



A new species of *Bernardia* (Euphorbiaceae, Acalyphoideae) with stellate trichomes from South America

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Abstract

Bernardia fluviatilis is described as a new species of Euphorbiaceae from the Upper Paraguay River Basin in central South America. A literature review, examination of herbarium specimens, and fieldwork suggest that the new taxon is most similar to *B. argentinensis* but differs by its young branches covered by a sparsely sericeous indumentum of simple trichomes, usually shorter staminate peduncles, cymules scattered along the axis of the staminate inflorescence, and staminate flower pedicel usually glabrous. Illustrations, photographs, information about the distribution, habitat, and conservation status of the new species, and a key to the morphologically similar species, are also provided.

Resumen

Bernardia fluviatilis se describe como una nueva especie de Euphorbiaceae de la Cuenca Alta del Río Paraguay, en el centro de América del Sur. El estudio de literatura y de especímenes de herbario, así como trabajo de campo sugieren que el nuevo taxón es más similar a *B. argentinensis*, pero se diferencia por sus ramas jóvenes cubiertas por un indumento escasamente seríceo de tricomas simples, pedúnculos estaminados usualmente más cortos, címulas dispersas a lo largo del eje de la inflorescencia estaminada y flores estaminadas con pedicelos generalmente glabros. También, se proporcionan ilustraciones, fotografías, información sobre la distribución, el hábitat y el estado de conservación de la nueva especie, así como una clave de las especies morfológicamente similares.

Key words: *Bernardia paraguariensis*, Chaco, Pantanal wetland

Introduction

Bernardia Houston ex Miller (1754: unpagued [189]) comprises about 70 species (Govaerts *et al.* 2000; Carrión 2020) distributed from the Southwestern United States to central Argentina, including the Caribbean. It belongs to the *Bernardia* clade in subfamily Acalyphoideae, along with the neotropical genera *Adenophaedra* (Müller Argoviensis 1865: 172) Müller Argoviensis (1874: 385), *Bahiana* Carrión (2022: 1200), and *Caryodendron* Karsten (1860: 91) (Carrión *et al.* 2022).

The presence of stellate trichomes in South American species of *Bernardia* is unusual and contrary to the pattern observed in the northern hemisphere species, where the presence of this character is extensive. While studying the *Bernardia* collections from South America, it was noticed that some specimens with stellate trichomes, from the Upper Paraguay River Basin, were morphologically different from the other South American species that also have

this character. Some of these collections were identified as *B. paraguariensis* Chodat & Hassler (1905: 503). However, these specimens do not belong to that taxon and are a new species to science.

The Upper Paraguay River Basin is about 600,000 km², located in the center of South America, and includes parts of Bolivia, Brazil, and Paraguay. The Pantanal is in this basin, which is the world's largest tropical wetland and a link between the Cerrado and Chaco ecoregions. The vegetation of this area is a mosaic of aquatics, floodable grasslands, alluvial forests, savannas (cerrados), forest savanna (cerradão), dry forests and a large area of monodominant savannas, and pioneer woodlands (Pott *et al.* 2011).

Here, we provide a description, taxonomic comments, and illustration of this new *Bernardia* species with stellate trichomes, a distribution map of the species, and an identification key to the morphologically similar species.

Materials and methods

Natural populations of the new species were visited in the municipality of Corumbá (state of Mato Grosso do Sul, Brazil) in November 2018, and *Bernardia* collections deposited in the following herbaria were studied: A, ALCB, BAB, BHCB, BM, CEN, CEPEC, CTES, F, GH, HAS, HUCS, HUEFS, HURB, ICN, K, LIL, LP, MBML, MO, NY, PACA, PMA, R, RB, SI, SP, SPF, P, UB, UFG, US, and VIC (acronyms according to Thiers continuously updated). Protologues of morphologically similar species were consulted and material preserved in alcohol and dried specimens were analyzed under a stereomicroscope. The morphological terminology follows Radford *et al.* (1974) and Beentje (2016). An informal conservation status was assessed based on the range size (criterion B) established by the IUCN (2022). The extent of occurrence (EOO) and area of occupancy (AOO) were calculated using the GeoCAT tool (Bachman *et al.* 2011).

