibliography: Jung-Mendaçolli (2007); Florentín *et al.* (2017).

Selected specimens: Area 1, Céu Azul, Borda do Parque, 24.V.2018, fl., *C.R. Rauber et al.* 52 (UNOP); Area 2, Capanema, 29.IV.2014, fl., *M.L. Toderke et al.* 203 (UNOP); Area 3, Foz do Iguazu, 7.VIII.2013, fl., *M.L. Toderke et al.* 79 (UNOP).

The species is distributed in South America, in Brazil, Argentina, Bolivia, Paraguay, and Uruguay. In Brazil it occurs in the Central-west, Southeast, and South regions of the country (Cabral 2009); in the Park it was found in all areas.

Flowers from November to February, and fruits from March to August (Cabral 2009). In the Park, the was found flowering and fruiting from February to December.

This species is characterized by abundant branching and by the lax, thyrsoid inflorescences.

10. *Galium* L., Sp. Pl. 1: 105. 1753.

10.1. *Galium hypocarpium* (L.) Endl. ex Griseb., Fl. Brit. W. I. 351. 1864[1861]. Fig. 5a

Supplementary Bibliography: Jung-Mendaçolli (2007); Oliveira *et al.* (2014).

Selected specimen: Area 1, Céu Azul, 29.VI.2017, fl. and fr., *E.L. Siqueira* 2224 (HCF).

This species has a very wide distribution, from the Caribbean islands, Central America, and all of South America (Delprete *et al.* 2004). In Brazil, it occurs in all regions except the North (BFG 2018); in the Park it was found only in the Céu Azul area (AF).

Reproduction may occur through all year (Delprete *et al.* 2004); in the Park, the was found fruiting in June.

Dempster (1990) recognized 4 subspecies, of which in ParNa inhabits *G.* subsp. *hypocarpium*. Differs from the others by its flowers up to four by each node and sessile leaves. This taxon differs from the other species of ParNa Iguazu by having stipules of the same shape and size as the leaves and orange drupaceous fruits.

11. *Geophila* D.Don, Prodr. Fl. Nepal. 136. 1825.

Key to species of *Geophila* in Iguazu National Park

1. Leaf blade widely ovate, cordiform, leaf lobes never overlapping; drupes dark purple or dark blue when ripe 11.1 *Geophila macropoda*
- 1'. Leaf blade oval, cordiform or subreniform, leaf lobes overlapping; drupes orange or red when ripe ...
..... 11.2 *Geophila repens*

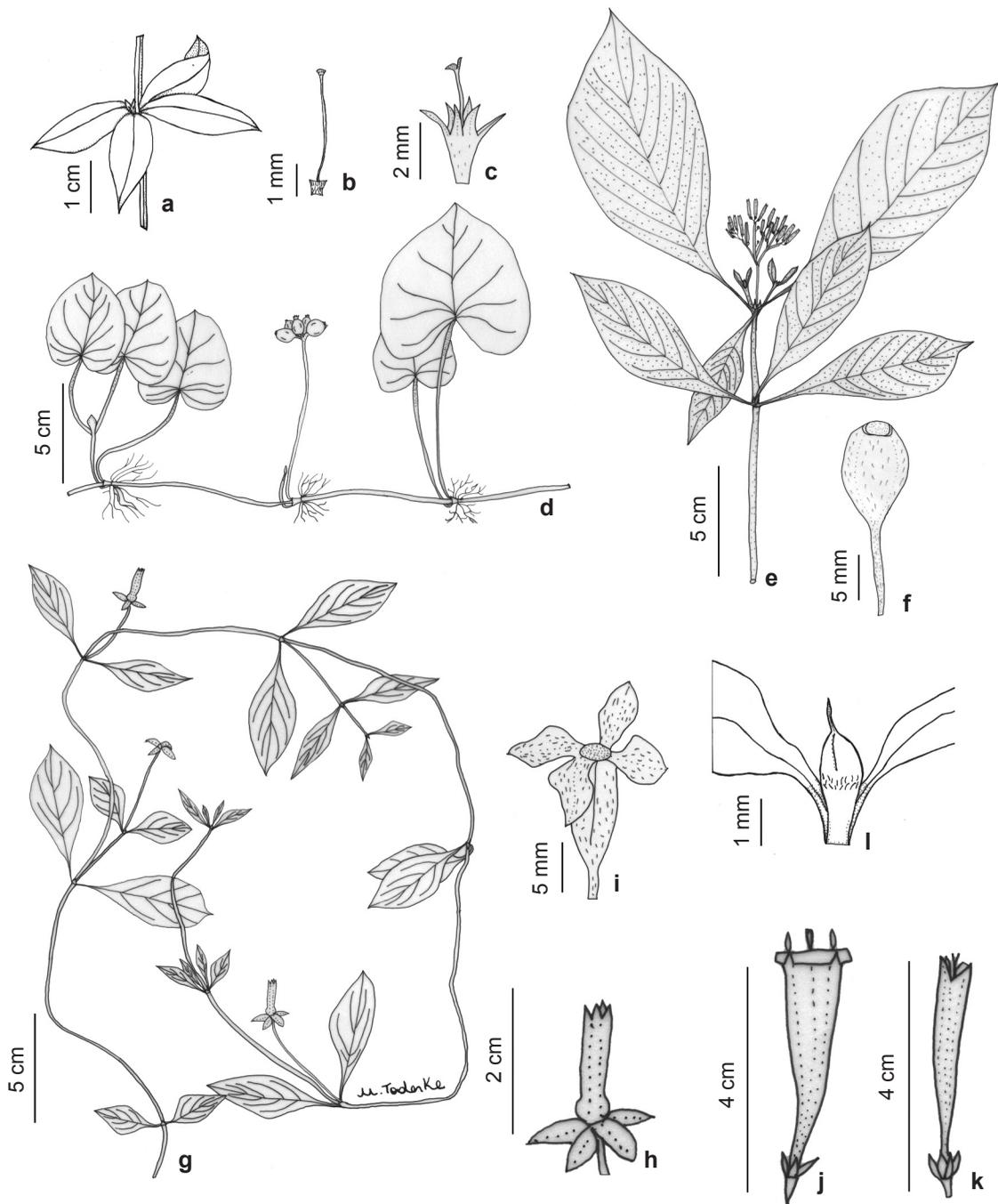


Figure 5 – a. *Galium hypocarpium* – leaf and stipule. b. *Guettarda uruguensis* – calyx with stigma. c-d. *Geophila macropoda* – c. calyx with stigma; d. habit. e-f. *Hamelia patens* – e. fertile branch; f. fruit berry. g-i. *Manettia paraguariensis* – g. habit; h. corolla; i. capsule. j. *Manettia cordifolia* – flower. k. *Manettia tweedieana* – flower. l. *Ixora venulosa* – stipule (a. Siqueira 2224 (HCF); b. Caxambu 7090 (HCF); c. Toderke 150 (UNOP); d. Toderke 122 (UNOP); e-f. Toderke 171 (UNOP); g-h. Toderke 211; i. Toderke 92 (UNOP); j. Toderke 169 (UNOP); k. Toderke 197 (UNOP); l. Caxambu 7921 (HCF).

11.1. *Geophila macropoda* (Ruiz & Pav.) DC., Prodr. 4: 537. 1830. Figs. 4f, 5c-d

Supplementary Bibliography: Delprete *et al.* (2005).

Selected specimens: Area 1, Céu Azul, 14.I.2014, fl., M.L. Toderke & M.L. Zimmermann 150 (UNOP); Area 2, Capanema, 7.XI.2013, fr., M.L. Toderke *et al.* 115 (UNOP); Area 3, Foz do Iguaçu, 22.V.2018, fr., C.R. Rauber *et al.* 3 (UNOP).

The species is distributed in Mexico by Central and South America, occurring until Bolivia, and Paraguay (Delprete *et al.* 2005). In Brazil, it occurs in the South region (BFG 2018), and in the Park it was found in all areas.

Flowers and fruits in December, February and July (Delprete *et al.* 2005). In the park, the was found flowering from January to March, and fruiting all year long.

This species is characterized by being a prostrate herb, with cordiform leaves and dark purple fruits.

11.2. *Geophila repens* (L.) I.M.Johnst., Sargentia 8: 281-282. 1949. Fig. 4g

Supplementary Bibliography: Jung-Mendaçolli (2007); Pereira & Kinoshita (2013).

