Article

Hoehnea 47: e1022019, 18 fig., 2020 http://dx.doi.org/10.1590/2236-8906-102/2019

Malpighiaceae Juss. in the Upper Paraná River Floodplain, States of Paraná and Mato Grosso do Sul, Brazil

Ricardo Pacifico[1,2] and Rafael Felipe de Almeida[3]

Recebido: 30.11.2019; aceito: 28.05.2020

How to cite: Pacifico, R. & Almeida, R.F. 2020. Malpighiaceae Juss. in the Upper Paraná River Floodplain, States of Paraná and Mato Grosso do Sul, Brazil. Hoehnea 47: e1022019. http://dx.doi.org/10.1590/2236-8906-102/2019.

ABSTRACT – (Malpighiaceae Juss. in the Upper Paraná River Floodplain, States of Paraná and Mato Grosso do Sul, Brazil). We present a taxonomic treatment for Malpighiaceae Juss. from the Upper Paraná River floodplain, Brazil, where 20 species in 12 genera were recognized. An identification key, morphological descriptions, photo plates, and comments on distribution and ecology of the species are provided. *Tetrapterys xylosteifolia* is recorded for the first time in both Paraná and Mato Grosso do Sul States in Brazil.
Keywords: Atlantic Rainforest, Cerrado, Malpighiales, Taxonomy

RESUMO – (Malpighiaceae Juss. na planície de inundação do alto rio Paraná, Estados do Paraná e Mato Grosso do Sul, Brasil). Apresentamos o tratamento taxonômico para Malpighiaceae Juss. na planície de inundação do rio Alto Paraná, Brasil, aonde 20 espécies e 12 gêneros foram registrados. Uma chave de identificação, descrições morfológicas, pranchas fotográficas e comentários sobre distribuição e ecologia das espécies são fornecidos. *Tetrapterys xylosteifolia* é citada pela primeira vez para os Estados do Paraná e Mato Grosso do Sul, Brasil.
Palavras-chave: Cerrado, Floresta Atlântica, Malpighiales, Taxonomia

Introduction

Malpighiaceae is a pantropical flowering plant family with about 1,300 species in 77 genera (Davis & Anderson 2010) and can usually be recognized by its malpighiaceous hairs, flowers with a pair of oil secreting glands at the base of each sepal, and unguiculate petals (Anderson 1981). This family is represented by lianas, shrubs or trees and attains its highest species richness in the Neotropical region (Davis & Anderson 2010).

River basins are long known to encompass a great diversity for some Malpighiaceae genera within forested habitats in the Neotropics (Anderson 1981, Anderson C. 1997, 2014, Almeida & Amorim 2014). One of the largest river basins in the Neotropical region is Paraná River Basin, which includes areas of Argentina, Paraguay, and seven States in Brazil (Stevaux 1994). Since 1998, when the Porto Primavera Dam was closed, the Upper Paraná River Floodplain (here mentioned as PIARP) is the only section of the Paraná river that maintains its natural hydrological processes (Agostinho *et al.* 2004).

During the last couple of decades, floristic research on PIARP included checklists of vascular plants [PIARP by Souza *et al.* (2009); Mata do Araldo by Slusarski & Souza (2012); Figueira lake by Kawakita & Souza (2003); epiphytes by Tomazini (2003); aquatic macrophytes by Ferreira *et al.* (2011)] and taxonomic treatments for Sapindaceae Juss. (Romagnolo & Souza 1994), Myrtaceae Juss. (Romagnolo & Souza 2004, 2006), Rubiaceae Juss. (Souza & Souza 1998), Poaceae Barnhart (Kawakita *et al.* 2016), *Crotalaria* L. (Garcia *et al.* 2013), and *Aeschynomene* L. (Souza *et al.* 2012). We present here a floristic treatment of Malpighiaceae from PIARP.

1. Universidade Estadual de Maringá, Departamento de Ciências Biológicas, 87020-900, Maringá, PR, Brasil
2. Corresponding author e-mail: ricardo_b9@hotmail.com
3. Scientifik Consultoria, 25651-090, Petrópolis, RJ, Brasil

Material and Methods

Study area - PIARP comprises an extensive floodplain of about 230 km long and up to 20 km wide, totally included in the Brazilian territory (Agostinho *et al.* 2004). It is located approximately between 22º38'-22º57' S and 53º05'-53º36' W (Figure 1) and partially overlaps with the municipalities of Porto Rico, São Pedro do Paraná, Marilena and Querência do Norte (in Paraná State), Batayporã, Novo Horizonte do Sul, Jateí and Taquarussu (in Mato Grosso do Sul State). Many localities in PIARP were subjected to anthropogenic activities, as deforestation and invasion by alien plants (Agostinho *et al.* 2004, Garcia *et al.* 2013). Three conservation units overlap totally or partially with PIARP: Ilha Grande National Park, Ivinhema State Park, and Environmental Protection Area (APA) of islands and flooded areas of Paraná River (Agostinho *et al.* 2004).

The left margin of the Paraná River is not exposed to seasonal floods and consists of colluvial soils deposited upon the Mesozoic sandstone of Caiuá formation (Stevaux 1994). The right margin presents both colluvial depositis formed *in situ* and terraces originated by fluvial processes associated with its paleodrainage system (Sallun *et al.* 2007). The region seasonally flooded is a plane lowland located at the right margin (Stevaux 1994), where the Paraná river has an anastomosed system that continuously generates islands by deposition of alluvial sandy sediments (Corradini *et al.* 2008).

The main vegetation type found in PIARP is the Submontane Semideciduous Seasonal Forest, which occurs at elevations between 100-600 m and is defined by the partial fall of leaves during dry seasons (IBGE 2012). Marshes, grasslands (Souza *et al.* 2009) and Cerrado remnants are also found surrounding seasonally flooded areas. The most representative plant families in PIARP are Fabaceae Lindl., Poaceae, and Rubiaceae Juss. (Souza *et al.* 2009). Phytosociologically, *Cecropia pachystachya* Trécul, *Inga vera* Wild. and *Guazuma ulmifolia* Lam. were reported by Campos *et al.* (2000) as tree species of high importance values in PIARP.

Floristic inventory and taxonomic study - The floristic inventory of PIARP started with annual expeditions between 1987-1999. In 1999 the study area was included in the Long Term Ecologic Research project (PELD/CNPq - site 6). Since then, seven-day floristic expeditions have been performed quarterly to cover both flood and dry seasons. Main sets of collections made in PIARP are housed in the herbaria HNUP and HUEM, both of which are located at the Maringá State University, Paraná, Brazil.

For the taxonomic study, morphological descriptions and phenology of the studied species were based on collections from CEPEC, HUEFS, HNUP, HUEM, MBM, RB, SP

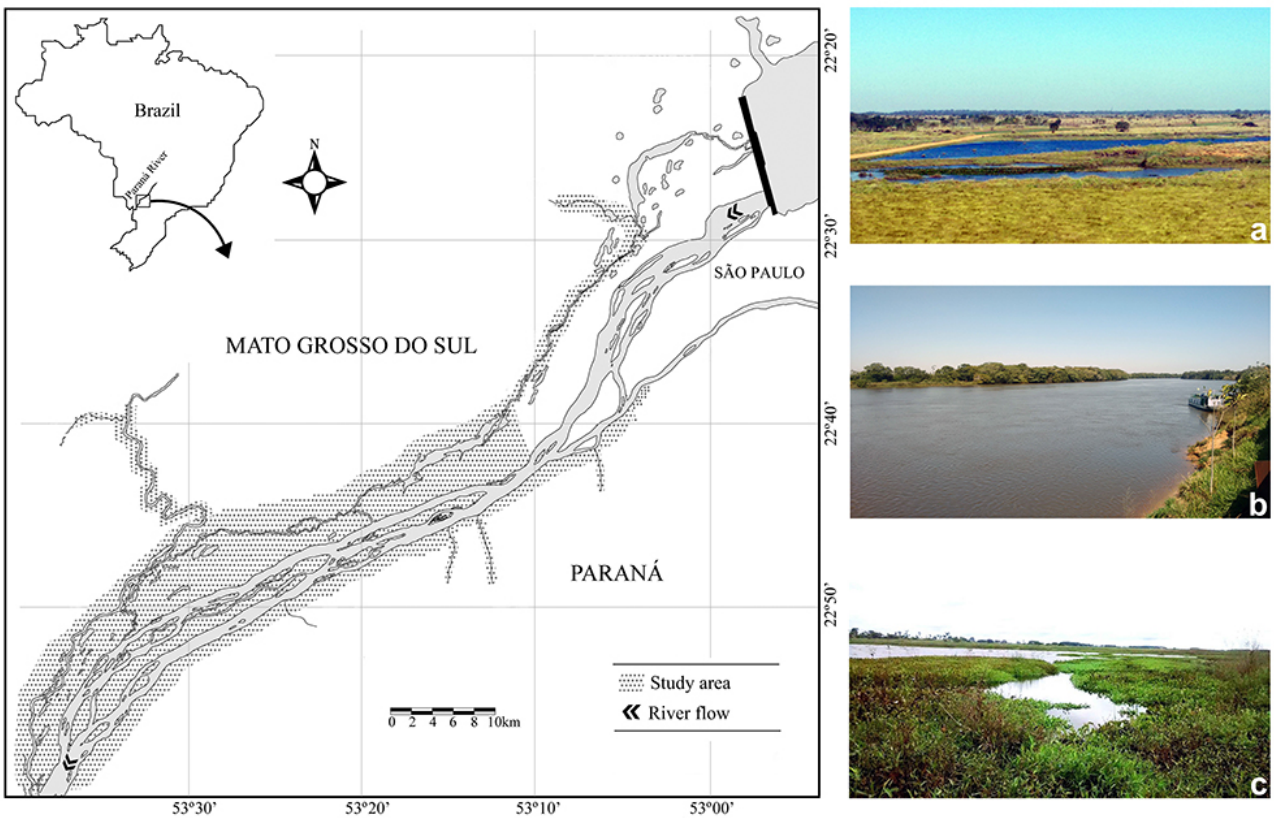

Figure 1. Map and habitats of the Upper Paraná River floodplain, Brazil. a. floodplain of the Paraná river surrounded by gallery forests. b. floodplain of the Ivinhema river. c. Guaraná lake (Photos a-b by M.R.M. Scoarize, c by R. Pacifico).

and UEC herbaria. The indumenta terminology follows Anderson (1981), structure shapes follow Radford *et al.* (1974), the inflorescence terminology and morphology follows Weberling (1965, 1989), and fruit terminology follows Spjut (1994) and Anderson (1981).

Results and Discussion

Malpighiaceae is represented in PIARP by 20 species in 12 genera. *Heteropterys* Kunth is the richest genus (5 spp.), followed by four genera with two species each [*Banisteriopsis* C.B.Rob., *Diplopterys* A.Juss., *Mascagnia* (Bertero *ex* DC.) Bertero, and *Tetrapterys* A.Juss.] and seven genera with one species each (*Alicia* W.R.Anderson, *Carolus* W.R.Anderson, *Dicella* Griseb., *Hiraea* Jacq., *Niedenzuella* W.R.Anderson, *Peixotoa* A.Juss., and *Stigmaphyllon* A.Juss.). Souza *et al.* (2009) reported seven species of Malpighiaceae in PIARP. Thus, our study increases in about 285% the richness of Malpighiaceae species recognized in this area.

Only three species [*Banisteriopsis muricata* (Cav.) Cuatrec., *Hiraea hatschbachii* C.E.Anderson and *Mascagnia divaricata* (Kunth) Nied.] were found in islands of PIARP, where floods are frequent. The reduced richness of Malpighiaceae in islands was probably determined by water level, turbulences, wave current, deposition and erosion processes, which usually affect plant occupation in floodplains (Junk *et al.* 1989, Junk & Piedade 1997, Ferreira & Stohlgren 1999). In Mutum island, *Hiraea hatschbachii* survives during floods by climbing on the forest canopy (R. Pacifico, personal observation). *Banisteriopsis muricata*, *H. hatschbachii* and *M. divaricata* seem to be flood-resistant because mature individuals of these species were found in localities exposed to annual floods. In turn, *Banisteriopsis campestris* (A.Juss.) Little, *Peixotoa reticulata* Griseb. and *Tetrapterys ambigua* (A.Juss.) Nied. are restricted to Cerrado remnants with dry soils during all year long.

Taxonomic treatment

Malpighiaceae Juss., Gen. Pl. 252. 1789. Type: *Malpighia* L.

Trees, shrubs, subshrubs to lianas; unicellular hairs T-Y-V-shaped, rarely aciculate; stipules epi- or interpetiolar, diminute or expanded. Leaves simple, opposite, rarely subopposite; leaf blade glandular, rarely eglandular, margins plane or revolute; petiole glandular, rarely eglandular. Inflorescences of first order of 1-3-flowered cincinni; second order inflorescences thyrsi, corymbs or umbels; third order inflorescences dichasia, thyrsi or panicles, axillary or terminal. Flowers zygomorphic, bisexual, heterocyclic, hypogynous; sepals 5, glands 0-2 per sepal, anterior sepal usually eglandular; petals 5, yellow or white to pink, free, clawed; posterior petal generally markedly different from lateral petals. Stamens (4-6-)10, iso- or heteromorphic; anthers pubescent or glabrous. Gynoecium 2-3-carpellate, free or connate, 1-ovulate; ovule pendulous, anatropous; styles 1-3, free, rarely connate, apex acute, obtuse, capitate or truncate; stigmas terminal or lateral. Fruit a drupe, nut or schizocarp, the latter splitting into 3 mericarps, smooth, setose or winged.