Taxonomy

Bernardia fluviatilis J.F. Carrión, *sp. nov.* (Figs. 1–2)

Type:—BRAZIL. Mato Grosso do Sul: Corumbá, Porto Amolar, atrás da base da Ecoa. 18°2'24"S, 57°29'28"W, 120 m elev., 24 November 2018 (♂ fl., ♀ fl., and fr.), Carrión & Antunes 1875 (holotype: HUEFS!, isotypes will be sent to the following herbaria: CEPEC, CGMS, COR, K, MO, NY, PMA, RB, US).

Diagnosis:—*Bernardia fluviatilis* is similar to *B. argentinensis* Lourteig & O'Donell (in Lourteig 1955: 75) because it is usually monoecious and has a membranaceous leaf blade with stellate trichomes, staminate inflorescences racemiform and elongated, and staminate flowers conspicuously pedicellate, but differs by its young branches covered by a sparsely (vs. densely) sericeous indumentum of simple trichomes (vs. simple and/or stellate trichomes), staminate peduncles 3–6 (vs. 5–25) mm long, cymules scattered (vs. congested to scattered) along the axis of the staminate inflorescences, and staminate flower pedicel usually glabrous (vs. covered by simple and/or stellate trichomes).

Description:—Usually monoecious shrubs, 0.4–2 m tall, with indumentum of simple and stellate trichomes. Stem and old branches glabrous, lenticellate; branches striate, cylindrical, young branches covered by sparsely sericeous indumentum of simple trichomes. Stipules 0.9–1.5 × 0.2–0.4 mm, lanceolate, attenuate, rigid, thickened, covered by appressed, simple trichomes, persistent after the leaf falls. Leaves alternate; blade membranaceous, ovate to elliptic, 3–11 × 1–5 cm; discolorous; base cuneate; margin serrate, with glandular teeth, basally entire; a conspicuous pair of circular basilaminar glands present, these sometimes reddish, and 3–7 inconspicuous circular glands present around the blade; apex attenuate to acute, sometimes obtuse; abaxial surface pubescent, trichomes stellate, with 3–11 arms, simple trichomes present on the veins and margin, adaxial surface puberulent, trichomes stellate, with 2–9 arms, smaller than those on abaxial surface; venation palmate-pinnate, secondary veins in 5–9 pairs, intersecondary veins percurrent, usually depressed; petiole 2–6 mm long, covered by appressed, simple trichomes. Staminate inflorescences axillary, spiciform, 0.6–2.9 cm long at anthesis, pedunculate, peduncle 3–6 mm long, erect, covered with appressed, simple trichomes, bracts (1–)2–10, scattered along the axis, concave, ovate, apex acuminate, 1–1.7 × 1.1–1.5 mm, pale yellow, thickened, ciliate, outer surface covered with sparse, appressed, simple trichomes, inner surface glabrous; each bract subtending cymules of 3–8 flowers; surrounded by many linear bracteoles, these 0.5–1 mm long, pubescent. Staminate flowers pedicellate, pedicel articulate, conspicuously exerted to the bract at anthesis, 2–4.2 mm long at anthesis, glabrous to glabrescent; sepals 3(–4), valvate, ovate, 0.8–1.1 × 0.5–0.8 mm, hyphodromous, outer surface with sparse, simple trichomes, these denser at the apex and base, inner surface glabrous; stamens 7–10; filaments