Selected specimens: Area 1, Céu Azul, 14.I.2014, fl. and fr., M.L. Toderke & M.L. Zimmermann 149 (UNOP); Area 2; Capanema, 7.XI.2013, fr., M.L. Toderke *et al.* 116 (UNOP); Area 3, Foz do Iguaçu, 22.V.2018, fr., C.R. Rauber *et al.* 1 (UNOP).

The species is distributed from Central America to southern Argentina (Williams 1973). In Brazil it occurs in states of all regions (BFG 2018), and in the Park it was found in all areas.

Flowers in the summer (Delprete *et al.* 2005). In the Park, the was found flowering in December and January and fruiting all year long.

This species is characterized by being a prostrate herb, with cordiform to reniform leaves having a truncate base and by its orange fruits.

12. *Guettarda* L., Sp. Pl. 2: 991. 1753.

12.1. *Guettarda uruguensis* Cham. & Schldt., Linnaea 4: 183. 1829. Fig. 5b

Supplementary Bibliography: Jung-Mendaçolli (2007); Pereira & Kinoshita (2013).

Selected specimen: Area 2, Matelândia, 30.X.2015, fl., M.G. Caxambu *et al.* 7090 (HCF).

This species is distributed throughout Bolivia, Argentina, Uruguay, and Brazil, where it occurs from the states of Minas Gerais, and Bahia unto the state of Rio Grande do Sul. (Delprete *et al.* 2005; BFG 2018). In the Park

it was collected in Matelândia in the area of Capanema.

Flowers from December to April (Delprete *et al.* 2005). In the Park the was found flowering in October.

This species differs from the remaining species of *Guettarda* inhabiting in Paraná state by having umbelliform axillary inflorescence or in multiflorous dichotomous cymes, flowers and fruits pilose, and 3-locular ovary (Delprete *et al.* 2005).

13. *Hamelia* Jacq., Enum. Syst. Pl. 2. 1760.

13.1. *Hamelia patens* Jacq., Enum. Syst. Pl. 16. 1760. Figs. 4h; 5e-f

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015).

Selected specimens: Area 1, Céu Azul, 14.I.2014, fl., M.L. Toderke & M.L. Zimmermann 145 (UNOP); Area 2, Capanema, 20.III.2014, fl., M.L. Toderke *et al.* 171 (UNOP); Area 3, Foz do Iguaçu, 18.XII.2013, fl., M.L. Toderke *et al.* 144 (UNOP).

The species is distributed from Mexico, Central, and South America to northern Argentina (Delprete *et al.* 2005). In Brazil it occurs in almost all states (BFG 2018), and in the Park it was found in all areas.

Flowers from December to February (Delprete *et al.* 2005); in the Park, the was found flowering and fruiting almost all year long.

This species is characterized by having generally 3-verticillate leaves, and showy, puberulous, and reddish-orange flowers.

14. *Ixora* L., Sp. Pl. 1: 110. 1753.

14.1. *Ixora venulosa* Benth., Linnaea 23: 446. 1850. Fig. 5l

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015).

Selected specimen: Area 1, Céu Azul, 5.X.2017, fl., M.G. Caxambu 7921 (HCF).

The species occurs in Paraguay and Argentina (Bacigalupo 1975; Delprete 2003) In Brazil it is distributed from the state of Mato Grosso to the state of Santa Catarina (BFG 2018); in the Park it was found in Céu Azul.

Flowers from May to December (Delprete *et al.* 2005), and in the Park, the was found flowering in October.

This species is easily recognized by its leaves with very dense secondary venation (30–60 veins per side) (Delprete *et al.* 2005; Jung-Mendaçolli 2007) and with a stipular sheath tubular, apically 1-fimbriate, prolonged above the corresponding pair of leaves.

15. *Manettia* Mutis ex L., Mant. Pl. Altera 558. 1771.

Key to species of *Manettia* in Iguacu National Park

1. Corolla thickened, cylindrical with slightly inflated base, red with yellow apex 15.2. *Manettia paraguariensis*
- 1'. Corolla membranous, tubular-claviform, red entirely.
 2. Stem winged; blades narrowly elliptic, margin slightly revolute; bracts elliptic and petiolate; corolla puberulous externally; capsule oblong..... 15.3. *Manettia tweedieana*
 - 2'. Stem wingless; blades elliptic or cordate, margin flat; bracts cordate and sessile; corolla glabrous externally; capsule ovoid or broadly ellipsoid 15.1. *Manettia cordifolia*

15.1. *Manettia cordifolia* Mart., Denkschr. Königl. Akad. Wiss. München, 9: 95, t. 7. 1824.

Figs. 5j; 6a

Supplementary Bibliography: Jung-Mendaçolli (2007); Marinero *et al.* (2012).

Selected specimens: Area 1, Céu Azul, 19.III.2014, fl., *O.S. Ribas et al.* 6058 (MBM); Area 2, Capanema, 20.III.2014, fl. and fr., *M. L. Toderke et al.* 169 (UNOP); Area 3, Foz do Iguacu, 12.XII.1999, fl., *A.C. Cervi et al.* 6959 (UPCB).

The species is distributed from Peru to Uruguay (Macias 1998). In Brazil it is widely distributed in all regions except the North, where it occurs only in Acre (BFG 2018); in the Park it was found in all areas.

Flowers and fruits throughout the year but has flowering peaks from October to January, and fruiting from June to August (Macias 1998). In the Park, the was found flowering from October to May, and fruiting in March.

This species has a great variability in leaf size and shape, ranging from elliptical to ovate blades, from obtuse to cordate at base, however can be distinguish by its bracts usually cordate and sessile, corolla tubular-claviform, and floral button rounded or obtuse at the apex.

15.2. *Manettia paraguariensis* Chodat, Bull. Herb. Boissier 7: 82. 1899.

Figs. 5g-i; 6b

Supplementary Bibliography: Jung-Mendaçolli (2007); Marinero *et al.* (2012).

Selected specimens: Area 1, Céu Azul, 12.X.2011, fl. and fr., *J.A. Lombardi et al.* 8730 (UNOP); Area 2, Capanema, 8.XI.2013, fl. and fr., *M.L. Toderke et al.* 123 (UNOP); Area 3, Foz do Iguacu, 22.V.2018, fl., *C.R. Rauber et al.* 13 (UNOP).

The species is distributed in South America, in Brazil, Argentina, Paraguay, and Uruguay (Macias 1998). In Brazil it is present throughout

the South region, in the Southeast only in São Paulo state and in the Central-west in Mato Grosso do Sul state (BFG 2018). In the Park it was found in all areas.

Flowers and fruits all year long (Macias 1998). In the Park, the was also found flowering and fruiting almost all year long.

This species is characterized by presenting a thick corolla that is bicolorous, with a yellow apex and red tube. The corolla also has an inflated base and apex rounded in button state, which represent the main differences with its closest relative *M. luteorubra* (Vell.) Benth. (Macias 1998; Marinero *et al.* 2012).

15.3. *Manettia tweedieana* K.Schum., Mart., *Fl. bras.* 6(6): 169. 1889.

Figs. 5k; 6c

Supplementary Bibliography: Jung-Mendaçolli (2007); Marinero *et al.* (2012).

Selected specimens: Area 1, Céu Azul, 28.IX.2018, fl., *C.R. Rauber et al.* 175 (UNOP); Area 2, Capanema, 29.IV.2014, fl., *M.L. Toderke et al.* 197 (UNOP); Area 3, Foz do Iguacu, 6.IX.2013, fr., *M.L. Toderke et al.* 94 (UNOP).

The species occurs in Brazil, and in Paraguay and Argentina in places that border Paraná (Macias 1998). In Brazil is mainly distributed in the state of Paraná, occurring in São Paulo, and Santa Catarina. In the Park, the was found in all areas. It is considered endangered by Marinero *et al.* (2012).

Flowers and fruits all year (Marinero *et al.* 2012). In the Park, the was found flowering in April, June and August and fruiting in June through August.

This species is characterized by thin and shortly winged stems, blades narrowly elliptic with long acuminate apex, and inflorescences 1-florous.