Key to the species of Malpighiaceae of PIARP

1. Umbels disposed in compound inflorescences or solitary umbels
2. Umbels disposed in dichasia or short thyrsi
3. Apex of styles expanded into a leaf-like structure …..…… *Stigmaphyllon bonariense*
3. Apex of styles capitate
4. Stipules expanded and fused, when deciduous leaving a concave scar on nodes, anthers never releasing pollen grains …… ……..……. *Peixotoa reticulata*
4. Stipules minute and free, anthers always releasing pollen grains
5. Mericarps with four lateral wings more developed than the dorsal wing, X-shaped .....……. *Tetrapterys xylosteifolia*
5. Mericarps with the dorsal wing more developed than the lateral wings
6. Leaves glabrescent, petals yellow …….....… *Diplopterys pubipetala*
6. Leaves tomentose or sericeous, petals white to pink
7. Leaf blades tomentose, secondary veins abaxially prominent, dorsal wing widely expanded .... *Banisteriopsis campestris*
7. Leaf blades sericeous, secondary veins abaxially impressed, dorsal wing widely expanded at apex and constricted at base …….....…… *Banisteriopsis muricata*
2. Solitary umbels
8. Leaves persistent when flowering, linear epipetiolar stipules ….....…. *Hiraea hatschbachii*
8. Leaves deciduous when flowering, petioles without linear stipules ……..... *Diplopterys lutea*
1. Thyrsi or corymbs

9. Corymbs, mericarps with two lateral wings fused into a single orbicular wing
10. Leaf blades velutine, petals yellow ..... *Mascagnia australis*
10. Leaf blades sericeous to glabrous, petals pink ..... *Mascagnia divaricata*
9. Thyrsi, mericarps with lateral wings not fused into a single orbicular wing, or nuts.
11. Bracts and bracteoles cucullate, nuts ..... *Dicella nucifera*
11. Bracts and bracteoles flat, mericarps
12. Mericarps with two or four lateral wings more developed than the dorsal wing, butterfly-shaped, X-shaped or orbicular
13. Petals white to pink, leaves strongly discolored when dry ..... *Alicia anisopetala*
13. Petals yellow to reddish, leaves concolored to slightly discolored when dry
14. Subshrubs, leaves abaxially densely tomentose ..... *Tetrapterys ambigua*
14. Lianas, leaves abaxially sericeous to glabrescent
15. Petioles glabrous, leaf blades with the margins glabrous, mericarps butterfly-shaped ..... *Carolus chlorocarpus*
15. Petioles glandular, leaf blades with the margins glandular, mericarps X-shaped ..... *Niedenzuella multiglandulosa*
12. Mericarps with lateral wings less developed than the dorsal wing or absent
16. Leaves abaxially sericeous or velutine becoming glabrescent with age
17. Petioles glandular at the base, floral peduncles absent ..... *Heteropterys argyrophaea*
17. Petioles glandular near the apex, floral peduncles 1.6-2 mm long ..... *Heteropterys byrsonimifolia*
16. Leaves always glabrous abaxially
18. Leaf blades linear to lanceolate 0.3-0.5 cm wide ..... *Heteropterys glabra*
18. Leaf blades narrowly elliptical to ovate 1.6-5.4 cm wide
19. Petioles glandular near the apex, bracteoles elliptical ..... *Heteropterys cochleosperma*
19. Petioles eglandular, bracteoles expanded and foliaceous ..... *Heteropterys eglandulosa*

1. ***Alicia anisopetala*** (A.Juss.) W.R.Anderson, Novon 16(2): 176. 2006.
Figure 2

Lianas; stems sericeous; stipules epipetiolar, triangular. Leaves decussate; petioles 8.8-15.5 mm long, 2-6-glandular; blades 6.7-15.6 × 3.7-8.3 cm, widely ovate, base cuneate, margin entire, 1-10-glandular near base, apex acute or cuspidate, adaxially glabrescent, abaxially tomentose. Thyrsi, solitary or arranged in panicles, axillar or terminal; cincinni bracts ca. 2.8 mm long, spatulate; peduncles 2.3-2.5 mm long; bracteoles 2.4-3.8 mm long, foliaceous. Flowers with pedicels 3-3.6 mm long; sepals 3.2-3.5 × 1.3-1.8 mm, narrowly triangular, adaxially glabrous, abaxially sericeous; glands 1.5-2 mm long, anterior sepal eglandular; petals white to pink, margin denticulate to shortly-fimbriate, adaxially glabrescent, abaxially densely sericeous; lateral petals limb 1.7-2.2 × 1-1.2 mm, claws 0.7-1 mm long; posterior petal limb ca. 3.6 × 1.8 mm, claw ca. 1.5 mm long. Fertile stamens 10, subisomophic; filaments 0.7-1.6 mm long; anthers 0.8-1.1 mm long; staminodes absent. Ovaries pilose; styles 3, 0.8-1.2 mm long, subisomorphic, glabrous; stigmas lateral. Mericarps winged, lateral wings 2, well-developed (butterfly-shaped), 1.5-2.4 cm long, free partially fused at base, sericeous; dorsal wing 4-6 mm long, sericeous.

Alicia anisopetala is widely distributed in South America (Anderson 2006). In Brazil, it occurs in all States of the southern and midwest regions, and in Mato Grosso do Sul and Bahia (Almeida 2020). In PIARP, *A. anisopelata* may be recognized by the combination of leaves strongly discolored when dry and butterfly-shaped mericarps. *Carolus chlorocarpus* shares with *A. anisopetala* the butterfly-shaped mericarps and differs by the leaves concolored when dry (vs. discolored) and flowers with yellow petals (vs. white to pink). *Alicia anisopetala* was only found in gallery forests at the left margin of PIARP, flowering and fruiting from April to July and December.

Material examined: BRAZIL. Paraná: Porto Rico. Córrego Caracú, margem direita, 5-IV-2006, *Ma.C. Souza et al. 1633* (HNUP, HUEM, HUEFS); 22-IV-2008, *R.S. Garcia et al. 27* (HNUP, HUEM, HUEFS); 3-VII-2012, *R. Pacifico et al. 36* (HNUP, HUEM); Rio Paraná, base da UEM, 14-XII-1992, *P.C. Mencacci & M.B. Romagnolo 6* (HNUP, HUEM); Porto de Areia Cristo Rei, 12-XII-2009, *Ma.C. Souza et al. 2221* (HNUP, HUEM); 2-VI-2011, *L.M. Garcia et al. 650* (HNUP, HUEM). São Pedro do Paraná. Ribeirão São Pedro, margem esquerda, 24-V-2007, *V.C. Harthman et al. 29* (HNUP, HUEM).

2. ***Banisteriopsis campestris*** (A.Juss.) Little**,** Phytologia 6: 506. 1959.
Figure 3

Erect subshrubs; stems sericeous to tomentose; stipules interpetiolar, triangular. Leaves decussate; petioles 3.6-4.7 mm

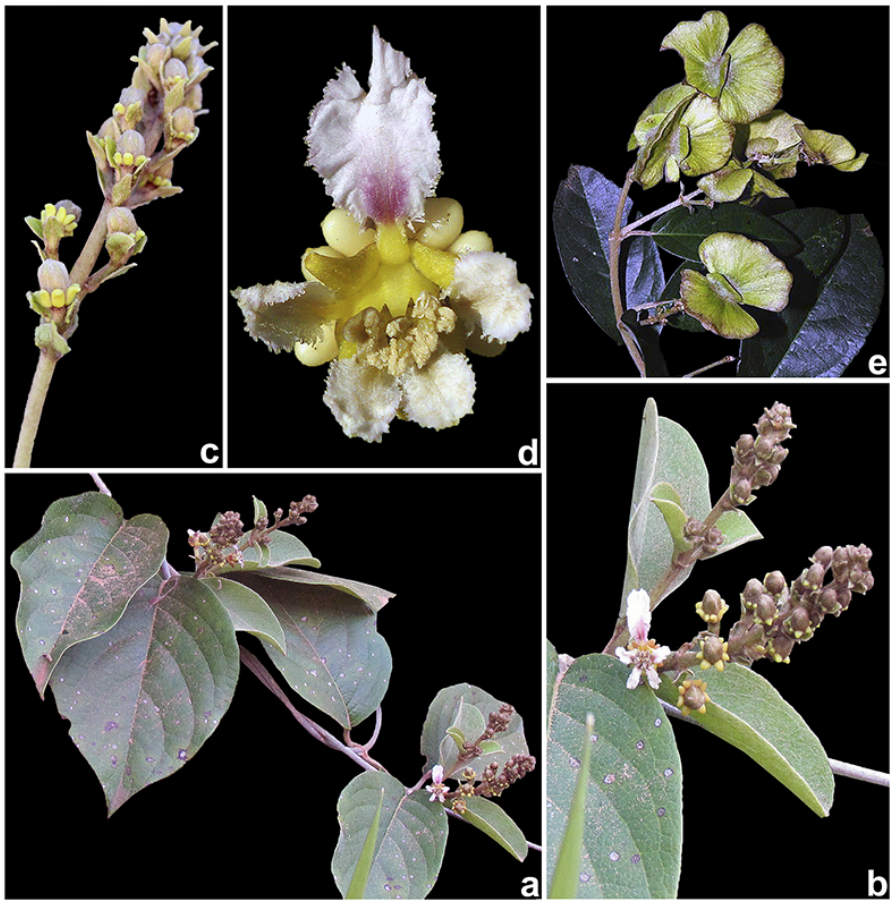

Figure 2. *Alicia anisopetala* (A.Juss.) W.R.Anderson. a. Flowering branch. b-c. Inflorescence. d. Flower in frontal view. e. Fruiting branch (Photos a-b by C.Takeuchi, c-d by M.R.Pace, e by E.F.Rossetto).

long, eglandular; blades 4.9-6.8 × 3.8-4.4 cm, elliptical, base subcordate to truncate, margin entire, apex mucronulate-cuspidate, both sides tomentose, 2-glandular at base. Umbels arranged in dichasia, 4-flowered; cincinni bracts 1.9-2.2 mm long, narrowly triangular; peduncles absent; bracteoles ca. 1.5 mm long, triangular. Flowers with pedicels ca. 1.5 cm long; sepals not seen; petals not seen; androecium and gynoecium not seen. Mericarps winged, dorsal wing well-developed and thickened along the upper margin, 2.1-2.3 cm long, densely sericeous-tomentose; lateral wings absent.

Banisteriopsis campestris occurs only in Brazil, where it is widely distributed in Cerrado areas from Paraná to Mato Grosso, Tocantins and Maranhão, and in Caatinga regions of Bahia (Flora do Brasil 2020). In PIARP, it may be distinguished by having tomentose leaves, pink petals, and mericarps with the dorsal wing widely expanded. It differs from *B. muricata* by the leaf blades abaxially tomentose (vs. sericeous) and 2-glandular at the base (vs. eglandular). *Banisteriopsis campestris* was found only in the right margin of PIARP, near the Ivinhema River, in Cerrado remnants that are not exposed to seasonal floods.

Material examined: BRAZIL. Mato Grosso do Sul: Taquarussú. Rio Ivinhema, 1998, *M.P. Fachini s.n.* (HNUP 13817, HUEM 27544).

3. *Banisteriopsis muricata* (Cav.) Cuatrec., Webbia 13: 503. 1958.
Figure 4

Lianas; stems glabrescent; stipules interpetiolar, triangular. Leaves decussate; petioles 0.8-1 cm long, eglandular; blades 7.3-10.8 × 3.1-6.8 cm, ovate or elliptical, base rounded to subcordate, margin entire, apex mucronate to cuspidate, adaxially glabrous, abaxially sericeous, eglandular. Umbels arranged in reduced dichasia, 4-flowered, axilar or terminal; cincinni bracts and bracteoles 0.7-1 mm long, narrowly triangular; peduncle absent. Flowers with pedicels 5.3-14 mm long; sepals ca. 2.3 × 1.4 mm, triangular, abaxially tomentose; glands ca. 1.5 mm long; anterior sepal eglandular; petals white to pink, margin fimbriate, both surfaces glabrous; lateral petals limb 4.3-5.6 × 3.3-4.6 mm, claws 0.7-1.3 mm long, posterior petal limb 5.3-5.7 × 3.7-3.9 mm, claw 1.8 mm long. Fertile stamens 10, heteromorphic;

Figure 3. *Banisteriopsis campestris* (A.Juss.) Little. a. Leaves in adaxial view. b. Inflorescence in side view. c. Flower in frontal view. d. Fruit in side view (Photos by R.F.Almeida).

filaments 1.1-3.5 mm long; anthers 0.6-0.8 mm long; staminodes absent. Ovaries pilose; styles 3, 2.5-4.2 mm long, isomorphic or subisomorphic, glabrescent; stigmas apical. Mericarps winged, dorsal wing well-developed and thickened along the upper margin, 1.6-3.6 cm long, sericeous; lateral wings absent.

Banisteriopsis muricata is widely distributed from Mexico to Argentina (Gates 1982). It is a common species in PIARP and occurs in both of its margins, besides its islands and river channels. *Banisteriopsis muricata* can be recognized by a combination of sericeous leaves, pink petals, and mericarps with the dorsal wing widely expanded at the base and constricted at the apex. It is morphologically related to *B. campestris* (see comments on this species). It was collected in gallery forests, islands and river channels, on hydromorphic soils, flowering from January to March, and fruiting from February to May and August.

Material selected: BRAZIL. Mato Grosso do Sul: Jateí. Rio Ivinhema, lagoa Peroba, 24-VIII-2011, *J.M. Garcia et al. 161* (HNUP, HUEM). Taquarussú. Rio Ivinhema, 15-V-1992, *Ma.C. Souza 2671* (HNUP, HUEM). Paraná: Marilena. Estrada entre Porto Eucalipto e Porto Maringá, ponte do rio Areia, 13-III-2007, *Ma.C. Souza et al. 1684* (HNUP, HUEM). Porto Rico. Rio Paraná, foz do canal Cortado, 20-III-2001, *Ma.C. Souza 2676* (HNUP, HUEM). São Pedro do Paraná. Rio Paraná, margem esquerda, área do Prasa, 12-II-2011, *G.S. Rosa et al. 185* (HNUP, HUEM).

4. *Carolus chlorocarpus* (A.Juss.) W.R.Anderson, Novon 16(2): 188. 2006.
Figure 5

Lianas; stems sericeous to glabrescent; stipules interpetiolar, triangular. Leaves decussate; petioles 3.1-5.6 mm long, eglandular; blades 3.5-9.8 × 0.9-2.8 cm, narrowly elliptical to lanceolate, base cuneate, margin entire, apex attenuate to acuminate, both sides sparsely sericeous to glabrescent, eglandular. Thyrsi, solitary, axillar; cincinni bracts 1.8-3.2 mm long, narrowly triangular; peduncles 1-1.5 mm long; bracteoles ca. 0.7 mm long, elliptical. Flowers with pedicels 3.5-4 mm long; sepals 1.8-1.9 × 0.8-1.2 mm, triangular to narrowly triangular, abaxially sericeous; glands ca. 1.2 mm long; anterior sepal eglandular; petals yellow, margin glandular-fimbriate, adaxially glabrescent, abaxially sericeous; lateral petals limb 2.6-4.3 × 2.4-3.7 mm, claw 1.4-2 mm long; posterior petal limb 1.9-2.2 × 1.8-2.5 mm, claw 1.8-2.1 mm long. Fertile stamens 10, subisomorphic; filaments 1.7-2.1 mm long; anthers ca. 1 mm long; staminodes absent. Ovaries pilose; styles 3, 1.1-1.4 mm long, isomorphic, glabrescent; stigmas lateral. Mericarps not seen.