0.3–0.7 mm long, alternating with shortly stalked segments of dissected disc; anthers 0.1–0.2 × 0.1–0.2 mm, basifixed, 4-locellate, dehiscent through longitudinal slits, connective emarginate. Pistillate inflorescence terminal, a sessile or shortly glomeruliform cyme, a pedunculate short, spiciform inflorescence, or an individual flower. Pistillate flowers sessile; each one subtended by 3 bracts, these ovate to lanceolate, ciliate, concave, unequal in size and shape, 1.2–1.9 × 0.7–1.4 mm, one bract conspicuously broader than the other two bracts, with an acute to attenuate apex, covered by appressed simple trichomes on the outer surface, glabrous on the inner surface, sometimes thickened on the basal sides, appearing glandulate; sepals 4–5, ovate, persistent, 0.8–1.8 × 0.5–1.4 mm, conspicuously ciliate, hyphodromous, outer surface with sparse, simple, appressed trichomes, inner surface glabrous; ovary globose, sericeous, styles 3(–4), bipartite, recurved, 0.4–0.8 mm long, branches to 0.5 mm, entire, stigmatic surface smooth, glabrous or sometimes with sparse, adpressed simple trichomes. Fruits globose, trilobed, 4.5–7 × 5–9 mm, verrucose, green when mature, sparsely sericeous, with persistent styles, bracts, and calyx; sometimes pedicellate, pedicel to 5 mm long; mericarps 2-valved, splitting septicidally then loculicidally; columella 2.5–4 mm long, trilobed, persistent. Seeds carinate, 3–5 (long) × 2–4 (deep) × 2.5–3.5 (wide) mm, with sinuate carina, cordiform in ventral view, verrucose to smooth, shiny, buff, sometimes marbled brown.