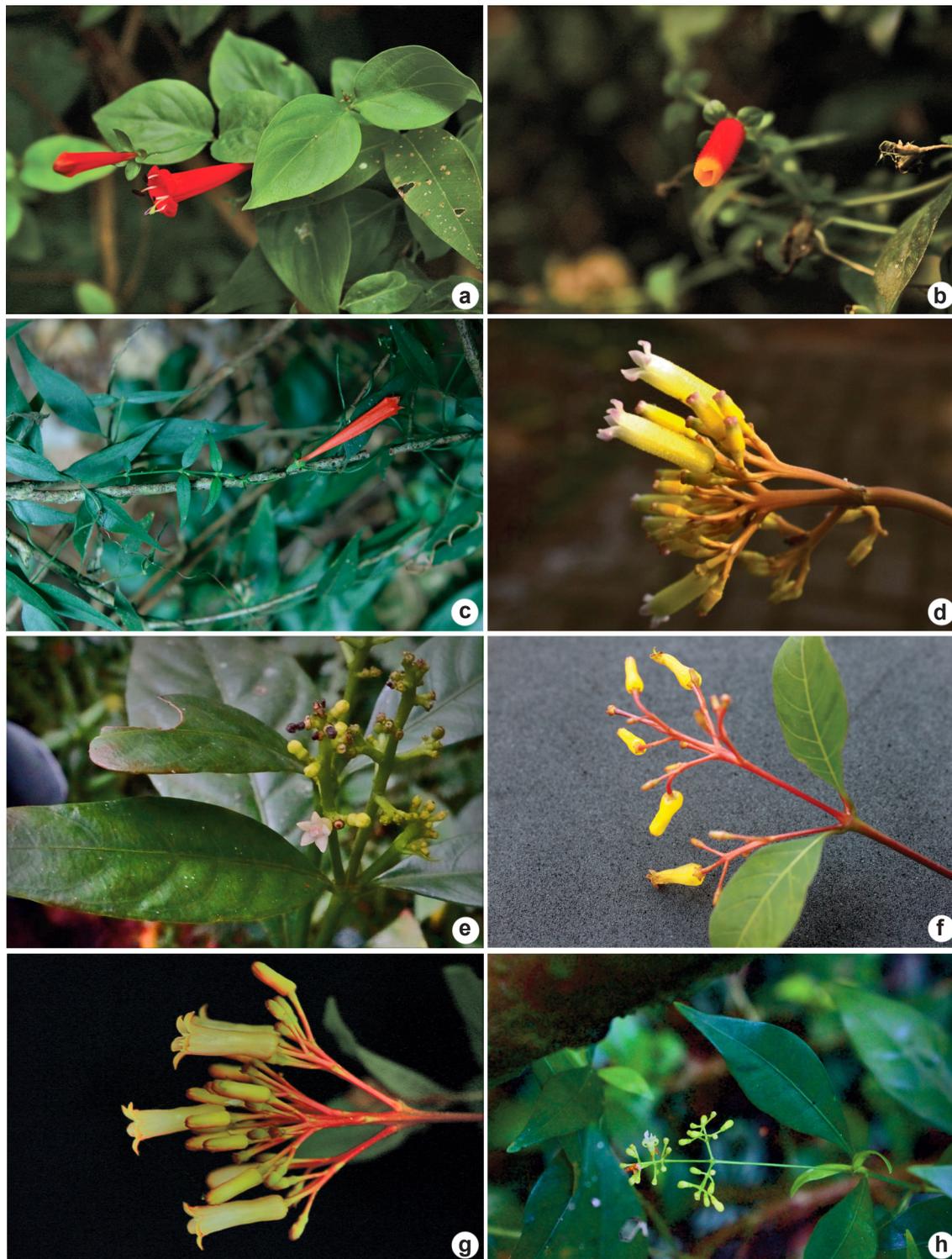


Figure 6 – a. *Manettia cordifolia* – flower. b. *Manettia paraguariensis* – flower. c. *Manettia tweedieana* – habit. d. *Palicourea australis* – inflorescence. e. *Palicourea brevicollis* – flower. f. *Palicourea croceoides* – inflorescence. g. *Palicourea marcgravii* – inflorescence. h. *Psychotria capillacea* – inflorescence. (Photos: a, g. Rauber CR, 2018; b, d. Zini AS, 2014; c,e, f-h. Toderke ML, 2014).

16. *Palicourea* Aubl., Hist. Pl. Guiane 1: 172. 1775.

Key to species of *Palicourea* in Iguaçu National Park

1. Corolla white.....16.2. *Palicourea brevicollis*
- 1'. Corolla yellow, lilac or purple.
2. Inflorescence in paniculate cymes.
 3. Panicles congested, flowers pubescent..... 16.4. *Palicourea macrobotrys*
 - 3'. Panicles lax, flowers glabrous..... 16.3. *Palicourea croceoides*
- 2'. Inflorescence in corymbiform cymes.
 4. Stipule lobes 2–7 mm long, corolla lobes 1.5–2 mm long..... 16.1. *Palicourea australis*
 - 4'. Stipule lobes up to 1 mm long, corolla lobes up to 1.3 mm long 16.5. *Palicourea marcgravii*

16.1. *Palicourea australis* C.M.Taylor, Novon 10(2): 161. 2000. Fig. 6d

Supplementary Bibliography: Ferreira Junior & Vieira (2015).

Selected specimen: Area 1, Céu Azul, 2.XI.2017, fl., M.G. Caxambu 7970 (HCF).

This species is endemic to Brazil and distributed in the states of Paraná, and Santa Catarina (BFG 2018). In the Park it was collected in the Céu Azul area (AF).

Flowers from November to February with fruits in the fall (Delprete *et al.* 2005), however, in the Park it was only found flowering in October.

This species is morphologically similar to *Palicourea marcgravii* which also occurs in the Park and has a pubescent yellowish corolla, with a lilac or purple apex, while *P. australis* has a densely pubescent corolla with stout trichomes externally, scurfy surface.

16.2. *Palicourea brevicollis* (Müll.Arg.) C.M.Taylor, Novon 25(1): 85. 2016.

Figs. 6e; 7a-b

Supplementary Bibliography: Jung-Mendaçolli (2007) as *Psychotria brevicollis*; Ferreira Junior & Vieira (2015) as a synonym of *Psychotria myriantha*.

Selected specimens: Area 1, Céu Azul, 14.I.2014, fr., M.L. Toderke & M.L. Zimmermann 147 (UNOP); Area 2, Capanema, 7.IX.2013, fl., M.L. Toderke *et al.* 113 (UNOP); Area 3, Foz do Iguaçu, 4.VII.2018, fr., C.R. Rauber *et al.* 107 (UNOP).

In South America, the species is distributed in Brazil, and Paraguay (Delprete *et al.* 2005). In Brazil, occurs in the South and Southeast of the country (BFG 2018); in the Park it was found in all areas.

Flowers from October to February and fruits from March to July (Delprete *et al.* 2005). In the

Park, the was found flowering and fruiting from February to May and from August to December, in January only fruits were found.

This species is characterized by hardened bilobate stipules, narrowly pyramidal inflorescence and nigrescent fruits when ripe.

16.3. *Palicourea croceoides* Ham., Prodr. Pl. Ind. Occid. 29. 1825. Figs. 6f; 7c

Supplementary Bibliography: Jung-Mendaçolli (2007); Pereira & Kinoshita (2013).

Selected specimens: Area 2, Capanema, 20.III.2014, fr., M.L. Toderke *et al.* 175 (UNOP); Area 3, Foz do Iguaçu, 17.XII.2013, fl. and fr., M.L. Toderke *et al.* 137 (UNOP).

The species is widely distributed throughout the eastern Caribbean islands, Colombia to Paraguay, and Argentina (Jung-Mendaçolli 2007). In Brazil it is present in the Central-west, Southeast and Northern regions and in the state of Paraná in the South region (BFG 2018). In the Park, the was found in Foz do Iguaçu and Capanema.

Flowers from November to February and fruits in February, May, and June. (Jung-Mendaçolli 2007). In the Park, the was found flowering in December and fruiting from December to March.

This species is characterized by inflorescence in paniculate lax, flowers glabrous, its membranous corolla that is completely yellow.

16.4. *Palicourea macrobotrys* (Ruiz & Pav.) Roem. & Schult., Syst. Veg., ed. 15 bis 5: 184. 1819.

Fig. 7d

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015).

Selected specimens: Area 2, Serranópolis do Iguaçu, 8.IX.1998, fr., S.R. Ziller 1685 (MBM); Area 3, Foz do Iguaçu, 7.VII.2016, fr., J.K. Hammes *et al.* 144 (UNOP).