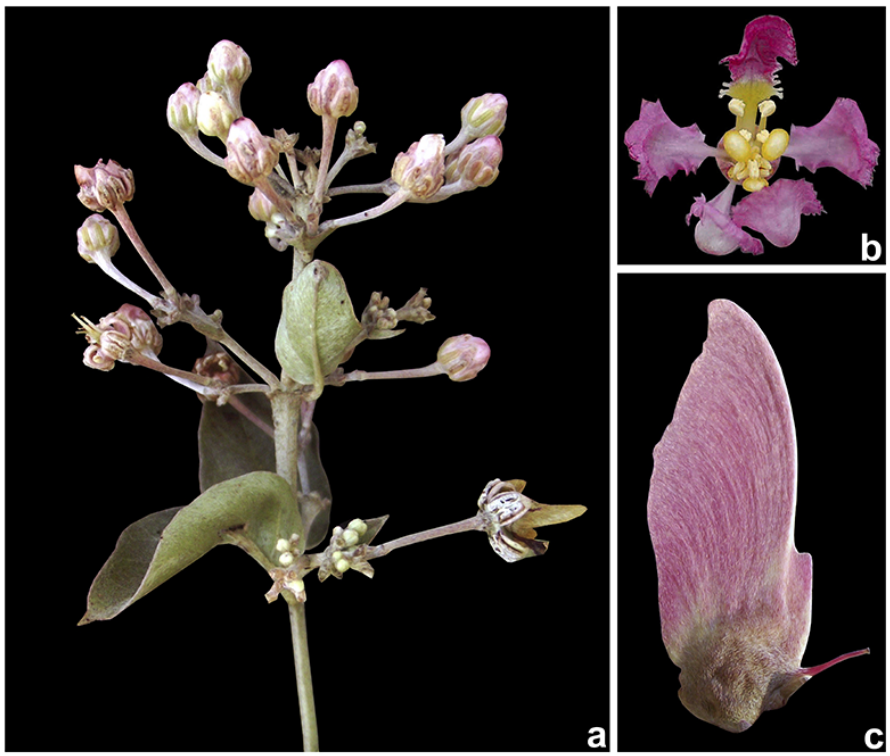

Figure 4. *Banisteriopsis muricata* (Cav.) Cuatrec. a. Inflorescence. b. Flower in frontal view. c. Fruit in side view (Photos by R.F.Almeida).

Carolus chlorocarpus occurs in Bolivia, Paraguay (Anderson 2006), and from Paraná to Bahia in Brazil (Flora do Brasil 2020). It can be recognized the leaf blades eglandular at the margin, flowers disposed in thyrsi, and butterfly-shaped mericarps. It could be confused with *A. anisopetala* (see the comments on this species). *Carolus chlorocarpus* was found only at the left margin of PIARP, in a gallery forest with hydromorphic soils, flowering in May.

Material examined: BRAZIL. Paraná: Porto Rico. Rio Paraná, Fazenda Porto Rico, 11-V-1988, *J.A. Leandrini 1* (HNUP, HUEM, HUEFS).

5. *Dicella nucifera* Chodat**,** Arch. Sci. Phys. Nat. ser. 3, 24: 500. 1890.
Figure 6

Lianas; stems sericeous; stipules interpetiolar, triangular. Leaves decussate; petioles 0.2-2 cm long, bearing a pair of glands at the base or the apex; blades 2.6-11.4 × 0.6-6.8 cm, elliptical to narrowly elliptical, base rounded, margin entire, apex shortly acuminate, adaxially glabrescent, abaxially sericeous-tomentose, 1-4-glandular on secondary veins. Thyrsi, axillar; cincinni bracts ca. 3.8 mm long, obovate; peduncles 5.2-5.5 mm long; bracteoles ca. 2.9 × 1.5 mm, foliaceous. Flowers with pedicels 1.1-1.7 mm long; sepals ca. 2.3 × 1.2 mm, narrowly triangular, abaxially sericeous; glands ca. 1.2 mm long; anterior sepal eglandular; petals yellow to reddish at age, margin sinuate to serrate, adaxially glabrescent, abaxially sericeous; lateral petals limb 4.5-5 × 1-2 mm, claw 0.8-1.5 mm long; posterior petal limb ca. 0.6 × 0.3-0.4 cm, claw ca. 0.2 cm long. Fertile stamens 10, subisomorphic; filaments 1.7-2.7 mm long; anthers ca. 1 mm long; staminodes absent. Ovaries pilose; styles 2, 1-1.2 mm long, isomorphic, glabrescent; stigmas lateral. Nut, subspherical, 2.5-3.5 cm diam., sericeous.

Dicella nucifera occurs from Argentina to southern Brazil (Chase 1981; Pessoa 2020). PIARP is the northernmost limit of its distribution. It can be readily recognized among Malpighiaceae of this area for being the only species with cucullate bracteoles and nuts. *Dicella nucifera* was found only at the left margin of PIARP, in gallery forests with hydromorphic soils, flowering from December to March, and fruiting in February and March.

Material examined: BRAZIL. Paraná: Porto Rico. Base de Pesquisa, 14-XII-1992, *P.C. Mencacci & M.B. Romagnolo* (HUEM 4475, HNUP 26701); Córrego Caracú, 14-XII-2004, *R. Zampar & V. Tomazini 2* (HNUP, HUEM); Mata do Araldo, 8-II-2006*, S.R. Slusarski et al. 441* (HNUP, HUEM, HUEFS); Rio Paraná, margem esquerda, 14-I-1999, *M.P. Fachini s.n.* (HNUP 26706, HUEM 26706); 12-I-1999, *M.P. Fachini 325* (HNUP, HUEM). São Pedro do Paraná. Ribeirão São Pedro, 3-III-2002, *Ma.C. Souza & A.C. Secorun s.n.* (HNUP 26721, HUEM 13189); 19-I-2004, *Ma.C. Souza 1280* (HNUP, HUEM); 27-III-2004, *Ma.C. Souza 1112* (HNUP, HUEM) 22-II-2005, *A.C. Fontana 42* (HNUP, HUEM).

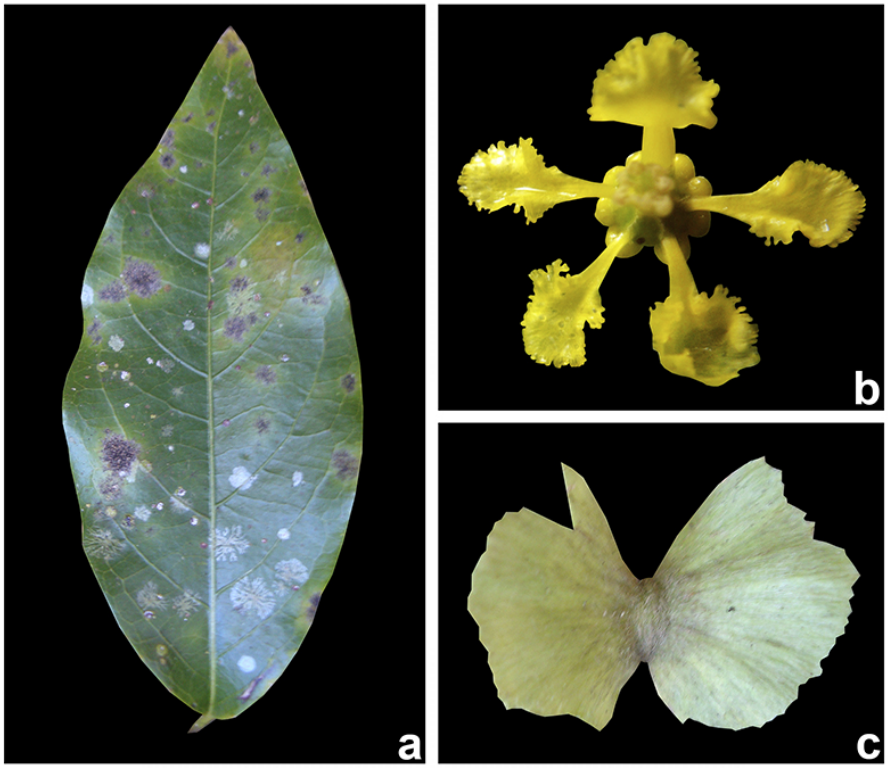

Figure 5. *Carolus chlorocarpus* (A.Juss.) W.R.Anderson. a. Leaf in adaxial view. b. Flower in frontal view. c. Fruit in frontal view (Photos a-b by P.H.B.Dettmann, c by M.Engels).

6. *Diplopterys lutea* (Griseb.) W.R.Anderson & C.C.Davis, Harvard Pap. Bot. 11(1): 10. 2006.
Figure 7

Lianas; stems glabrescent; stipules not seen. Leaves deciduous. Umbels, 4-flowered, axillar; cincinni bracts and bracteoles ca. 2 mm long, narrowly triangular; peduncle absent. Flowers with pedicels 10.9-20.2 mm long; sepals ca. 2 × 1.4 mm, triangular, abaxially glabrescent; eglandular; petals yellow, margin fimbriate, adaxially glabrescent, abaxially sericeous; lateral petals limb 3.6-6.3 × 4.1-5 mm, claw 1.4-2.7 mm long; posterior petal limb ca. 3.5 × 4.3 mm, claw ca. 3.6 mm long. Fertile stamens 10, heteromorphic; filaments 2-4.3 mm long; anthers 0.8-1.1 mm long; staminodes absent. Ovaries pilose; styles 3, 3.8-3.9 mm long, isomorphic, lateral styles glabrous, anterior style pilose; stigmas apical. Mericarps not seen.

Diplopterys lutea occurs in Argentina, Paraguay, Bolivia, Peru, and in Brazil from Paraná to Maranhão (Gates 1982). It can be easily recognized in PIARP for being the only species of Malpighiaceae with deciduous leaves. *Diplopterys lutea* was found exclusively in the left margin of PIARP, in gallery forests with hydromorphic soils, flowering from August to September.

Material examined: BRAZIL. Paraná: Querência do Norte. Rio Paraná, Porto Floresta, 19-IX-1992, *Ma.C. Souza 1318* (HNUP, HUEM). Santa Cruz do Monte Castelo. Rio Paraná, margem esquerda, 18-VIII-1994, *M.E. Previdello 114* (HNUP, HUEM).

7. *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis, Harvard Pap. Bot. 11(1): 13. 2006.
Figure 8

Lianas; stems glabrescent; stipules interpetiolar, narrowly triangular. Leaves decussate; petioles 1.7-3.4 mm long, eglandular; blades 6.1-9.5 × 3.4-4.1 cm long, elliptical, base rounded to cuneate, margin entire, apex acute, cuspidate to subcaudate, both surfaces glabrescent, 2-glandular near margin. Umbels arranged in short thyrsi, axillar or terminal; cincinni bracts 1.5-1.8 mm long, narrowly triangular; peduncle absent; bracteoles 1.5-1.8 mm long, narrowly triangular. Flowers with pedicels 8.9-16 mm long; sepals ca. 2.5 × 1.5 mm, oblong to elliptical, abaxially sericeous, glands ca. 1.4 mm long, anterior sepal eglandular; petals yellow, margin denticulate to shortly fimbriate, adaxially glabrescent, abaxially sericeous, lateral petals limb 4.6-6.2 × 4.6-6.4 mm, claw 1.4-1.7 mm long; posterior petal limb ca. 5.2 × 5 mm, claw 3-3.6 mm long. Fertile stamens 10, heteromorphic; filaments 1.5-4.1 mm long; anthers 1-1.6 mm long; staminodes absent. Ovaries pilose; styles 3, 1.3-4 mm long, heteromorphic, glabrous; stigmas apical. Mericarps not seen.

Diplopterys pubipetala is widespread in Brazil and extends its distribution to Colombia, Peru, Bolivia, and

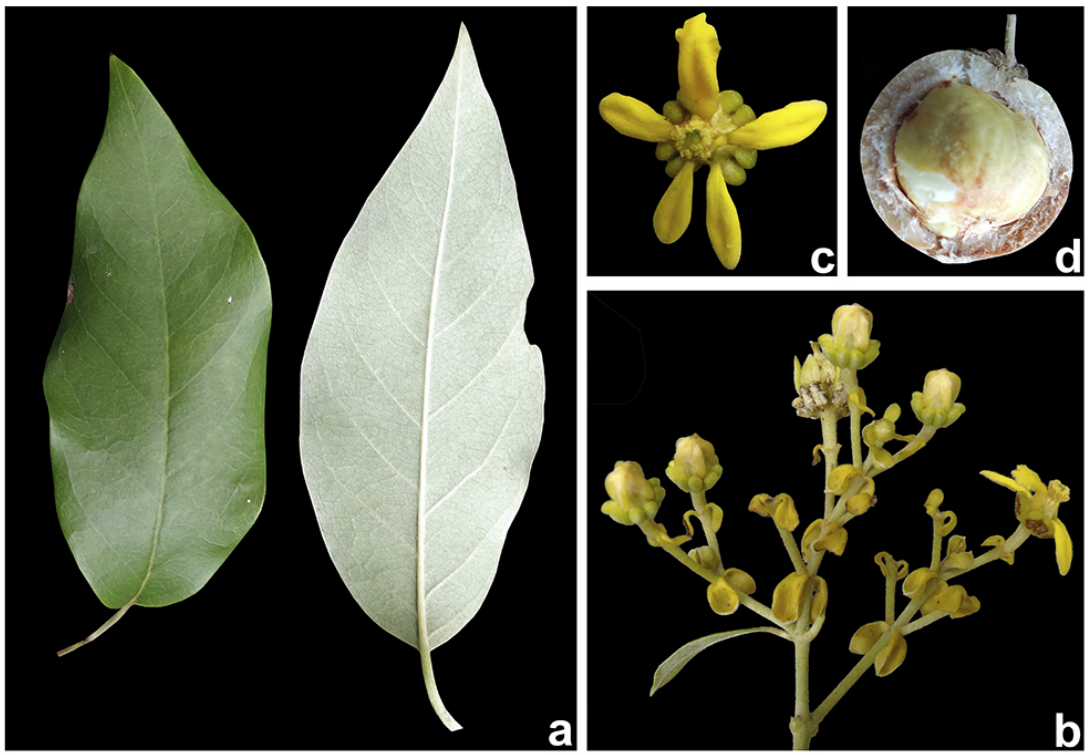

Figure 6. *Dicella nucifera* Chodat. a. Leaf in adaxial (left) and abaxial (right) views. b. Inflorescence in side view. c. Flower in frontal view. d. Fruit in transversal section (Photos by A.Junior).