The species is distributed in South America in Brazil, Colombia, Peru, and Bolivia (Delprete

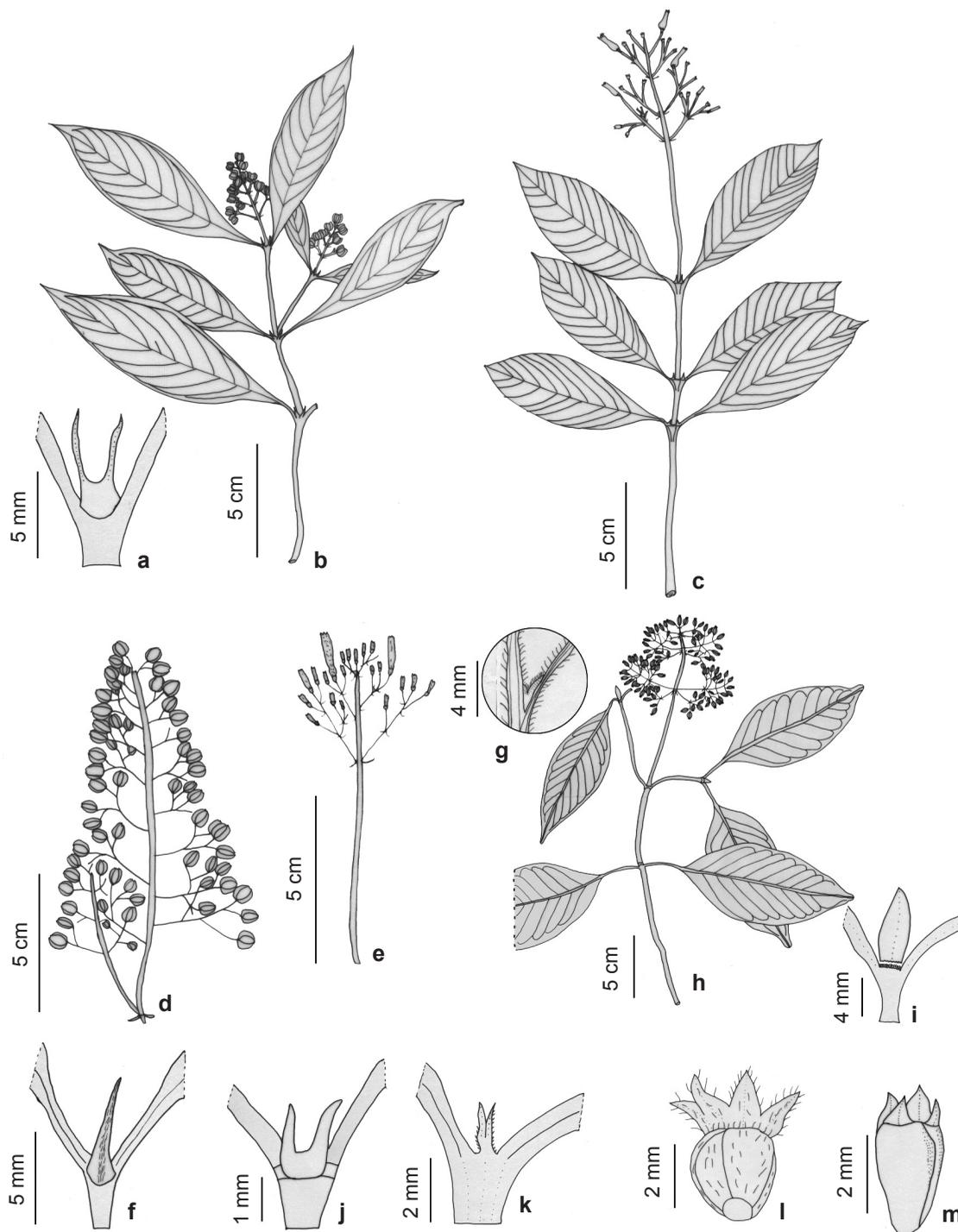


Figure 7 – a-b. *Palicourea brevicollis* – a. stipule sheath; b. fertile branch. c. *Palicourea croceoides* – fertile branch. d. *Palicourea macrobotrys* – infructescence. e. *Palicourea marcgravii* – inflorescence. f. *Psychotria capillacea* – stipule sheath. g-i. *Psychotria carthagenensis* – g. domatia; h. fertile branch; i. stipule sheath. j. *Psychotria leiocarpa* – stipule sheath. k. *Psychotria suterella* – stipule sheath. l. *Richardia brasiliensis* – schizocarpic fruit. m. *Spermacoce riparia* – fruit capsule. (a. Toderke 74 (UNOP); b. Toderke 210 (UNOP); c. Toderke 137 (UNOP); d. Ziller1685 (MBM); e. Hatschbach 10430 (MBM); f. Toderke 128 (UNOP); g-h. Toderke 72 (UNOP); i. Toderke 146 (UNOP); j. Toderke 209 (UNOP); k. Toderke 214 (UNOP); l. Toderke 89 (UNOP); m. Toderke 208 (UNOP)).

et al. 2005). In Brazil, it occurs in the Southeast and Central-west, in the North it occurs in Acre, Amazonas and Rondônia, in the Northeast in Bahia and in the South in Paraná (BFG 2018). In the Park, the was found in Foz do Iguacu and Serranópolis (Capanema area).

Flowers in March and April and fruits from April to June in Paraná (Delprete *et al.* 2005). In the Park, the was found fruiting in July and September.

This species is characterized by having much longer inflorescences than others of the same genus that occur in the Park, being narrowly pyramidal, almost cylindrical.

16.5. *Palicourea marcgravii* A.St.-Hil., Hist. Pl. Remarq. Bresil, 231, t. 22 1824. Figs. 6g; 7e
Supplementary Bibliography: Jung-

Mendaçolli (2007); Ferreira Junior & Vieira (2015).

Selected specimen: Area 3, Foz do Iguacu, 1.XII.2018, fl., C.R. Rauber *et al.* 216 (UNOP).

In Brazil, it occurs in states of all regions (BFG 2018). In the Park it was found only in the Foz do Iguacu area.

Flowers through all year and fruits from January to July (Taylor 2007). In the Park, the was found flowering in November and flowering and fruiting in December, and March.

This species is similar to *Palicourea australis*, but it differs by having the corolla externally pubescent, without stout trichomes, and yellowish on base and purple or lilac on apex.

17. *Psychotria* L., Syst. Nat., ed. 10. 2: 929. 1759.

Key to species of *Psychotria* in Iguacu National Park

1. Stipules entire; ripe fruit yellow, orange, vinaceous or red.
 2. Leaf blade 30–70 × 9–20 mm; pedicellate..... 17.1. *Psychotria capillacea*
 - 2'. Leaf blade 50–130 × 20–60 mm; sessile flowers.
 3. Stipule deciduous, with obtuse apex; inflorescence lax 17.2. *Psychotria carthagenensis*
 - 3'. Stipules persistent, when deciduous, are trapped by the sheath, sharp apex forming a slight constriction; inflorescence congested..... 17.3. *Psychotria fractistipula*
- 1'. Stipules bilobate; ripe fruits blue, purple or black.
 4. Inflorescence peduncle 0.5–3 cm long; corolla white with yellow ring at the apex of the tube..... 17.4. *Psychotria leiocarpa*
 - 4'. Sessile inflorescences; corolla white or slightly lilac..... 17.5. *Psychotria suterella*

17.1. *Psychotria capillacea* (Müll.Arg.) Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 22: 202. 1940. Figs. 6h; 7f

Supplementary Bibliography: Jung-Mendaçolli (2007); Pereira & Kinoshita (2013).

Selected specimens: Area 2, Capanema, 29.IV.2014, fr., M.L. Toderke *et al.* 198 (UNOP); Area 3, Foz do Iguacu, 5.VII.2018, fr., C.R. Rauber *et al.* 114 (UNOP).

The species is distributed in Paraguay and Brazil, where it occurs in the states of São Paulo, Paraná and Mato Grosso do Sul (Jung-Mendaçolli 2007; BFG 2018). In the Park, the was found in Foz do Iguacu and Capanema.

Flowers in November and fruits from March to October (Jung-Mendaçolli 2007). In the Park, the was found flowering in December, February and March and with fruits from February to April and from July to September.