Paraguay (Gates 1982). It can be recognized in PIARP by a combination of glabrescent leaves, solitary umbels, and petals abaxially sericeous. *Diplopterys pubipetala* can be easily differentiated from *D. lutea* (the only congener in the area) by its persistent leaves (vs. deciduous). *Diplopterys pubipetala* was found only in the right margin of PIARP, near the Guiraí river, in gallery forests with hydromorphic soils that are not exposed to seasonal floods, flowering in November.

Material examined: BRAZIL. Mato Grosso do Sul: Taquarussú. Rio Guiraí, 4-XI-2005, *A.C. Fontana 194* (HNUP, HUEM).

8. *Heteropterys argyrophaea* A.Juss., Ann. Sci. Nat., Bot. sér. 2, 13: 274. 1840.

Lianas; stems sericeous or glabrescent, hairs sessile; stipules interpetiolar, triangular. Leaves decussate; petioles 5.6-10.3 mm long, bearing a pair of glands at the base; blades 5.8-12.9 × 3.3-7 cm, elliptical to widely ovate, rarely obovate, base cuneate or rounded, margin entire, apex acute, adaxially glabrous, abaxially sericeous, eglandular. Thyrsi, axillar or terminal; cincinni bracts ca. 3 mm long, lanceolate; peduncles absent; bracteoles ca. 1.1 mm, triangular. Flowers with pedicels 2.6-4.4 mm long; sepals 2.5-2.8 × 1-1.1 mm, narrowly triangular, abaxially sericeous, glands 0.9-1.2 mm long, anterior sepal eglandular; petals yellow, margin sinuate, both surfaces glabrous; lateral petals limb 1.9-2.9 × 1.6-2.1 mm, claw 1.1-2.4 mm long; posterior petal limb 2.8-3.1 × 1.4-1.7 mm, claw 1.3-2 mm long. Fertile stamens 10, heteromorphic; filaments 1.6-2.2 mm long; anthers ca. 1 mm long; staminodes absent. Ovaries pilose; styles 3, 1.4-2.2 mm long, isomorphic, glabrous; stigmas subapical. Mericarps winged, dorsal wing well-developed and thickened along the lower margin, 1.6-1.9 cm long, sericeous to glabrescent; lateral wings absent.

Heteropterys argyrophaea occurs form Argentina to Paraguay (Amorim 2003) and the Brazilian States of Paraná, Mato Grosso do Sul, São Paulo and Minas Gerais (Flora do Brasil 2020). In PIARP, it can be recognized by a combination of leaves discolored when dry, petioles glandular at the base, and mericarps with the dorsal wing well-developed and thickened along the lower margin. It differs from *Heteropterys cochleosperma* by the leaves abaxially sericeous (vs. glabrous) and petioles bearing a pair of glands at the base (vs. glands close to the apex). *Heteropterys argyrophaea* was found on both margins of PIARP, in gallery forests with hydromorphic soils, flowering in November, December, February and March, and fruiting in May.

Material examined: BRAZIL. Mato Grosso do Sul: Batayporã. Rio Baía, Remanescente Florestal da Fazenda

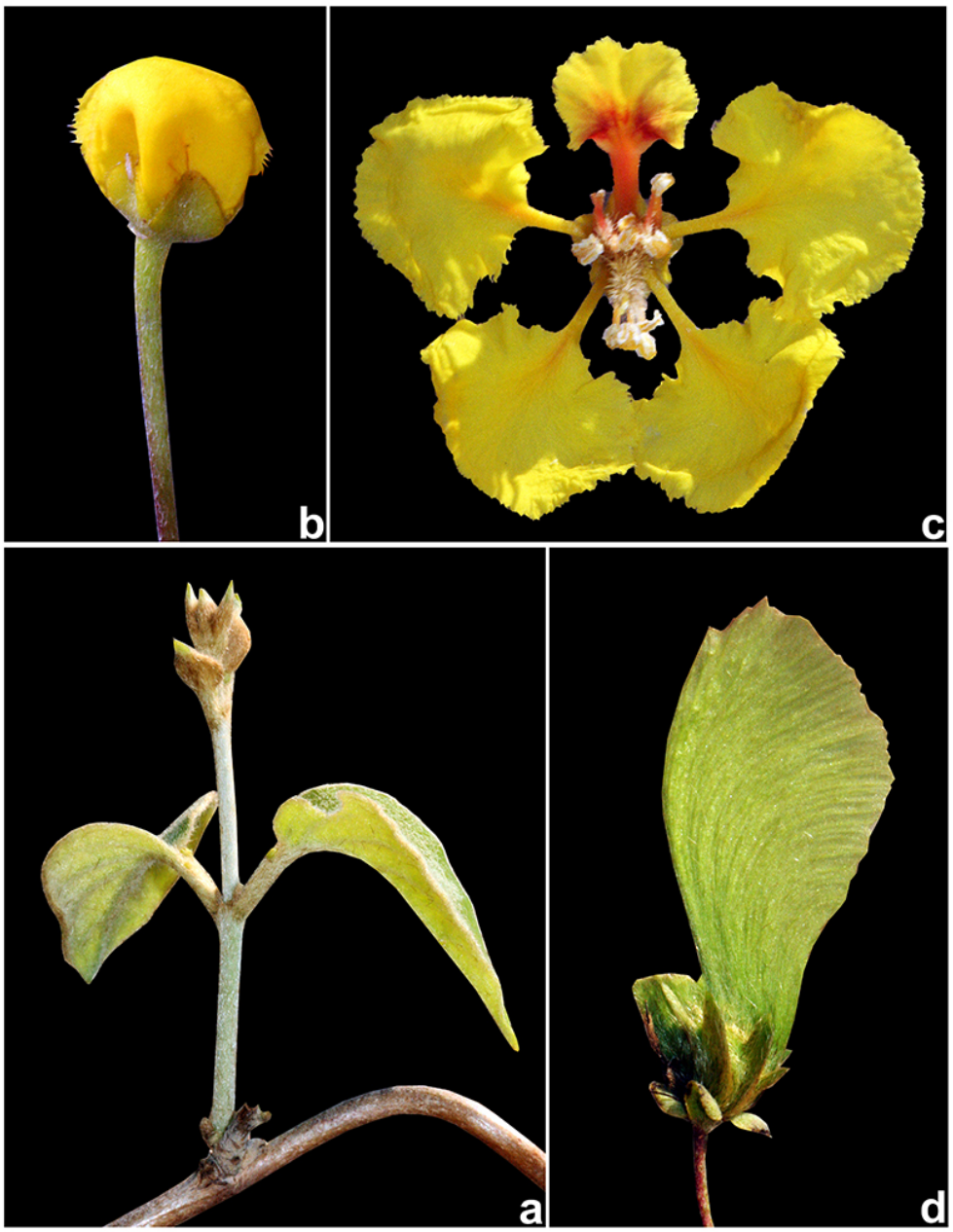

Figure 7. *Diplopterys lutea* (Griseb.) W.R.Anderson & C.C.Davis. a. Branchlet in side view. b. Floral bud in side view. c. Flower in frontal view. d. Fruit in side view (Photos by M.O.O.Pellegrini).

Unida, 14-XII-2004, *Ma.C. Souza & A.C. Secorun 4* (HNUP, HUEM). Paraná: Porto Rico. Córrego Caracú, 9-III-1992, *R. Pilati 105* (HNUP, HUEM); 5-V-2014, *C.E. Bento Fernandes 304* (HNUP, HUEM); Rio Paraná, Mata do Araldo, 9-XI-1992, *Ma.C. Souza-Stevaux 303* (HNUP, HUEM); Rio Paraná, Margem esquerda, 29-XI-1999, *K.K. Kita et al. 295* (HNUP, HUEM); 16-XI-1993, *P.M. Silva 112* (HNUP, HUEM). São Pedro do Paraná. Rio Paraná, margem esquerda, barranca de arenito, 13-II-1992, *F.R. Rosado et al. s.n.* (HNUP 4276, HUEM 23978).

9. *Heteropterys byrsonimifolia* A.Juss., Ann. Sci. Nat., Bot. sér. 2, 13: 276. 1840.
Figure 9

Erect shrubs; stems glabrescent; stipules interpetiolar, triangular. Leaves decussate; petioles 2.4-3.3 mm long, generally bearing a gland at the apex; blades 8-9.5 × 3.2-4 cm, narrowly-elliptical or oblong, base rounded or cuneate, margin entire, apex acute, adaxially glabrescent, abaxially sparsely velutine or glabrescent, eglandular. Thyrsi, terminal; cincinni bracts ca. 1 cm long, elliptical; peduncles 1.6-2 mm

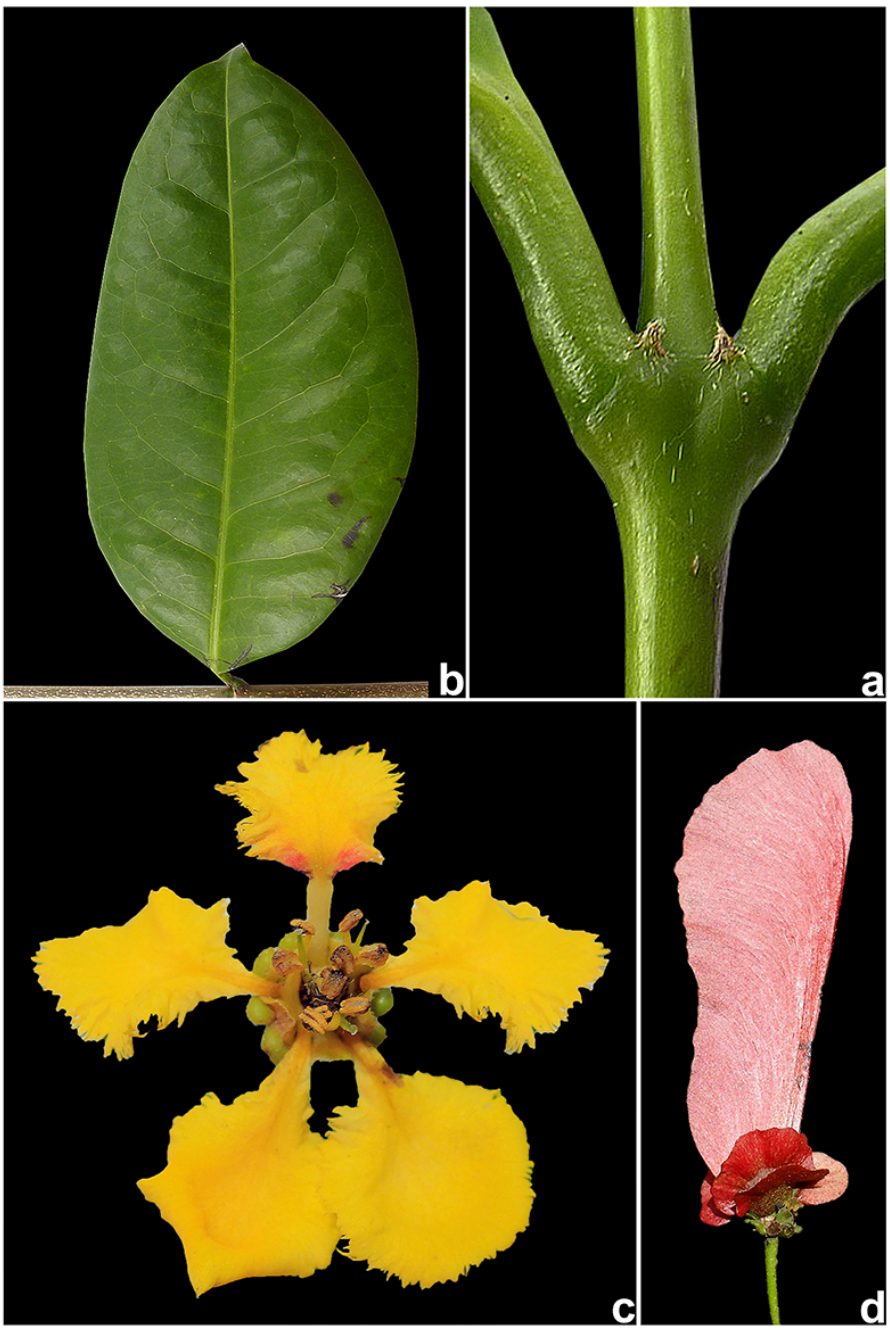

Figure 8. *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis. a; stipules in frontal view. b. Leaf in adaxial view. c. Flower in frontal view. d. Fruit in side view (Photos by A.Popovkin).

long; bracteoles ca. 1.8 mm long, elliptical. Flowers with pedicels 2.9-4.1 mm long; sepals 2.5-2.7 × 1-1.7 mm, triangular, abaxially sparsely sericeous; glands ca. 1.5 mm long; anterior sepal eglandular; petals yellow (not seen). Fertile stamens 10, heteromorphic; filaments 1.9-2.9 mm long; anthers 0.6-0.8 mm long; staminodes absent. Ovaries pilose; styles 3, 2.2-2.7 mm long, subisomorphic, glabrous; stigmas subapical. Mericarps not seen.

Heteropterys byrsonimifolia occurs only in Brazil, from Mato Grosso south to Paraná and east to Bahia (Flora do Brasil 2020; Pessoa *et al.* 2014). In PIARP, it may be recognized by a combination of shrubby habit, branches with white lenticels, coriaceous leaves and flowers disposed in thyrsi. It differs from *Heteropterys eglandulosa* by the shrubby habit (vs. climbing habit) and leaves that are abaxially sericeous becoming glabrescent with age (vs. glabrous). *Heteropterys byrsonimifolia* was found in the right margin of PIARP, in a disturbed and deforested site with dry soils that are not exposed to seasonal floods, flowering in September.

Figure 9. *Heteropterys byrsonimifolia* A.Juss. a. Inflorescence in side view. b. Flower in frontal view. c. Fruit in side view (Photos by R.F.Almeida).

Material examined: BRAZIL. Mato Grosso do Sul: Batayporã. Estrada between Batayporã e Taquarussú, 25-IX-2000, *Ma.C. Souza 2679* (HNUP, HUEM).

10. *Heteropterys cochleosperma* A.Juss., Ann. Sci. Nat., Bot. sér. 2, 13: 274. 1840.
Figure 10

Lianas; stems glabrous; stipules not seen. Leaves decussate; petioles 5.1-11 mm long, bearing a pair of glands close to the apex; blades 6.5-10.3 × 2.3-5.4 cm, narrowly-elliptical, elliptical or narrowly-ovate, base cuneate or attenuate, margin entire, apex acute, acuminate or cuspidate, both surfaces glabrous, eglandular. Thyrsi, terminal or axillar; cincinni bracts 1.1-2.6 cm long, foliaceous; peduncles 3.8-4.3 mm long; bracteoles ca. 1.9 mm long, elliptical. Flowers with pedicels 3-3.5 mm long; sepals 1.5-1.7 × 1.1-1.2 mm, triangular or ovate, abaxially sericeous, eglandular; petals yellow, margin entire or slightly sinuate, both surfaces glabrous; lateral petals limb 2.8-3 × 1.8-2 mm, claw 1.4-2.1 mm long, posterior petal limb ca. 2.2 × 1.8 mm, claw 2.2-2.3 mm long. Fertile stamens 10, heteromorphic; filaments 1.7-2.3 mm long; anthers 0.8-1 mm long; staminodes absent. Ovaries pilose; styles 3, 1.8-2.5 mm long, subisomorphic, glabrous; stigmas subapical. Mericarps winged, dorsal wing well-developed and thickened along the lower margin, 2.2-3.4 cm long, sericeous to glabrescent; lateral wings absent.

Heteropterys cochleosperma occurs in the Brazilian States of Paraná, Mato Grosso do Sul, São Paulo, Goiás and Bahia, and in Paraguay (*Landrum 8597*, MBM; Flora do Brasil 2020; Pessoa *et al.* 2014). In PIARP, it can be recognized by a combination of petioles glandular at the apex and mericarps with the dorsal wing well-developed and thickened along the lower margin. It is morphologically related to *H. argyrophaea* (see comments on this species). *Heteropterys cochleosperma* was collected on both margins of PIARP, in gallery forests with hydromorphic soils, flowering in March, and fruiting from May to July.

Material examined: BRAZIL. Mato Grosso do Sul: Jateí. Mata da Lagoa do Finado Raimundo, 1-VI-2005, *Ma.C. Souza 3019* (HNUP, HUEM); Rio Ivinhema, Parque Estadual do rio Ivinhema, 27-IV-2010, *G.F. Pereira et al. 406* (HNUP, HUEM). Paraná: Marilena. Rio Areia, margem direita, 25-III-2008, *S. Rodrigues et al. 104* (HNUP, HUEM); 30-V-2011, *C.E.B. Fernandes et al. 11* (HNUP, HUEM). Porto Rico. Córrego Caracú, margem direita, 27-III-2008, *Ma.C. Souza et al. 1879* (HNUP, HUEM); Rio Paraná, margem esquerda, 7-VI-1992, *Ma.C. Souza 2398* (HNUP, HUEM); 20-VII-2012, *R. Pacifico et al. 42* (HNUP, HUEM, HUEFS).

Figure 10. *Heteropterys cochleosperma* A.Juss. a. Flowering branch. b. Detail of floral buds and flowers. c. Fruit in side view (Photos by R.Pacifico).

São Pedro do Paraná. Rio Paraná, porto de Areia Cristo Rei, 2-VI-2011, *L.M. Garcia et al. 659* (HNUP, HUEM).

11. *Heteropterys eglandulosa* A.Juss., Fl. Bras. Merid. III: 27. 1833.
Figure 11

Lianas; stems glabrous; stipules not seen. Leaves decussate to subopposite, petioles 4-6 mm long, eglandular; blades 3.5-13.3 × 1.6-5.4 cm, elliptical to narrowly-elliptical, base cuneate or rounded, margin entire, apex acuminate, both surfaces glabrous, eglandular. Thyrsi, axillar or terminal; cincinni bracts 2-4 mm long, foliaceous; peduncles 2.8-3.8 mm long; bracteoles 1.8-2 mm long, foliaceous. Flowers with pedicels 1.8-3.3 mm long; sepals 2-2.2 × 1-1.2 mm, narrowly triangular, abaxially sericeous; glands 1-1.3 mm long; anterior sepal eglandular; petals yellow, margin sinuate or shortly denticulate, both surfaces glabrous; lateral petals limb 2.4-3.2 × 1.8-3.3 mm; claw 1.8-3 mm long, posterior petal limb 2-3.2 × 1-1.2 with claw 1.8-2.2 mm long. Fertile stamens 10, heteromorphic; filaments 1.4-3.2 mm long; anthers ca. 0.8 mm long; staminodes absent. Ovaries pilose; styles 3, 2-2.6 mm long, subisomorphic, glabrous; stigmas subapical. Mericarps winged, dorsal wing well-developed and thickened along the lower margin, 1.9-2.9 cm long, sericeous to glabrescent; lateral wings absent.

Heteropterys eglandulosa occurs only in eastern Brazil, from São Paulo to Piauí (Flora do Brasil 2020; Pessoa *et al.* 2014). In PIARP, it can be recognized by its leaves with eglandular petioles, bracteoles foliaceous, and mericarps with the dorsal wing well-developed and thickened along the lower margin. It could be confused with *H. byrsonimifolia* (see comments on this species). It was collected on both margins of PIARP, in gallery forests with hydromorphic soils, flowering in April, October and December, and fruiting in October and November.

Material examined: BRAZIL. Mato Grosso do Sul: Batayporã. Rio Samambaia, margem direita, 4-X-2006, *T.S. Michelan et al. s.n.* (HNUP 12110, HUEM 23981); Rio Samambaia, margem esquerda, 1-XI-2011, *Ma.C. Souza et al. 2536* (HNUP, HUEM). Novo Horizonte do Sul. Rio Guiraí, 10-XII-2009, *Ma.C. Souza et al. 2257* (HNUP, HUEM). Paraná: Marilena. Rio Areia, margem direita, 19-X-2007, *K.K. Kita et al. 1307* (HNUP, HUEM); 19-XII-2007, *K.K. Kita et al. 1309* (HNUP, HUEM).

12. *Heteropterys glabra* Hook. & Arn., Bot. Misc. 3: 157. 1833.

Erect subshrubs; stems glabrescent; stipules absent. Leaves decussate or subopposite, petioles 1.6-4.9 mm long, generally bearing a pair of glands at the apex; blades 4.2-7.3 × 0.3-0.5 cm, linear to lanceolate, base attenuate, margin entire, apex acute, adaxially sericeous, abaxially glabrous, eventually bearing glands close to the margin or

Figure 11. *Heteropterys eglandulosa* A.Juss. a. Flowering branch in side view. b. Flower in frontal view. c. Fruit in side view (Photos by R.F.Almeida).

the midrib. Thyrsi, axillar or terminal; cincinni bracts not seen; peduncles 5-6.1 mm long; bracteoles 1.3-1.6 mm long, triangular. Flowers with pedicels 1.7-2.1 mm long; sepals 1.8-2 × 0.8-1 mm, narrowly triangular, abaxially sericeous; glands 1-1.2 mm long; anterior sepal eglandular; petals yellow, margin sinuate, both surfaces glabrous; lateral petals limb 3.2-3.6 × 2.5-3.8 mm; claw 1.5-2.1 mm long, posterior petal limb 3.3-3.6 × 2.6 mm, claw 1.6-1.8 mm long. Fertile stamens 10, subisomorphic; filaments 2-2.5 mm long; anthers ca. 1.3 mm long; staminodes absent. Ovaries pilose; styles 3, 1.5-1.9 mm long, subisomorphic, glabrous; stigmas subapical. Mericarps not seen.

Heteropterys glabra occurs in Argentina, Paraguay, and in Brazil from Rio Grande do Sul north to Mato Grosso (Flora do Brasil 2020). It can be easily recognized among Malpighiaceae of PIARP by having leaf blades linear to lanceolate. *Heteropterys glabra* was found in the right margin of PIARP, on grasslands with hydromorphic soils, flowering from July to August, and fruiting in July.

Material examined: BRAZIL. Mato Grosso do Sul: Jateí. Rio Ivinhema, campinho, 24-VIII-2011, *L.M. Garcia et al. 684* (HNUP, HUEM); 20-VII-2012, *M.C. Souza 2677* (HNUP, HUEM).

13. *Hiraea hatschbachii* C.E.Anderson, Edinburgh J. Bot. 71(3): 365. 2014.
Figure 12

Lianas; stems glabrescent; stipules linear, epipetiolar. Leaves decussate; petioles 6-11.1 mm long, bearing a pair of glands at the apex to eglandular; blades 6.4-15.2(-19.5) × 2.7-8.8 cm, elliptical to narrowly elliptical, base cuneate or rounded, margin entire, apex acute or mucronate, concolored, both surfaces sericeous or glabrescent, abaxial surface bearing 2-6 glands between the midrib and the margin, or eglandular. Umbels, solitary, 4-flowered, axillar; cincinni bracts not evident; peduncles absent; bracteoles ca. 1.8 mm long, ovate. Flowers with pedicels 11-14 mm long; sepals 1.9-2.1 × 1.6-1.9 mm, triangular, abaxially sericeous; eglandular or with glands 1.8-2 mm; petals yellow, margin denticulate, both surfaces glabrous; lateral petals limb 4.6-6.8 × 4.8-6.6 mm, claw 2.2-3.6 mm long, posterior petal limb 3.6-4.7 × 4-4.5 mm, claw 4.1-4.3 mm long. Fertile stamens 10, heteromorphic; filaments 1.6-2 mm long; anthers 0.6-1.2 mm long; staminodes absent. Ovaries pilose; styles 3, 3.8-4.8 mm long, subisomorphic, glabrescent; stigmas subapical. Mericarps winged, lateral wings 2, more developed than the dorsal wing (butterfly-shaped), 1.3-2.2 cm long, free at the base, sericeous; dorsal wing 3-6 mm long, sericeous.

Hiraea hatschbachii occurs only in the States of Paraná and Mato Grosso do Sul (Anderson 2014; Flora do Brasil 2020; Francener *et al.* 2018). *Hiraea hatschbachii* can be readily recognized bthe linear epipetiolar stipules, a feature that is absent in all the remaining Malpighiaceae of PIARP. It was collected on both margins of PIARP, in its islands, river channels and affluent streams, on hydromorphic soils

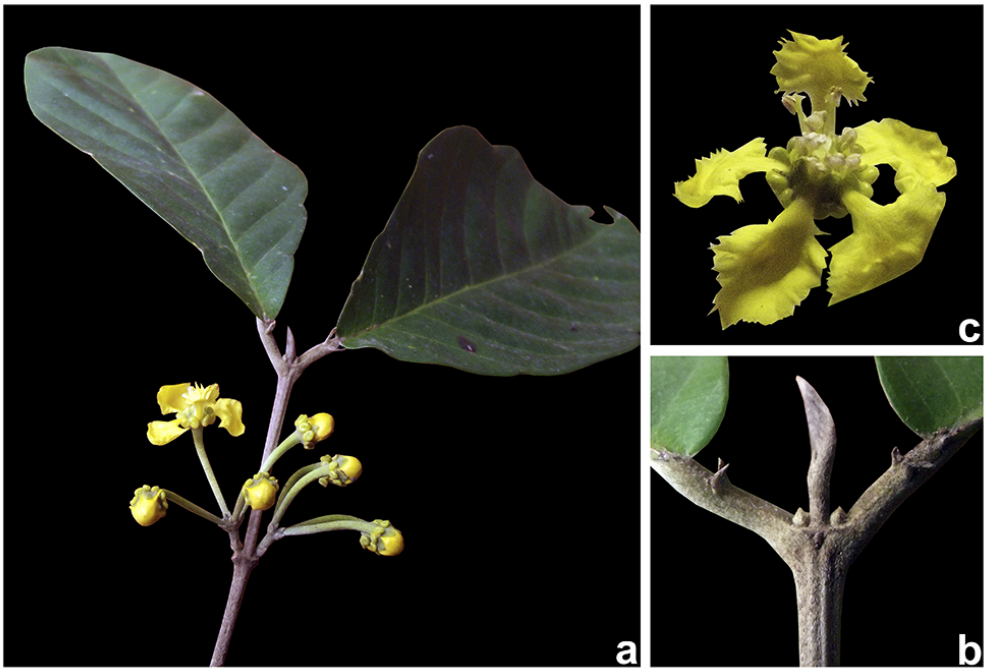

Figure 12. *Hiraea hatschbachii* C.E.Anderson. a. Flowering branch in side view. b. Petioles with linear stipules in frontal view. c. Flower in frontal view (Photos by R.F.Almeida).

where floods are frequent, flowering from October to April (except in January), and fruiting from December to July.

Material selected: BRAZIL. Mato Grosso do Sul: Batayporã. Rio Samambaia, margem esquerda, 9-IV-2012, *J.M. Garcia et al 200* (HNUP, HUEM). Jateí. Canal Ipuitã, margem direita, 7-V-2009, *K. Kawakita 1067* (HNUP, HUEM). Taquarussú. Canal Ipuitã, 22-I-1988, *Ma.C. Souza-Stevaux 208* (HNUP, HUEM). Paraná: Porto Rico. Rio Paraná, Ilha Mutum, 18-IV-2016, *R. Pacifico et al. 30* (HNUP, HUEM). São Pedro do Paraná. Porto de Areia Presalino Semprebom, 23-XI-2012, *G.S. Rosa et al 286* (HNUP, HUEM).

14. *Mascagnia australis* C.E.Anderson, Brittonia 53(3): 408. 2001.
Figure 13

Lianas; stems sericeous or glabrescent, hairs sessile or shortly peduncled; stipules linear, interpetiolar. Leaves decussate to subopposite, petioles 7.5-12.2 mm long, eglandular; blades 7-9.1 × 2.9-5.1 cm, elliptical, base cuneate or rounded, margin entire, apex acuminate or cuspidate, rarely obcordate, subconcolored, both surfaces sparsely sericeous or glabrescent, abaxially bearing 1-4 glands between a midrib e a margin, or eglandular. Corymbs, axillar; cincinni bracts ca. 4.4 mm long, narrowly triangular; narrowly triangular; peduncles ca. 6 mm long, bracteoles 1.2-1.3 mm long, linear to narrowly triangular. Flowers with pedicels ca. 6 mm long; sepals ca. 2 × 1 mm, triangular, abaxially sericeous; glands ca. 2 mm long; anterior sepal eglandular; petals yellow, margin entire, both surfaces glabrous; lateral petals limb ca. 3.9-4 × 2.4-2.9 mm; claw ca. 0.5 mm long, posterior petal limb ca. 4 × 1.8 mm, claw ca. 0.8 mm long. Fertile stamens 10, subisomorphic; filaments 1.2-1.6 mm long; anthers 1-1.3 mm long; staminodes absent. Ovaries pilose; styles 3, 3.4-3.6 mm long, subisomorphic, glabrous; stigmas subapical. Mericarps winged, lateral wings 2, more developed than the dorsal wing, ca. 10 mm long, fused at the base, sericeous; dorsal wing ca. 3.4 mm long, sericeous.