This species is characterized by its small, entire stipules; lax, cymose inflorescences and red fruits.

17.2. *Psychotria carthagenensis* Jacq., Enum. Syst. Pl. 16. 1760. Figs. 7g-i; 8a

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015).

Selected specimens: Area 1, Céu Azul, 24.V.2018, fr., C.R. Rauber *et al.* 40 (UNOP); Area 2, Capanema, 7.XI.2013, fl., M.L. Toderke *et al.* 114 (UNOP); Area 3, Foz do Iguacu, 6.VII.2013, fr., M.L. Toderke *et al.* 72 (UNOP).

The species is widely distributed from Costa Rica to Argentina and Paraguay (Delprete *et al.* 2005). In Brazil, the species has a distribution throughout the country (BFG 2018), and in the Park, the was found in all areas.

Flowers and fruits all year long (Jung-Mendaçolli 2007). In the Park it was found flowering from November to March and fruiting throughout the year.

This species is easily distinguish from remaining species of *Psychotria* inhabiting Paraná state, by having the leaf domatia in pocket (Romero

et al. 2015), ovate or obovate stipules, entire, apex obtuse, early caducous, and lax inflorescences.

17.3. *Psychotria fractistipula* L.B.Sm., R.M.Klein & Delprete, Fl. Ilustr. Catarin. Rubiaceas 2: 556. 2005.

Supplementary Bibliography: Ferreira Junior & Vieira (2015).

Selected specimen: Area 2: Serranópolis do Iguacu, 29.X.2015, fl., M.G. Caxambu 7039 (HCF).

The species is endemic to Brazil, occurring in the states of Santa Catarina, and Paraná (BFG 2018). In the Park, the was found in Serranópolis do Iguacu in the Capanema area.

According to Delprete *et al.* (2005) this species flowers during the summer; in the Park, the was found with flowers in October.

This species and *Psychotria carthagenensis* share the early caducous stipules, entire, ovate or obovate, and leaf domatia in pocket, characters that allow to differentiate them from remaining species of the genus in Paraná state. The only differences are the obtuse apex of the stipule and the congested partial inflorescences. The taxonomic status of *P. fractistipula* must be evaluated in depth including micromorphology, pollinic, ecologic and molecular analysis.

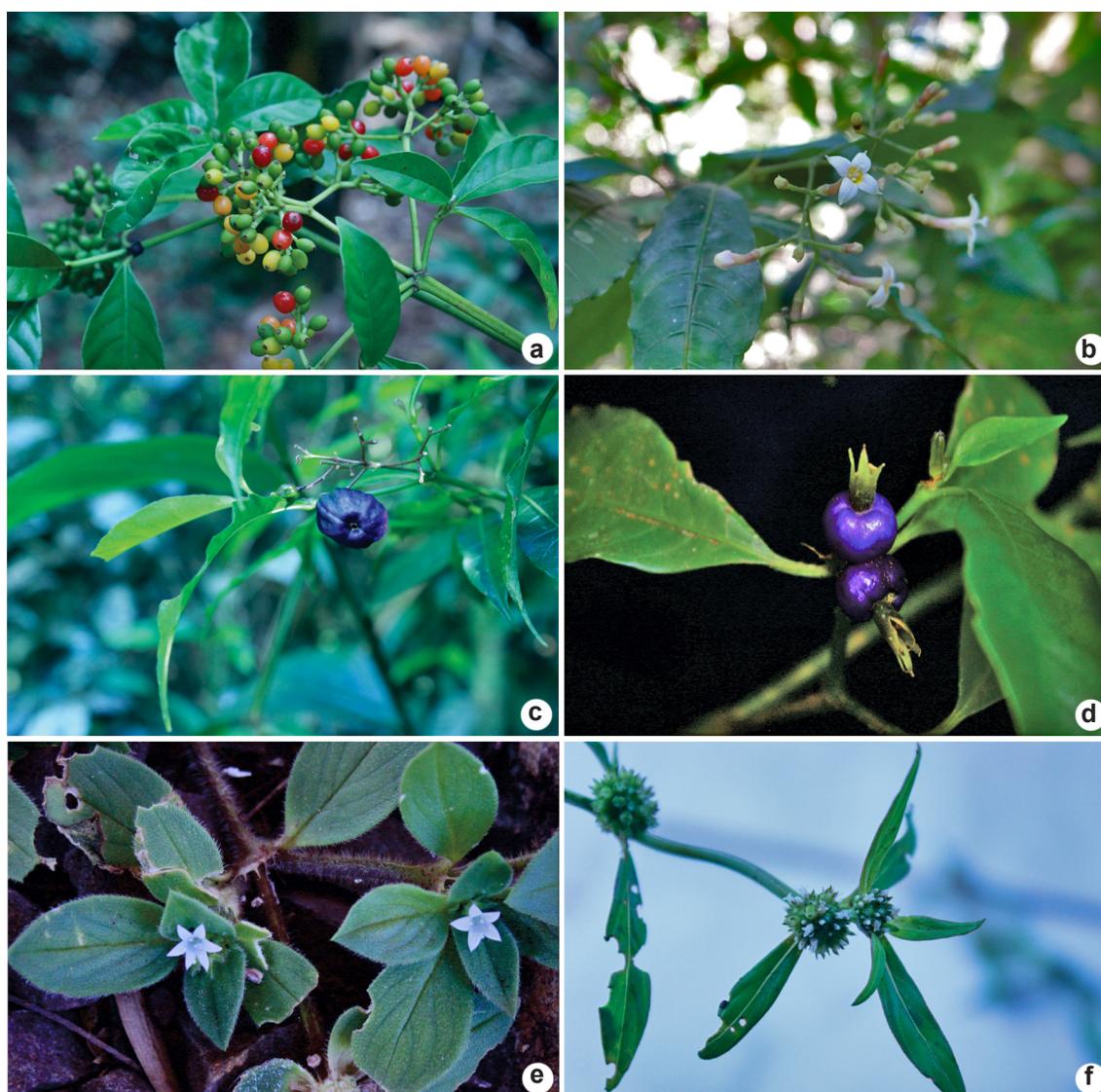


Figure 8 – a. *Psychotria carthagenensis* – infructescence. b-c. *Psychotria leiocarpa* – b. inflorescence; c. fruit. d. *Psychotria suterella* – fruit. e. *Richardia brasiliensis* – flowers. f. *Spermacoe riparia* – inflorescence. (Photos: b-e. Rauber CR, 2018; f. Zini AS, 2014; a. Toderke ML, 2014).

17.4. *Psychotria leiocarpa* Cham. & Schltldl., *Linnaea* 4: 22. 1829. Figs. 7j; 8b-c

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015). **Selected specimens:** Area 1, Céu Azul, 24.V.2018, fr., C.R. Rauber et al. 44 (UNOP); Area 2, Capanema, 7.XI.2013, fl. and fr., M.L. Toderke et al. 112 (UNOP); Area 3, Foz do Iguacu, 17.XII.2013, fr., M.L. Toderke et al. 141 (UNOP).

The species is distributed the Southeast of Brazil until Argentina (Jung-Mendaçolli 2007). In Brazil, it occurs in the South, Southeast and in some Northeast states (BFG 2018); in the Park, the was found in all areas.

Flowers from August to January and fruits from March to August (Jung-Mendaçolli 2007). In the Park, the was found flowering in March, May, June, and from August to December, and fruiting in January, March, May, June, July, October, and December.

This species is characterized by narrow leaves, white corolla with inner apex of the tube yellow and blue fruits with longitudinal ridges.

17.5. *Psychotria suterella* Müll.Arg., *Fl. bras.* (Martius) 6(5): 380. 1881. Figs. 7k; 8d

Supplementary Bibliography: Jung-Mendaçolli (2007); Ferreira Junior & Vieira (2015). **Selected specimens:** Area 1, Céu Azul, 12.XII.2018, fr., C.R. Rauber et al. 234 (UNOP).

The species is distributed in South America in Brazil, and Argentina (Delprete et al. 2005) In Brazil, it occurs in the South and Southeast of the country (BFG 2018); in the Park, the was found in the Céu Azul area.

It flowers practically all year and fruits from January to April (Delprete et al. 2005). In the Park, the was found flowering in January and February, fruiting in May, June, August, and December.

This species is characterized by its dark blue fruit with large, persistent green calyx.

18. *Richardia* L., Sp. Pl. 1: 330. 1753.

18.1. *Richardia brasiliensis* Gomes, Mem. Ipecacuanha Fusca 31, t. 2. 1801. Figs. 7l; 8e

Supplementary Bibliography: Jung-Mendaçolli (2007); Pereira & Kinoshita (2013). **Selected specimens:** Area 1, Santa Tereza do Oeste, 3.V.2013, fl. and fr., M.L. Toderke et al. 89 (UNOP); Area 3, Foz do Iguacu, 7.VIII.2013, fl. and fr., M.L. Toderke et al. 88 (UNOP).

The species is widely distributed throughout North America, the Caribbean islands, all South America and as an introduced species into Africa, and Asia. (Lewis & Oliver 1974; Delprete et al.

2005). In Brazil, it occurs in states of all regions of the country (BFG 2018) and in the Park, the was found in Foz do Iguacu and at Santa Tereza do Oeste in the Céu Azul area.

Flowers and fruits practically all year in warmer regions and in spring and summer in temperate zones (Lewis 1974). In the Park, the was found flowering in February, April, May and from August to December.

This species is characterized by its prostrate, herbaceous habit, glomeruliform and terminal inflorescence, usually 6-lobed corolla, and by schizocarpic fruit with three mericarps.

19. *Spermacoce* L., Sp. Pl. 1: 102. 1753.

19.1. *Spermacoce riparia* Cham. & Schltldl., *Linnaea* 3: 355. 1828. Figs. 7m; 8f

Supplementary Bibliography: Flora do Brasil 2020.

Selected specimens: Area 2, Capanema, 20.III.2014, fl. and fr., M.L. Toderke et al. 170 (UNOP).

Distribution is difficult to assess because its identification has been confused over the years with *Spermacoce glabra* Michx. (Bacigalupo 1972). According to Nuñez et al. (Florentin et al. 2020), The species occurs only in South America: Paraguay, Bolivia, Peru, Argentina, Uruguay, and Brazil. In this country, it occurs in the states of the South, Southeast, Central-west and Bahia (BFG 2018); in the Park, the was found in Capanema.

In the Park, the was found flowering and fruiting in March and April on riverbanks.

This species is characterized by being a glabrous plant, numerous pseudoaxillary glomeruli (unilateral position), very small flowers, stamens and stigma included, fruits indehiscent or tardily dehiscent at the apex, seed obovate, 1.5–2.5 × 0.8–1.45 mm; plano-convex in cross section; ventral side with a wide, shallow groove,.

All species recorded in the Iguacu National Park are native to Brazil, only *Palicourea australis* and *Psychotria fractistipula* are considered endemic to south region of the country (BFG 2018). Most of the species found are widely distributed and some of the more restricted ones occur in other countries, since the Park is located close to other South American countries and borders Argentina.

The area with the highest species richness was Foz do Iguacu, with 13 genera and 24 species, with four exclusive to this area. In the Céu Azul area, there are 22 species of which eight are exclusive, distributed in 13 genera and in Capanema 11 genera

Table 1 – Distribution of Rubiaceae species in the Iguazu National Park.

Species	Foz do Iguazu SSF	Capanema SSF	Céu azul	
			SSF	AF
<i>Borreria latifolia</i> (Aubl.) K.Schum.				x
<i>Borreria orientalis</i> E.L. Cabral, R.M. Salas & L.M. Miguel	x			
<i>Borreria schumannii</i> (Standl. ex Bacigalupo) E.L. Cabral & Sobrado	x	x	x	x
<i>Cephalanthus glabratus</i> (Spreng.) K.Schum.	x			
<i>Chomelia obtusa</i> Cham. & Schltld.	x		x	
<i>Coccocypselum condalia</i> Pers.				x
<i>Coccocypselum hasslerianum</i> Chodat				x
<i>Cordia concolor</i> (Cham.) Kuntze				x
<i>Coussarea contracta</i> (Walp.) Müll.Arg.	x	x		
<i>Diodia saponariifolia</i> (Cham. & Schltld.) K.Schum.	x	x		
<i>Faramea hyacinthina</i> Mart.	x			
<i>Galianthe brasiliensis</i> (Spreng.) E.L.Cabral & Bacigalupo	x	x		
<i>Galianthe hispidula</i> (A.Rich. ex DC.) E.L.Cabral & Bacigalupo	x	x	x	
<i>Galianthe laxa</i> Cham.	x	x	x	
<i>Galium hypocarpium</i> (L.) Endl. ex Griseb.				x
<i>Geophila macropoda</i> (Ruiz & Pav.) DC.	x	x	x	x
<i>Geophila repens</i> (L.) I.M.Johnst.	x	x	x	x
<i>Guettarda uruguensis</i> Cham. & Schltld.		x		
<i>Hamelia patens</i> Jacq.	x	x	x	
<i>Ixora venulosa</i> Benth.			x	
<i>Manettia cordifolia</i> Mart.	x	x	x	
<i>Manettia paraguariensis</i> Chodat	x	x	x	x
<i>Manettia tweedieana</i> K.Schum.	x	x	x	
<i>Palicourea australis</i> C.M.Taylor				x
<i>Palicourea brevicollis</i> (Müll.Arg.) C.M.Taylor	x	x	x	x
<i>Palicourea croceoides</i> Ham.	x	x		
<i>Palicourea macrobotrys</i> (Ruiz & Pav.) Schult.	x	x		
<i>Palicourea marcgravii</i> A.St.-Hil.	x			
<i>Psychotria capillacea</i> (Müll.Arg.) Standl.	x	x		
<i>Psychotria carthagenensis</i> Jacq.	x	x	x	x
<i>Psychotria fractistipula</i> L.B.Sm., R.M.Klein & Delprete.		x		
<i>Psychotria leiocarpa</i> Cham. & Schltld.	x	x	x	x
<i>Psychotria suterella</i> Müll.Arg.				x
<i>Richardia brasiliensis</i> Gomes	x			x
<i>Spermacoce riparia</i> Cham. & Schltld.		x		
Total of species:	24	21	22	

and 21 species were found (Tab. 1). Some species are widely distributed along the Park's trails, seven occur in all areas and in both forest formations, while 20 species occur only in SSF and seven species occur only in AF (Tab. 1).

Palicourea and *Psychotria* were the genera that presented the highest species richness in the study areas, with five species each. The species of these two genera together represent 28.5% of the collected taxa. These data contradict the results of other studies in the Atlantic Forest, where the genus *Psychotria* is represented with, at least, twice of species richness than *Palicourea* (Pereira *et al.* 2006; Pereira & Kinoshita 2013). The results of the authors cited are justified since *Psychotria* is the largest genus of Rubiaceae, with 1,834 species (Davis *et al.* 2009) and one of the ten largest in Brazil, with 251 species (BFG 2015). *Palicourea* is relatively small in comparison, having only 74 species in Brazil (BFG 2018). Also, many neotropical species of *Psychotria* are being transferred to *Palicourea*, as was the case of *Palicourea brevicollis* (Taylor & Hollowell 2016). These transfers are following the results of recent phylogenetic analyses (*e.g.*, Razafimandimbison *et al.* 2014) that showed that many species of *Psychotria* subg. *Heteropsychotria* Aubl. belong to *Palicourea*.

The genera *Borreria*, *Galianthe* and *Manettia* were also found to comprise a significant number of species (3), each representing 8.5% of the species found. *Coccocypselum* and *Geophila* presented two species each, while the other 12 genera were represented by only one species each.

Of the 35 species that occur in the Park, we highlight two species concerning their conservation status or restricted distribution: *Manettia tweedieana*, distributed mainly in Paraná, São Paulo and Santa Catarina, and is considered almost threatened (BFG 2018) and locally endangered by Marinero *et al.* (2012) to Paraná state; and *Borreria orientalis* which is distributed in Brazil only in the state of Paraná (Cabral *et al.* 2012; BFG 2018).