Mascagnia australis occurs only in Brazil, from Rio Grande do Sul to Mato Grosso do Sul (Flora do Brasil 2020). It can be identified in PIARP by its flowers disposed in corymbs, yellow petals, and mericarps with two lateral wings more developed than the dorsal wing and fused at the base. It differs from *Mascagnia divaricata* by the leaves with eglandular petioles (vs. 3-6 glandular) and flowers with yellow petals (vs. purple). *Mascagnia australis* was collected in the left margin of PIARP, in gallery forests with hydromorphic soils, flowering and fruiting in August.

Material examined: BRAZIL. Paraná: Marilena. Rio Areia, margem direita, 23-VIII-2011, *L.M. Garcia et al. 667* (HNUP, HUEM).

15. *Mascagnia divaricata* (Kunth) Nied., Nat. Pflanzenfam, III, 4: 55. 1896.

Lianas; stems sericeous or glabrescent, hairs sessile; stipules oblong-linear, interpetiolar. Leaves decussate; petioles (8.3-)12-22.4 mm long, bearing 3-6 glands irregularly distributed; blades 10.6-13.5 × 5.4-7.6 cm,

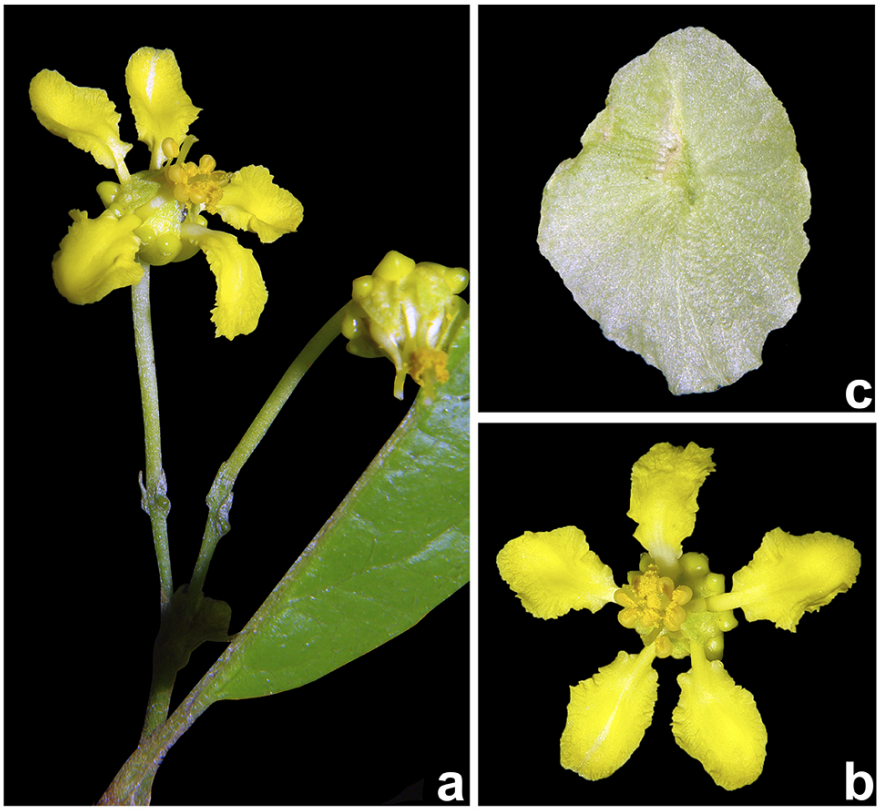

Figure 13. *Mascagnia australis* C.E.Anderson. a. Flowering branch in side view. b. Flower in frontal view. c. Fruit in frontal view (Photos by C.F.Hall).

ovate or elliptical, base subcordate or rounded, margin entire, apex cuspidate, concolored, adaxially glabrous, abaxially sparsely sericeous or glabrous, bearing 1-5 glands between the midrib and the margin. Corymbs, axillar or terminal; cincinni bracts 0.6-2.8 cm long, foliaceous; peduncles ca 1.3 mm long, bracteoles ca. 1 mm long, triangular. Flowers with pedicels 5.5-9 mm long; sepals 1.6-2 × 0.9-1.1 mm, triangular, abaxially sericeous; glands 0.7-1.3 mm long; anterior sepal eglandular; petals purple, margin denticulate, both surfaces glabrous; lateral petals limb 2.1-3.1 × 1.7-2.6; claw 0.6-0.8 mm long; posterior petal limb ca. 2.7 × 2.4 mm, claw 0.9-1.6 mm long. Fertile stamens 10, heteromorphic; filaments 0.8-1.3 mm long; anthers 1-1.3 mm long; staminodes absent. Ovaries pilose; styles 3, 1.2-1.3 mm long, isomorphic, glabrescent; stigmas subapical. Mericarps winged, lateral wings 2, more developed than the dorsal wing, 8.2-9.3 mm long, fused at the base, sparsely sericeous; dorsal wing 2.7-3.5 mm long, sparsely sericeous.

Mascagnia divaricata is widespread in western Brazil, from Rio Grande do Sul to Amapá (Flora do Brasil 2020), and extends its distribution south to Paraguay and Argentina. It can be recognized in PIARP by a combination of glandular bracteoles, flowers disposed in corymbs, purple petals, and mericarps with two lateral wings more developed than the dorsal wing and fused at the base. It is morphologically related to *M. australis* (see comments on this species). *Mascagnia divaricata* was found in the left margin of PIARP and on its islands, in gallery forests with hydromorphic soils, flowering in March, and fruiting in March and December.

Material examined: BRAZIL. Paraná: Porto Rico. Rio Paraná, canal Cortado, 18-III-1994, *A. Carrito s.n.* (HNUP 4270, HUEM 27495); Ilha Mutum, 21-III-1994, *M. Curti 50* (HNUP, HUEM); Rio Paraná, margem esquerda, 10-XII-1993, *M.E. Previdello 120* (HNUP, HUEM); 1998, *M.P. Fachini 953* (HNUP, HUEM).

16. *Niedenzuella multiglandulosa* (A.Juss.) W.R.Anderson, Novon 16(2): 200. 2006.
Figure 14

Lianas; stems sparsely sericeous, hairs shortly peduncled; stipules not seen. Leaves decussate; petioles 3.8-6.7 mm long, bearing a pair of glands in the upper half, blade 4.1-10.9 × 1.9-4.1 cm, narrowly-elliptical, base rounded, margin entire, apex mucronate, adaxially glabrescent, abaxially sericeous or glabrescent, bearing glands at the margin. Thyrsi, axillar or terminal; cincinni bracts 0.6-2 cm long, foliaceous; peduncles 1.2-3 mm long; bracteoles 1.3-1.6 mm long, narrowly triangular. Flowers with pedicels 5.2-6.1 mm long; sepals 4-4.5 × 1.9-2.3 mm, narrowly triangular, abaxially sericeous; glands 2.3-2.6 mm long; anterior sepal eglandular; petals not seen. Fertile stamens

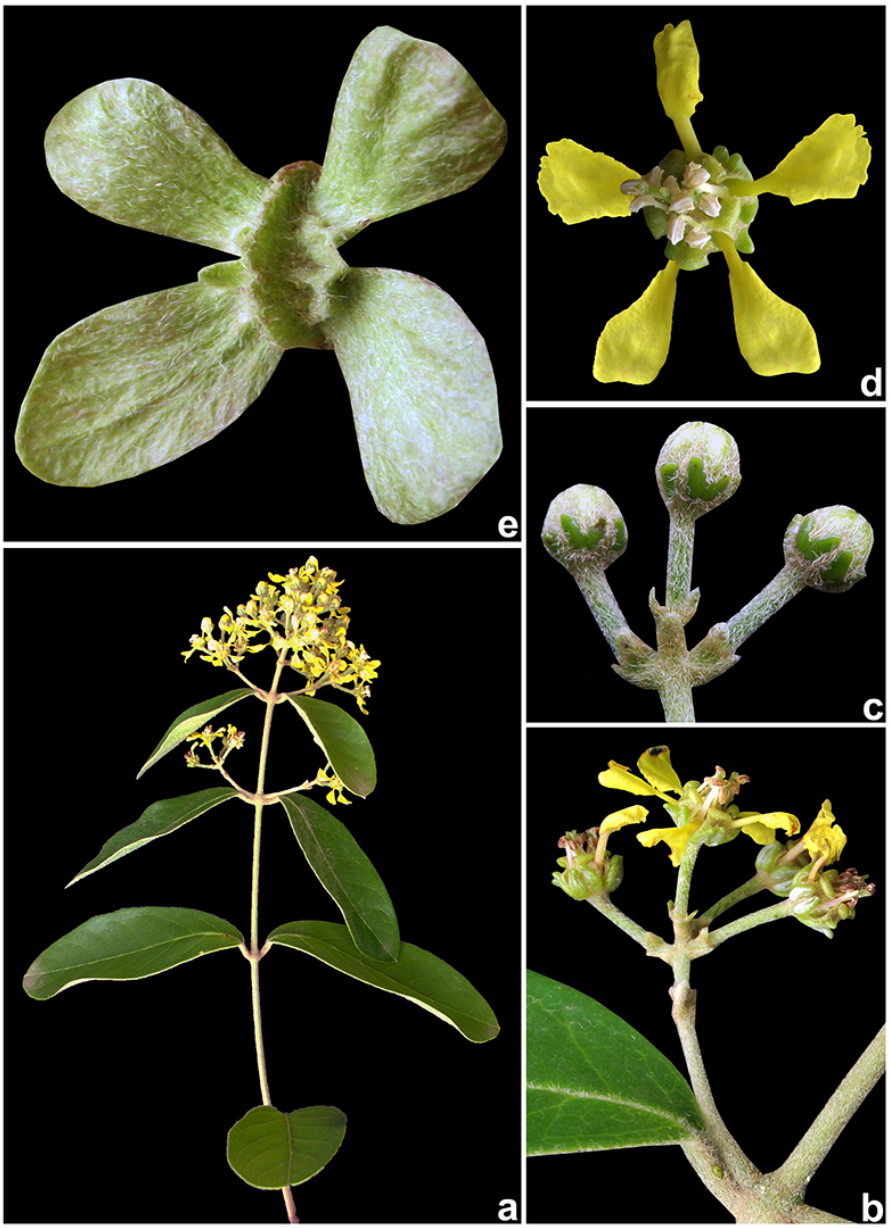

Figure 14. *Niedenzuella multiglandulosa* (A.Juss.) W.R.Anderson. A. Flowering branch in side view. b. Inflorescence in side view. c. Floral buds in side view. d. Flower in frontal view. e. Fruit in frontal view (Photos by R.F.Almeida).

10, subisomorphic; filaments 1.5-1.8 mm long anthers not seen; staminodes absent. Gynoecium not seen. Mericarps winged, lateral wings 4, more developed than the dorsal wing (X-shaped), 7.1-14.9 mm long, free at the base, sericeous; dorsal wing ca. 2.5 mm long, sericeous.

Niedenzuella multiglandulosa is widespread in Brazil (Flora do Brasil 2020; Anderson 2006). In PIARP, it can be recognized by the leaf blades glandular at the margin, flowers disposed in thyrsi and X-shaped mericarps. It shares the combination of climbing habit and X-shaped mericarps only with *T. xylosteifolia*, and may be differentiated from this species by the glandular petioles (vs. eglandular) and flowers disposed in thyrsi (vs. umbels). *Niedenzuella multiglandulosa* was collected only around affluent streams of the left margin of PIARP, in gallery forests that are not exposed to seasonal floods, flowering and fruiting in May.

Material examined: BRAZIL. Paraná: Marilena. Rio Areia, margem direita, 20-V-2008, *R.S. Garcia et al. 22* (HNUP, HUEM); 30-V-2011, *J.G. Servilheri et al. 13* (HNUP, HUEM). Porto Rico. Córrego Caracú, 5-V-2014, *C.E.B. Fernandes 315* (HNUP, HUEM).

17. *Peixotoa reticulata* Griseb., Linnaea 13: 213. 1839. Figure 15

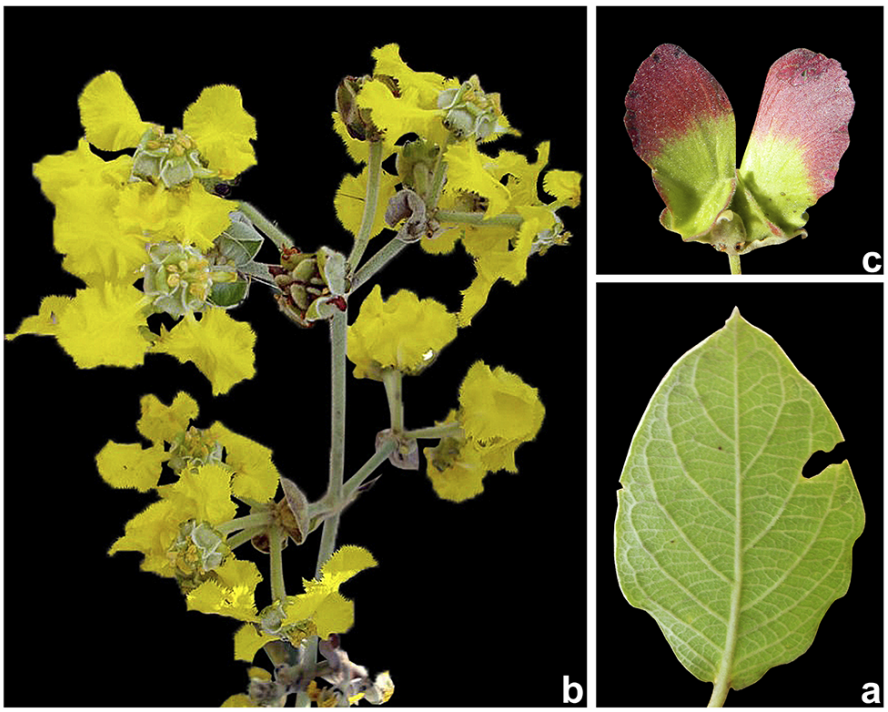

Figure 15. *Peixotoa reticulata* Griseb. a. Leaf in abaxial view. b. Inflorescence in side view. c. Fruits in side view (Photos by R.F.Almeida).