In addition to these 35 species of Rubiaceae for the Iguazu National Park, other names were found cited in consulted herbaria with misidentified samples: *Borreria valens* Standl. is a specimen of *B. orientalis*; *Faramea stenantha* Müll.Arg. and *Rudgea jasminoides* (Cham.) Müll.Arg. refer to *F. hyacinthina*; *Manettia luteo-rubra* (Vell.) Benth. is actually *M. paraguariensis*; *Palicourea mamillaris* (Müll.Arg.) C.M.Taylor is

a collection of *P. brevicollis*; *Psychotria alba* Ruiz & Pav. is actually *P. carthagenensis*. In addition to these, additional names were found: *Psychotria micranta* Kunth, which is an extra-Brazilian species and a specimen identified as *Oldenlandia salzmannii* (DC.) Benth. & Hook.f. ex B.D.Jacks., but actually does not belong to Rubiaceae.

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References

- Bacigalupo NM & Cabral EL (1999) Revisión de las especies americanas del género *Diodia* (Rubiaceae - Spermaceae). Darwiniana 37: 153-165.
- Bacigalupo NM (1972) Observaciones sobre algunas especies de los géneros *Spermacee* L. y *Spermaceodes* O.K. (Rubiaceae). Darwiniana 17: 341-357.
- Bacigalupo NM (1975) Rubiaceas nuevas para la flora argentina y uruguaya. Darwiniana 19: 510-519.
- BFG - The Brazil Flora Group (2015) Growing knowledge: an overview of seed plant diversity in Brazil. Rodriguésia 66: 1085-1113.
- BFG - The Brazil Flora Group (2018) Brazilian Flora 2020: innovation and collaboration to meet Target 1 of the Global Strategy for Plant Conservation (GSPC). Rodriguésia 69: 1513-1527.
- Boff L (2016) Orchidaceae Juss. Epífitas e Hemiepífitas do Parque Nacional do Iguazu - PR. Masters Dissertation (Conservation and Management of Natural Resources) - Centro de Ciências Biológicas e da Saúde, Universidade Estadual do Oeste do Paraná, Cascavel. 76p.
- Bridson D & Forman L (2004) The Herbarium Handbook. The Royal Botanic Gardens, Kew. 214p.
- Cabral EL & Bacigalupo NM (1997) Revisión del Género *Galianthe* Subg. *Ebelia* Stat. Nov. (Rubiaceae: Spermaceae). Annals of the Missouri Botanical Garden 84: 857-877.
- Cabral EL & Salas RM (2007) *Coccocypselum pulchellum* (Rubiaceae), nuevo registro para Argentina. Darwiniana 45: 181-187.
- Cabral EL (2009) Revisión sinóptica de *Galianthe* subgen. *Galianthe* (Rubiaceae: Spermaceae), con una sección nueva. Annals of the Missouri Botanical Garden 96: 27-60.
- Cabral EL, Miguel LM & Salas RM (2011) Dos especies nuevas de *Borreria* (Rubiaceae) sinopsis y clave de las especies para Bahia, Brasil. Acta Botanica Brasílica 25: 255-276.

- Cabral EL, Miguel LM & Salas RM (2012) Comentarios sobre la identidad taxonómica de *Borreria valens* (Rubiaceae) y descripción de *Borreria orientalis*, nueva especie de Argentina, Brasil y Paraguay. Boletín de la Sociedad Argentina de Botánica 47: 427-434.
- Campos MTV, Brito JM & Taylor C (1999) Rubiaceae. In: Ribeiro JELS, Hopkins MJG, Vincentini A, Sothers CA, Costa MAS, Brito JM, Souza MAD, Martins LHP, Lohmann LG, Assunção PACL, Pereira EC, Silva CF, Mesquita MR & Procópio LC (eds.) Flora da Reserva Ducke: guia de identificação das plantas vasculares de uma floresta de terra-firme na Amazônia Central. INPA, Manaus. Pp. 625-647.
- Cervi AC & Borgo M (2007) Epífitos vasculares no Parque Nacional do Iguaçu, Paraná (Brasil). Levantamento preliminar. Fontqueria 55: 415-422.
- Costa CB & Mamede MCH (2002) Sinopse do gênero *Coccocypselum* P. Br. (Rubiaceae) no estado de São Paulo, Brasil. Biota Neotropica 2: 1-14.
- Davis AP, Govaerts R, Bridson DM, Ruhsam M, Moat J & Brummit NA (2009) A global assessment of distribution, diversity, endemism, and taxonomic effort in the Rubiaceae. Annals of the Missouri Botanical Garden 96: 68-78.
- Delprete PG (2003) Revision and Typification of some species of *Ixora* (Rubiaceae) from central and southern Brazil. SIDA, Contributions to Botany 20: 1471-1480.
- Delprete PG & Jardim JG (2012) Systematics, taxonomy and floristics of Brazilian Rubiaceae: an overview about the current status and future challenges. Rodriguésia 63: 101-128.
- Delprete PG, Smith LB & Klein RM (2004) Rubiaceae. In: Reis A (ed.) Flora Ilustrada Catarinense. Vol.1. Herbário Barbosa Rodrigues, Itajaí. Pp. 1-344.
- Delprete PG, Smith LB & Klein RM (2005) Rubiaceae. In: Reis A (ed.) Flora Ilustrada Catarinense. Vol. 2. Herbário Barbosa Rodrigues, Itajaí. Pp. 345-843.
- Dempster L (1990) The genus *Galium* (Rubiaceae) in South America. IV. Allertonia 5: 283-345.
- Ferreira Junior M & Vieira AOS (2015) Espécies arbóreo-arbustivas da família Rubiaceae Juss. na bacia do Rio Tibagi, PR, Brasil. Hoehnea 42: 289-336.
- Filgueiras TS, Brochado AL, Nogueira PE & Guala II GF (1994) Caminhamento - um método expedito para levantamentos florísticos qualitativos. Cadernos de Geociências 2: 39-43.
- Florentin MN, Florentín JE & Salas RM (2020) Integrative taxonomic analyses sheds light on three historically disputed American Spermaceae species, and a key to the American species of Spermaceae (Spermaceae, Rubiaceae). Systematic Botany 45: 585-606.
- Florentin JE, Florentin MN & Cabral EL (2017) A synopsis of *Galianthe* (Rubiaceae) in Rio Grande do Sul, Southern Brazil, and a new endemic species from Serra Geral. Acta Botanica Brasilica 31: 619-638.
- Gomes M (2003) Reavaliação taxonômica de algumas espécies dos gêneros *Coussarea* Aubl. e *Faramea* Aubl. (Rubiaceae, tribo Coussareae) Acta Botanica Brasilica 17: 449-466.
- Gris D & Temponi LG (2017) Similaridade Florística entre trechos de Floresta Estacional Semidecidual do Corredor de Biodiversidade Santa Maria - PR. Ciência Florestal 27: 1069-1081.
- Hammes JK (2017) Flora de Acanthaceae Juss. e Verbenaceae J.St.-Hil. (Lamiales) no Parque Nacional do Iguaçu, Paraná, Brasil. Masters dissertation (Conservation and Management of Natural Resources) - Centro de Ciências Biológicas e da Saúde. Universidade Estadual do Oeste do Paraná, Cascavel. 76p.
- Hammes JK, Silva MG, Kameyama C & Temponi LG (2021) Flora of Acanthaceae of Iguaçu National Park, Paraná, Brazil. Rodriguésia 72: e00762019.
- Hentz Junior EJ (2018) Sinopse de Bignoniaceae Juss. no Parque Nacional do Iguaçu, Paraná, Brasil. Course Completion Report. Universidade Estadual do Oeste do Paraná, Cascavel. 58p.
- IAPAR - Instituto Agrônômico do Paraná (2010) Cartas climáticas do Paraná. Available at <<http://www.iapar.br/modules/conteudo/conteudo.php?conteudo=863>>. Access on 26 April 2019.
- IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (1999) Plano de Manejo do Parque Nacional do Iguaçu. IBAMA, Brasília. 80p.
- IBGE - Instituto Brasileiro de Geografia e Estatística (2012) Manual Técnico da Vegetação Brasileira. 2nd ed. IBGE, Rio de Janeiro. 271p.
- IPNI - The International Plant Names Index (2019) Available at <<http://www.ipni.org>>. Access on 26 April 2019.
- Jesus CS (2017) Listagem Florística de Cyperaceae e Poaceae no Parque Nacional do Iguaçu, Paraná, Brasil. Masters dissertation (Conservation and Management of Natural Resources) Centro de Ciências Biológicas e da Saúde. Universidade Estadual do Oeste do Paraná, Cascavel. 77p.
- Jung-Mendaçolli SL (2007) Rubiaceae. In: Wanderley MGL, Shepherd GJ, Melhem TSA & Giulietti AM (eds.) Flora fanerogâmica do estado de São Paulo. Instituto de Botânica, São Paulo. Vol. 5, pp. 259-460.
- Lautert M, Temponi LG, Viveros RS & Salino A (2015) Lycophytes and ferns composition of Atlantic Forest conservation units in western Paraná with comparisons to other areas in southern Brazil. Acta Botanica Brasilica 29: 499-508.
- Lewis WH & Oliver RL (1974) Revision of *Richardia* (Rubiaceae). Brittonia 26: 271-301.
- Maack R (2012) Geografia física do estado do Paraná. 4th ed. Editora UEPG, Ponta Grossa. 526p.

- Macias L (1998) Estudos taxonômicos do gênero *Manettia* Muttis ex L. (Rubiaceae) no Brasil, Paraguai, Argentina e Uruguai. Doctoral thesis. Universidade Estadual de Campinas, Campinas. 358p.
- Marinero FEC, Rodrigues WA & Cervi AC (2012) *Manettia* (Rubiaceae) no estado do Paraná, Brasil. *Rodriguésia* 63: 635-647.
- Oliveira JA, Salimena FRG & Zappi D (2014) Rubiaceae da Serra Negra, Minas Gerais, Brasil. *Rodriguésia* 65: 471-504.
- Pereira GF (2007) A família Rubiaceae Juss. na vegetação ripária de um trecho do alto Rio Paraná, Brasil, com ênfase à tribo Spermaceae. Dissertação. Universidade Estadual de Maringá, Maringá. 68p.
- Pereira ZV & Kinoshita LS (2013) Rubiaceae Juss. do Parque Estadual das Várzeas do Rio Ivinhema, MS, Brasil. *Hoehnea* 40: 205-251.
- Pereira ZV, Carvalho-Okano RM & Garcia FCP (2006) Rubiaceae Juss. da Reserva Florestal Mata do Paraíso, Viçosa, MG, Brasil. *Acta Botanica Brasilica* 20: 207-224.
- Razafimandimbison SG, Taylor CM, Wikstro N, Paillet T, Khobandeh A & Bremer B (2014) Phylogeny and generic limits in the sister tribes Psychotrieae and Palicoureeae (Rubiaceae): evolution of schizocarps in Psychotria and origins of bacterial leaf nodules in the Malagasy species. *American Journal of Botany* 101: 1102-1126.
- Roderjan CV, Galvao F, Kuniyoshi YS & Hatschbach GG (2002) As unidades fitogeográficas do estado do Paraná, Brasil. *Ciência & Ambiente* 24: 75-92.
- Romero MF, Gonzalez AM & Salas RM (2015) Estudios morfo-anatómicos de domacios foliares en Rubiáceas Argentinas. *Boletín de la Sociedad Argentina de Botánica* 50: 493-514.
- Silveira MF (2010) Rubiaceae - Rubioideae Verdc. do Parque Nacional da Serra da Canastra, Minas Gerais, Brasil. Dissertação de Mestrado. Universidade Estadual de Campinas, Campinas. 118p.
- Souza DC & Souza MC (1998) Levantamento florístico das tribos Psychotrieae, Coussareeae e Morindeae Rubiaceae na região de Porto Rico, alto Rio Paraná. *Acta Scientiarum* 20: 207-212.
- Souza RF, Machado AS, Galvão F & Figueiredo Filho A (2017) Fitossociologia da Vegetação Arbórea do Parque Nacional Do Iguaçu. *Ciência Florestal* 27: 853-869.
- Souza VC & Lorenzi H (2012) Botânica sistemática: guia ilustrado para identificação das famílias de Fanerógamas nativas e exóticas no Brasil, baseado em APG III. 3rd ed. Instituto Plantarum de Estudos da Flora Ltda., Nova Odessa. 768p.
- Stearn WT (1992) *Botanical Latin*. 4th ed. Timber Press, Portland. 560p.
- Taylor CM (2007) Psychotri. In: Jung-Mendaçolli S (ed.) Rubiaceae. Flora fanerogâmica do estado de São Paulo. Instituto de Botânica, São Paulo. Pp.389-412.
- Taylor CM & Hollowell VC (2016) Rubiacearum americanarum magna hama pars XXXV: the new group Palicourea sect. Nonatelia, with five new species (Palicoureeae). *Novon* 25: 69-110.
- Thiers B [continuously updated] Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available at <<http://sweetgum.nybg.org/science/ih/>>. Access on 24 April 2019.
- Williams LO (1973) *Geophila* (Rubiaceae) in North America. *Phytologia* 26: 263-264.
- Zappi DC, Calió MF & Pirani Jr (2014) Flora da Serra do Cipó, Minas Gerais: Rubiaceae. *Boletim de Botânica Universidade de São Paulo* 32: 71-140.

List of exsiccates

AC Cervi 3963 (1.2), 3905 (9.1), 6959 (15.1). **AM Rodolfo** 31 (15.2). **C Snak** 16 (6.1), 15 (8.1), 17 (15.2). **CR Rauber** 144 (1.2), 18, 248 (1.3), 198, 202 (2.1), 250 (4.1), 235 (4.2), 302 (5.1), 2 (6.1), 109 (8.1), 231, 399 (9.1), 90, 219 (9.2), 52, 94 (9.3), 3 (11.1), 1 (11.2), 54, 429 (13.1), 357, 400 (15.1), 13, 105 (15.2), 175 (15.3), 34, 107, 209 (16.2), 201, 216 (16.5), 114 (17.1), 40, 85, 210 (17.2), 44, 104, 136, 190, 264 (17.4), 234, 300 (17.5). **E Barbosa** 2201 (15.3). **EL Siqueira** 2224 (10.1). **GB Mano** 66 (9.2). **GG Hatschbach** 9461 (1.2), 10430 (15.5). **JA Lombardi** 8771 (8.1), 8704 (11.1), 8730 (15.2). **JK Hammes** 144 (16.4). **LC Ferneda Rocha** 3, 40 (1.2), 21, 27 (1.3), 1, 38 (8.1) 30 (9.2), 22, 24 (9.3), 72, 14, 17 (11.1), 34, 73 (11.2), 26 (13.1), 02, 15, 18, 23, 29, 31, 32, 33, 37 (16.2), 20 (16.5), 39 (17.1), 13, 35 (17.2), 16, 25, 36, 71 (17.4). **LCP Lima** 744, 793 (8.1). **LG Temponi** 669 (1.2), 722 (1.3), 1175 (4.2), 701 (6.1), 637 (8.1), 512 (9.2), 461, 727 (9.3), 451, 573 (11.2), 720, 738, 789, 1065 (13.1), 695 (15.2), 869 (15.3), 443, 580, 708, 788, 868 (16.2), 713, 786 (16.3), 905 (16.5), 518, 870, 897, 914 (17.2), 574 (17.4), 678 (18.1). **LHSM Conceição** 106 (3.1), 105 (15.2). **LP Poli** 2 (8.1). **MG Caxambu** 8880 (3.1), 7624 (6.1), 7090 (12.1), 7921 (14.1), 7970 (16.1), 7039 (17.3). **ML Toderke** 70 (1.1), 77, 131, 140, 164 (1.2), 163, 173 (1.3), 216 (4.2), 162 (6.1), 73, 143, 136 (8.1), 124, 132 (9.1), 30, 117, 139, 151, 154, (9.2), 79, 129, 165, 181, 203, 220 (9.3), 76, 82, 87, 90, 115, 122, 150, 179, 195, 217 (11.1), 78, 91, 116, 125, 135, 149, 180 (11.2), 60, 127, 168, 145, 144, 171, 205 (13.1), 169, 194 (15.1), 75, 92, 123, 172, 204, 211 (15.2), 94, 197 (15.3), 74, 85, 98, 113, 121, 133, 161, 177, 210, 147 (16.2), 137, 175 (16.3), 160 (16.4), 84, 128, 166, 178, 198, 219 (17.1), 72, 80, 114, 134, 146, 174, 207, 213 (17.2), 20, 86, 97, 112, 128, 141, 148, 153, 176, 215 (17.4), 64, 214 (17.5), 88, 89, 130, 167, 206 (18.1), 170, 208 (19.1). **OS Ribas** 6050 (7.1), 7372 (9.1). **PH Labiak** 3822 (7.1). **SR Ziller** 1685 (16.4).

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