Erect shrubs; stems velutine, hairs long peduncled; stipules foliaceous, interpetiolar. Leaves decussate; petioles 4.6-11.5 mm long, bearing a pair of sessile glands close to the apex; blades 9.7-11.8 × 7.9-11.9 cm, broadly ovate, base truncate, subcordate or rounded, margin entire, apex acute, adaxially sparsely velutine, abaxially variably tomentose-velutine, bearing glands close to the margin, or eglandular. Umbels arranged in dichasia, 4-flowered, terminal; cincinni bracts 4.4-7(-12) mm long, foliaceous; peduncles absent; bracteoles not seen. Flowers with pedicels 8-17 mm long; sepals (3.9-)4.9-7.2 × 3.2-4.5 mm, narrowly triangular, abaxially velutine; glands ca. 1.6 mm long; anterior sepal eglandular; petals yellow, margin denticulate or fimbriate, both surfaces glabrescent; lateral petals limb 6-6.8 × 4.6-6.9 mm, claw 0.7-1.1 mm long; posterior petal limb ca. 4.9 × 4.8 mm, claw ca. 1.3 mm long. Fertile stamens 5, subisomorphic; filaments 1-1.3 mm long; anthers 1.5-1.8 mm long; staminodes 5, 1.7-2 mm long. Ovaries pilose; styles 3, 1.7-2.2 mm long, subisomorphic, glabrescent; stigmas capitate. Mericarps winged, dorsal wing more developed than the lateral wings and thickened along the upper margin, 1.9-2.6 cm long, velutine; lateral wings 2, 2.6-3.2 mm long, velutine.

Peixotoa reticulata is widespread in Brazil, from Bahia to Paraná (Flora do Brasil 2020), extending to Paraguay and Bolivia (Anderson 1982). It can be easily identified among other Malpighiaceae of PIARP for having stipules that are expanded and fused, leaving a concave scar on the nodes after falling away. *Peixotoa reticulata* was found only in the right margin of PIARP, around the Ivinhema River, in a Cerrado remnant with dry soils that are not exposed to seasonal floods.

Material examined: BRAZIL. Mato Grosso do Sul: Taquarussú. Rio Ivinhema, Cerrado, 1998, *M.P. Fachini s.n.* (HNUP 13818, HUEM 27545); *M.P. Fachini s.n.* (HNUP 13819, HUEM 27547).

18. ***Stigmaphyllon bonariense*** (Hook. & Arn.) C.E.Anderson, Brittonia 48(4): 543. 1997.
Figure 16

Lianas; stems sericeous or tomentose, hairs shortly peduncled; stipules not seen. Leaves subopposite, petioles 1.9-4.2 cm comp., bearing a pair of glands at the apex; blades 4.9-11.6 × 5.2-11.4 cm, ovate to cordiform, base cordate, subcordate or rounded, margin entire, apex mucronate, adaxially tomentose, sericeous or glabrescent, abaxially tomentose, eglandular. Umbels arranged in dichasia, 8-16(-27)-flowered, axilar or terminal; cincinni bracts 2.9-6.6 mm long, triangular to narrowly triangular; peduncles 7.1-18 mm long; bracteoles 1.6-1.8 mm long, narrowly triangular. Flowers with pedicels 7.3-15.5 mm long; sepals ca. 2.3 × 2.3 mm, triangular, abaxially tomentose; glands 1.7-2 mm; anterior sepal eglandular; petals yellow, margin denticulate, both surfaces glabrous; lateral petals limb 6.4-9.4 × 5.2-8.9 mm; claw 2-3.8 mm long; posterior petal limb 6.6-7 × 4.9-5.2 mm, claw 3.5-3.6 mm long. Fertile stamens 10, heteromorphic; filaments 2.2-3.7 mm long; anthers

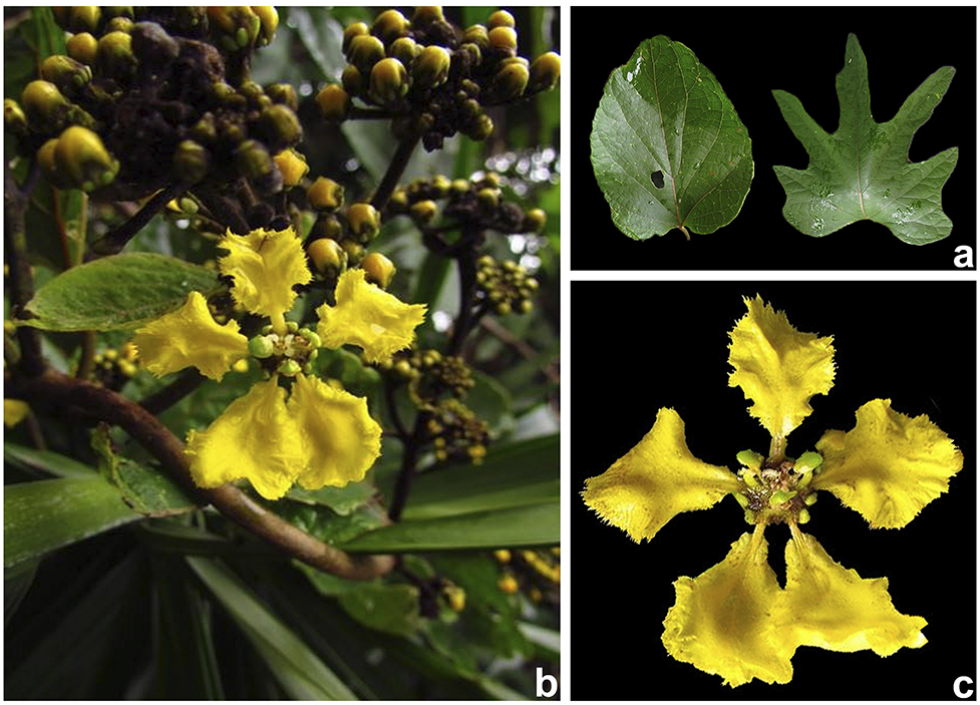

Figure 16. *Stigmaphyllon bonariense* (Hook. & Arn.) C.E.Anderson. a. Leaves in abaxial view. b. Inflorescence in side view. c. Flower in frontal view (Photos by L.Funez).

0.7-1.2 mm long; staminodes absent. Ovaries pilose; styles 3, 3.2-3.7 mm long, subisomorphic, glabrescent; stigmas foliaceous 2-2.6 × 1.9-2.1 mm. Mericarps not seen.

Stigmaphyllon bonariense occurs in Uruguay, Paraguay, Argentina (Anderson 1997), and from Rio Grande do Sul to São Paulo in Brazil (Flora do Brasil 2020). It can be readily recognized among Malpighiaceae of PIARP by its styles apically expanded into a leaflike structure. *Stigmaphyllon bonariense* was collected on both margins of PIARP, in gallery forests with hydromorphic soils, flowering from September to October and from January to March.

Material examined: BRAZIL. Mato Grosso do Sul: Batayporã. Rio Baía, fazenda Bom Futuro, 2-III-2002, *Ma.C. Souza 1585* (HNUP, HUEM). Jateí. Mata do Finado Raimundo, 16-X-2007 *S.R. Slusarski et al. s.n.* (HNUP 6940, HUEFS 218918, HUEM 18077); Rio Ivinhema, mata do campinho,12-II-1995, *M.E. Previdello et al. s.n.* (HNUP 13192, HUEM 26724). Paraná: Porto Rico. Rio Paraná, margem esquerda, jusante do canal Cortado, 17-X-1994, *D.C. Souza et al. s.n.* (HNUP 4473, HUEM 26727); Mata do Araldo, 21-IX-1994, *M.B. Romagnolo s.n.* (HNUP 13191, HUEM 26723); montante da base UEM, 26-X-2002, *V. Tomazini & R. Zampar 183* (HNUP, HUEM); remanescente entre a Base de pesquisa e a cidade, 16-I-1994, *Ma.C. Souza 1366* (HNUP, HUEM). São Pedro do Paraná. Rio Paraná, margem esquerda, Porto São José, 15-I-1995, *M.E. Previdello 117* (HNUP, HUEM); Proximidades do Porto de Areia, 25-III-2008, *Ma.C. Souza et al. 1878* (HNUP, HUEM).

19. *Tetrapterys ambigua* Nied., Pflanzenr. Malpighiaceae 168. 1928.

Figure 17

Erect subshrubs; stems variably tomentose; hairs long peduncled; stipules narrowly interpetiolar, triangular. Leaves decussate; petioles up to 1.5 mm long, bearing a pair of glands at the apex; blades 2.2-3.2 × 1.3-1.9 cm, elliptical, base cuneate to rounded, margin entire, apex acute, adaxially sparsely tomentose, abaxially densely tomentose, bearing a pair of glands at the base (usually hidden by the indumentum). Thyrsi, axillar or terminal; cincinni bracts not seen; peduncles ca. 2.9 mm long; bracteoles 2.3-2.6 mm long, triangular. Flowers with pedicels 4.9-5.5 mm long; sepals 2.4-3 × 1.2-1.5 mm, narrowly triangular, abaxially tomentose; glands 1.6-1.9 mm long; anterior sepal eglandular; petals yellow to reddish, margin entire or denticulate, both surfaces glabrous; lateral petals limb 4.6-5.7 × 3.6-4.8 mm, claw 0.7-0.9 mm long; posterior petal limb ca. 4.5 × 4.2 mm, claw ca. 1.6 mm long. Fertile stamens 10, heteromorphic; filaments 1-2.2 mm long; anthers ca. 0.8 mm long; staminodes absent. Ovaries pilose; styles 3, 1.7-2 mm long, subisomorphic, stigmas subapical. Mericarps not seen.

Tetrapterys ambigua occurs in Bolivia and midwest Brazil (Francener *et al.* 2015), extending its distribution to the States of Tocantins and Minas Gerais (Flora do Brasil 2020). It can be recognized by a combination of subshrubby habit, leaves abaxially densely tomentose, thyrsi, and petals yellow to reddish. It differs from *T. xylosteifolia* by the subshrubby habit (vs. climbing habit), petioles glandular

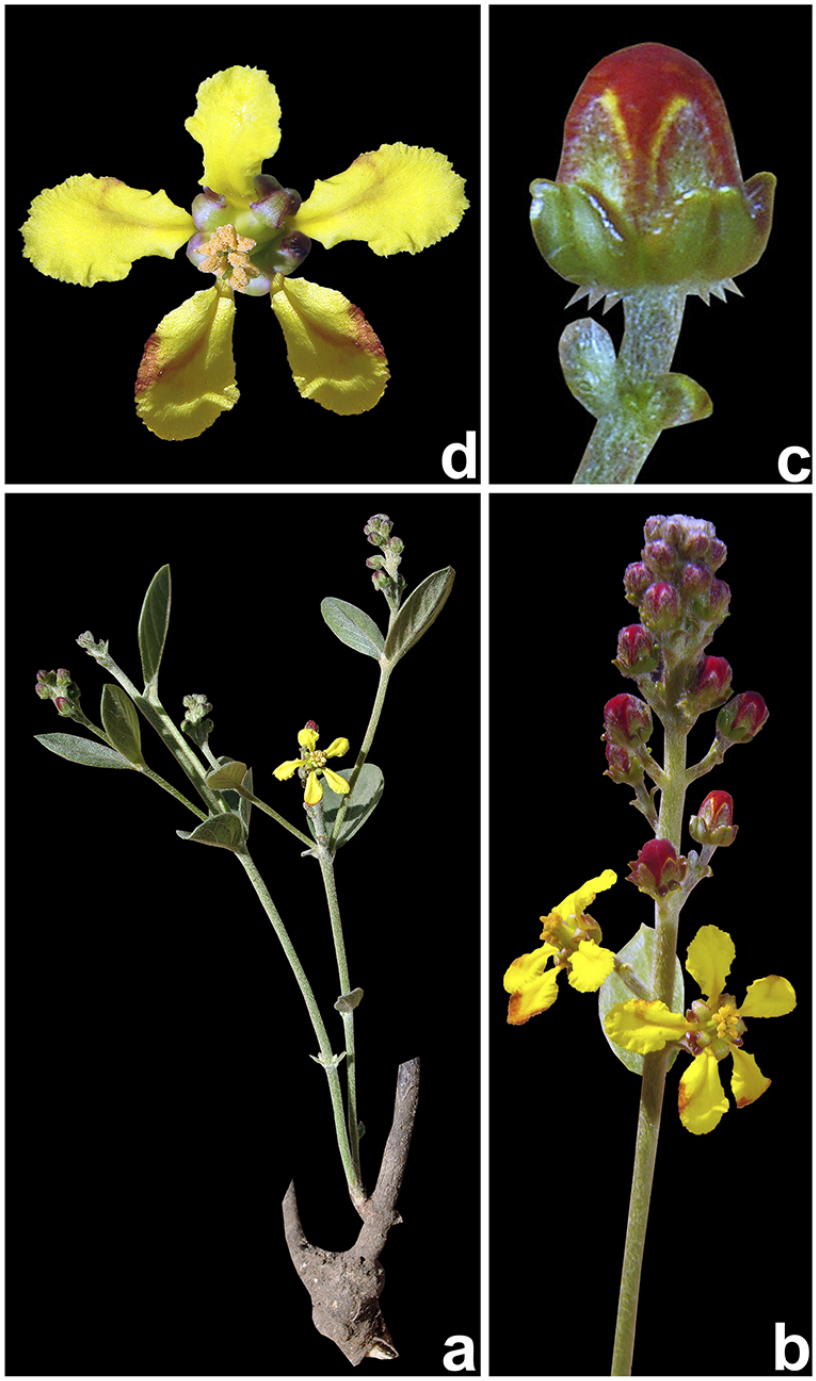

Figure 17. *Tetrapterys ambigua* (A.Juss.) Nied. a. Habit showing underground xylopodium. b. Inflorescence in side view. c. Floral bud in side view. d. Flower in frontal view (Photos by C.F.Hall).

at the apex (vs. eglandular), and flowers disposed in thyrsi (vs. umbels). *Tetrapterys ambigua* was found only in the right margin of PIARP, in a Cerrado remnant with on dry soils that are not exposed to seasonal floods.

Material examined: BRAZIL. Mato Grosso do Sul: Nova Andradina. Rio Ivinhema, 1998, *I. Tanaka s.n.* (HNUP 13820, HUEM 27706).

20. *Tetrapterys xylosteifolia* A.Juss., Fl. Bras. Merid. 3: 7. 1833.
Figure 18

Lianas; stems sericeous or tomentose, hairs sessile or shortly peduncled; stipules narrowly interpetiolar, triangular. Leaves decussate; petioles 4.7-10 mm long, eglandular; blades 2.1-6.2 × 1.3-3.4 cm, elliptical, base subcordate, margin

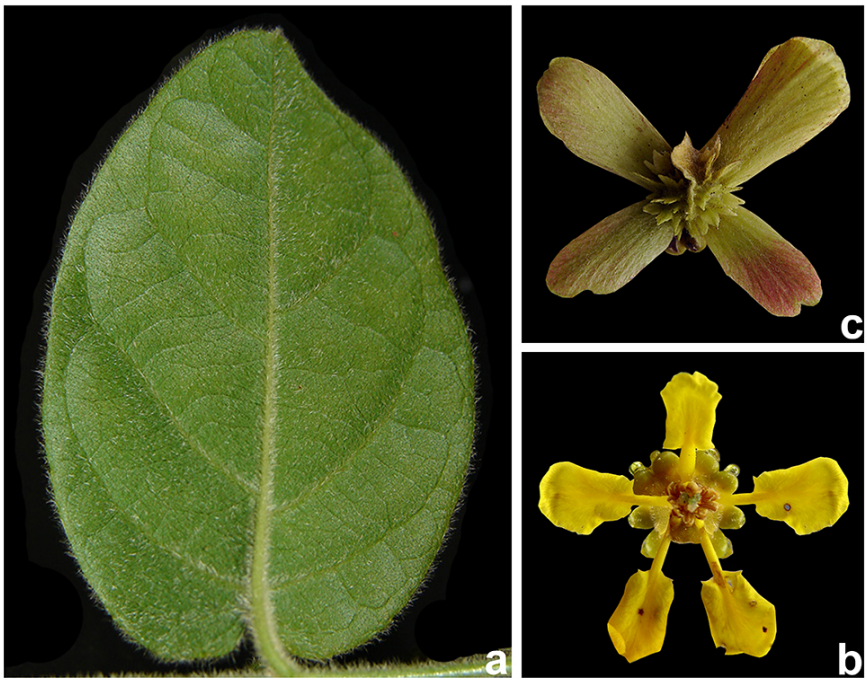

Figure 18. *Tetrapterys xylosteifolia* A.Juss. A. Leaf in abaxial view. b. Flower in frontal view. c. Fruit in dorsal view (Photos by A.Medeiros).

entire, apex rounded, concolored, adaxially glabrescent, abaxially velutine, bearing 1-4 pairs of glands in the margin in its basal portion. Umbels arranged in compound dichasia, 4-flowered, axilar or terminal; cincinni bracts 0.6-1.6 cm long, foliaceous; peduncles 4.5-6.2 mm long; bracteoles 1.1-1.5 mm long, ovate. Flowers with pedicels 5.6-6.6 mm long; sepals 1.5-2 × 1-2.1 mm, triangular or ovate, abaxially glabrescent; glands 1.6-2 mm long; anterior sepal eglandular; petals yellow to reddish, margin entire or slightly sinuate, both surfaces glabrescent; lateral petals limb 4.2-5.1 × 3.4-4.5 mm; claw 1.7-2.6 mm long; posterior petal limb 3.3-3.7 × 3.3-3.5 mm, claw 3-3.2 mm long. Fertile stamens 10, subisomorphic; filaments 1.6-1.9 mm long; anthers 1-1.5 mm long; staminodes absent. Ovaries pilose; styles 3, 1.5-2 mm long, subisomorphic, glabrescent; stigmas apical. Mericarps winged, lateral wings 4, well-developed (X-shaped), 6.8-13.2 mm long, free at the base, sparsely sericeous; dorsal wing absent.

Tetrapterys xylosteifolia occurs only in Brazil and was previously cited for the States of Rio Grande do Sul, Santa Catarina, São Paulo and Bahia (Flora do Brasil 2020). It is here recorded for the first time for both Mato Grosso do Sul (see Francener *et al.* 2015, 2018) and Paraná States (see Flora do Brasil 2020). *Tetrapterys xylosteifolia* can be recognized by a combination of leaves abaxially velutine, 4-flowered umbels that are disposed in dichasia, and X-shaped mericarps. For comparisons with *N. multiglandulosa* and *T. ambigua* see comments on these species. It was collected on both margins of PIARP, in gallery forests with hydromorphic soils, flowering in June, July and September, and fruiting from July to August.

Material examined: BRAZIL. Mato Grosso do Sul: Batayporã. Rio Baía, Remanescente florestal da Fazenda Unida, 3-VI-2005, *A.C. Fontana 56* (HNUP, HUEM); 12-VIII-2008, *Ma.C. Souza et al. 1108* (HNUP, HUEM); 20-VII-2012, *E.D. Mauri et al. s.n.* (HNUP 13822). Taquarussú. Canal Corutuba, Espigão do Macaco, 26-X-1998, *I. Tanaka s.n.* (HNUP 5093, HUEM 28255). Paraná: Porto Rico. Rio Paraná, Mata do Araldo, 10-IX-2005, *V.A. Pereira s.n.* (HNUP 4470, HUEM 28143). Porto São José, 7-IV-1959, *G. Hatschbach 5617* (MBM)

Acknowledgements

We thank the curators of all herbaria, for their assistance; C.E.B. Fernandes and K. Kawakita, for the logistical support; J.L.L. Pereira, for preparing the map; A. Junior, A. Medeiros, A. Popovkin, C.F. Hall, C. Takeuchi, E.F. Rossetto, L. Funez, M. Engels, M.O.O. Pellegrini, M.R. Pace, M.R.M. Scoarize, and P.H.B. Dettmann, for giving us permission to use their photographs in this study; two anonymous reviewers for their comments on an earlier version of this manuscript. RP was sponsored by a CAPES doctoral fellowship.

Literature cited

Agostinho, A.A., Thomaz S.M. & Gomes, L.C. 2004. Threats for biodiversity in the floodplain of the Upper Paraná River: effects of hydrological regulation by dams. Ecohydrology & Hydrobiology 4: 255-256.

Almeida, R.F. 2020. *Alicia* W.R.Anderson (Malpighiaceae). In: Flora do Brasil 2020 em construção. Jardim Botânico do Rio de Janeiro. Available at http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB155 (access on 24-II-2020).

Almeida, R.F. & Amorim, A.M.A. 2014. *Stigmaphyllon caatingicola* (Malpighiaceae), a new species from seasonally dry tropical forests in Brazil. Phytotaxa 174(2): 82-88.

Amorim, A.M.A. 2003. Estudos Taxonômicos em *Heteropterys* (Malpighiaceae). Tese de Doutorado, Universidade de São Paulo, São Paulo.

Anderson, C.E. 1982. A monograph of the genus *Peixotoa* (Malpighiaceae). Contributions from the University of Michigan Herbarium 15: 1-92.

Anderson, C.E. 1997. Monograph of *Stigmaphyllon* (Malpighiaceae). Systematic Botany Monographs 51: 1-313.

Anderson, C.E. 2014. *Hiraea cuneata*, *H. macrophylla*, and four new species confused with them: *H. hatschbachii*, *H. occhionii*, *H. reitzii*, and *H. restingae* (Malpighiaceae). Edinburgh J. Bot. 71: 361-378.

Anderson ,W.R. 1981. Malpighiaceae. In: N. Smith (ed.). Botany of the Guiana Highland — Part XI. Memoirs of the New York Botanical Garden 32: 21-305.

Anderson, W.R. 2006. Eight segregates from the Neotropical genus *Mascagnia* (Malpighiaceae). Novon 16: 168-204.

Campos, J.B., Romagnolo, M.B. & Souza, M.C. 2000. Structure, composition and spatial distribution of tree species in a remnant of the semideciduous seasonal Alluvial Forest of the upper Paraná River Floodplain. Brazilian Archives of Biology and Technology 43: 185-194.

Chase, M.W. 1981. A revision of *Dicella* (Malpighiaceae). Systematic Botany 6: 159-171.

Corradini, F.A., Stevaux, J.C. & Fachini, M.P. 2008. Geomorfologia e distribuição da vegetação ripária na Ilha Mutum, Rio Paraná - PR/MS. Geociências 27: 345-354.

Davis, C.C. & Anderson, W.R. 2010. A complete generic phylogeny of Malpighiaceae inferred from nucleotide sequence data and morphology. American Journal of Botany 97: 2031-2048.

Ferreira, F.A., Mormul, R.P., Thomaz, S.M., Pott, A. & Pott, V.J. 2011. Macrophytes in the upper Paraná river floodplain: checklist and comparison with other large South American wetlands. Revista de Biología Tropical 59: 541-556.

Ferreira, L.V. & Stohlgren, T.J. 1999. Effects of river level fluctuation on plant species richness, diversity, and distribution in a floodplain forest in Central Amazonia. Oecologia 120: 582-587.

Flora do Brasil 2020 [em construção]. Malpighiaceae. Jardim Botânico do Rio de Janeiro. Available at http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB155 (access on 9-IX-2019).

Francener, A., Almeida, R.F., Sebastiani, R. 2018. Check-list de Malpighiaceae do estado de Mato Grosso do Sul. Iheringia - Série Botânica 73: 264-272

Francener, A, Damasceno-Júnior, G.A., & Gomes-Klein, V.L. 2015. *Tetrapterys* Cav. (Malpighiaceae) from Brazilian Midwest. Acta Botanica Brasilica 29: 143-156.

Garcia, J.M., Kawakita, K., Souza, M.C. & Miotto, S.T.S. 2013. O gênero *Crotalaria* L. (Leguminosae, Faboideae, Crotalarieae) na Planície de Inundação do Alto Rio Paraná, Brasil. Revista Brasileira de Biociências 11: 209-226.

Gates, B. 1982. *Banisteriopsis*, *Diplopterys* (Malpighiaceae). Flora Neotropica 30: 1-238.

IBGE. 2012. *Manual Técnico da Vegetação Brasileira.* 2ed. Ministério do Planejamento, Orçamento e Gestão, Rio de Janeiro.

Junk, W.J., Bayley, P.B. & Sparks, R.E. 1989. The flood pulse concept in river-floodplain systems. Canadian special publication of fisheries and aquatic sciences 106: 110-127.

Junk, W.J. & Piedade, M.T.F. 1997. Plant life in the floodplain with special reference to herbaceous plants. In: W.J. Junk (ed.). The Central Amazon Floodplain: Ecology of a Pulsing System. Springer Berlin Heidelberg, Berlin, pp. 147-185.

Kawakita, K., Rodrigues, R.S. & Filgueiras, T.S. 2016. Poaceae em uma planície de inundação no Brasil: listagem florística e novas ocorrências. Hoehnea 43: 203-216.

Kawakita, K. & Souza, M.C. 2003. Levantamento florístico e fitofisionomia da lagoa Figueira, planície alagável do alto rio Paraná - Porto Rico, Paraná, Brasil. Acta Scientiarum Biological Sciences 25: 145-155.

Pessoa, C. 2020. *Dicella* Griseb. (Malpighiaceae). In: Flora do Brasil 2020 em construção. Jardim Botânico do Rio de Janeiro. Available at http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB8852 (access on 24-II-2020).

Pessoa, C., Costa, J. A. S. & Amorim, A.M.A. 2014. Flora da Bahia: Malpighiaceae 2 -*Heteropterys* Kunth. Sitientibus, sér. Ciências Biológicas 14.

Radford, A.E., Dickison, W.C., Massey, J.R. & Bell, C.R. 1974. Vascular Plant Systematics. Harper & Row, New York.

Romagnolo, M.B. & Souza, M.C. 1994. Sapindaceae da planície de inundação do trecho superior do rio Paraná. Unimar 16: 61-81.

Romagnolo, M.B. & Souza, M.C. 2004. Os gêneros *Calycorectes* O. Berg, *Hexachlamys* O. Berg, *Myrcianthes* O. Berg, *Myrciaria* O. Berg e *Plinia* L. (Myrtaceae) na planície alagável do alto rio Paraná, Brasil. Acta Botanica Brasilica 18: 613-627.

Romagnolo, M.B. & Souza, M.C. 2006. O gênero *Eugenia* L. (Myrtaceae) na planície de alagável do Alto Rio Paraná, Estados de Mato Grosso do Sul e Paraná, Brasil. Acta Botanica Brasilica 20: 529-548.

Sallun, A.E.M., Suguio, K. & Stevaux, J.C. 2007. Proposição formal do Alogrupo Alto Rio Paraná (SP, PR e MS). Geologia USP - Série Científica 7: 49-70.

Slusarski, S.R. & Souza, M.C. 2012. Inventário florístico ampliado na Mata do Araldo, Planície de Inundação do Alto Rio Paraná, Brasil. Revista de estudos ambientais 14: 14-27.

Souza, D.C. & Souza, M.C. 1998. Levantamento florístico das tribos Psychotrieae, Coussareeae e Morindeae (Rubiaceae) na região de Porto Rico, alto rio Paraná. Acta Scientiarum Biological Sciences 20: 207-212.

Souza, M.C., Kawakita, K., Slusarski, S. & Pereira, G. 2009. Vascular flora of the Upper Paraná River floodplain. Brazilian Journal of Biology 69: 735-745.

Souza, M.C., Vianna, L.F., Kawakita, K. & Miotto, S.T.S. 2012. O gênero *Aeschynomene* L. (Leguminosae, Faboideae, Dalbergieae) na planície de inundação do alto rio Paraná, Revista Brasileira de Biociências 10: 198-210.

Spjut, R.W. 1994. A systematic treatment of fruit types. The New York Botanical Garden, New York.

Stevaux, J. 1994. The upper Paraná river (Brazil): Geomorphology, sedimentology and paleoclimatology. Quaternary International 21: 143-161.

Tomazini, V. 2003. Epífitas vasculares em vegetação ripária da planície alagável do alto rio Paraná, Brasil. Dissertação de Mestrado, Universidade Estadual de Maringá, Maringá.

Weberling, F. 1965. Typology of inflorescences. Botanical Journal of the Linnean Society 59: 15-221.

Weberling, F. 1989. Morphology of flowers and inflorescences. Cambridge University, Cambridge.

ISSN da publicação *online* 2236-8906