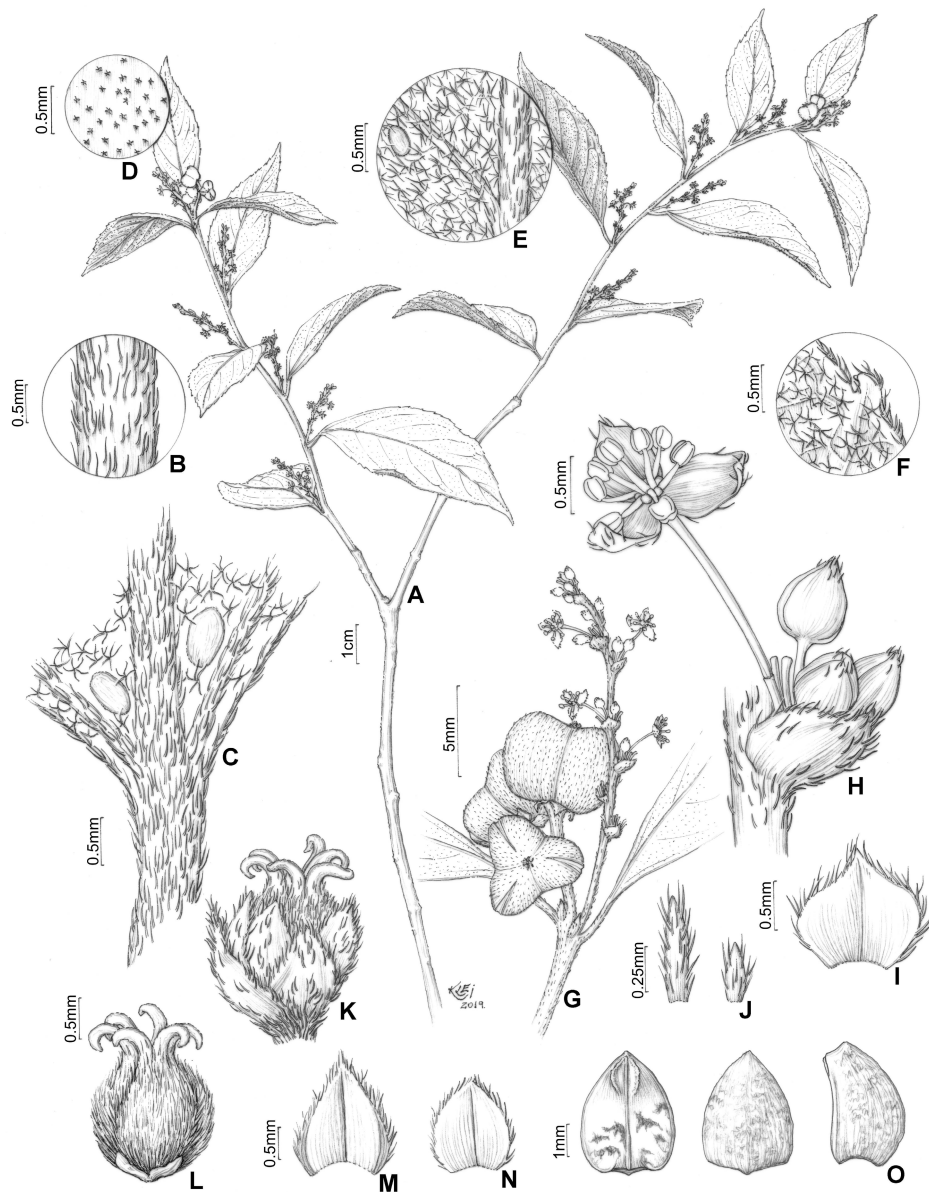


FIGURE 1. *Bernardia fluviatilis*. A, fertile branch; B, detail of young branch showing indumentum; C, detail of abaxial leaf surface with basilaminar glands; D, detail of adaxial leaf surface with indumentum; E, detail of abaxial leaf surface with indumentum; F, detail of leaf margin with glandular teeth; G, fruits and staminate inflorescence; H, staminate cymule and flower at anthesis; I, staminate bract in ventral view; J, staminate bracteoles; K, pistillate flower; L, gynoecium; M, pistillate bract; N, pistillate sepal; O, seeds, from left to right in ventral, dorsal and lateral view. Drawings by Klei Sousa, based on Carrion & Antunes 1875.



FIGURE 2. *Bernardia fluviatilis*: A, habit; B, fertile branches with detail of leaf blade margin; C, staminate inflorescence with detail of flower; D, fruits. Photographs by J.F. Carrión.

Additional specimens examined (paratypes):—BOLIVIA. Santa Cruz: Germán Busch, Puerto Quijarro, Puerto Isabel, Laguna Mandiore, 18°11'49.1"S, 57°30'37.8"W, 23 November 2010 (♂ fl., ♀ fl., and fr.), *Yule et al. 81* (CGMS). BRAZIL. Mato Grosso: Poconé, Morro do Caracará (Ilha Fluvial), Parque Nacional do Pantanal, 100 m elev., 17°51'2"S, 57°26'53"W, 4 May 2001 (♂ fl., ♀ fl., and fr.), *Damasceno Junior et al. 2290* (COR, SP); Mato Grosso do Sul: "Cerro Pedrera, circa Cerro Morriño, sed trans Riacho Navileque, 50–60 km N. Forte Olimpo, Alto Paraguay", 30 March 1980 (♀ fl. and fr.), *Bernardi 20410* (MO, NY, US); Corumbá, a 200 m da divisa com Bolivia, estrada do Jacadigo, 12 July 1972 (♂ fl., ♀ fl., and fr.), *Almeida de Jesus 1706* (RB); *ibid.*, Sub-região Pantanal do Paraguai, Morro do Amolar, 645 m elev., 18°1'09.2"S, 57°32'3.8"W, 25 November 2010 (♂ fl., ♀ fl., and fr.), *Stefanello et al. 258* (CGMS); *ibid.*, Baía do Taquaral, 88 m elev., 18°2'28.2"S, 57°29'26.2"W, 26 November 2010 (♂ fl., ♀ fl., and fr.), *Stefanello et al. 263* (CGMS); *ibid.*, Região da Serra do Amolar, próximo à ECOA, 18°02'28.2"S, 57°29'26.1"W, 26 November 2010 (♂ fl., ♀ fl., and fr.), *Neves et al. 68* (CGMS); *ibid.*, Porto Amolar, atrás da base da Ecoa, 18°2'24"S, 57°29'28"W, 120 m elev., 24 November 2018 (♂ fl.), *Carrión & Antunes 1877* (HUEFS); *ibid.*, (♂ fl., ♀ fl., and fr.), *Carrión & Antunes 1879* (HUEFS). PARAGUAY. Alto Paraguay: (as "Chaco Paraguayo"), Puerto Casado, Obraje Mosquito, December 1916 (♂ fl., ♀ fl., and fr.), *Rojas 2169* (A, SI).

Distribution:—*Bernardia fluviatilis* occurs in the Pantanal wetland, in border areas of Bolivia (Puerto Quijarro, Santa Cruz), Brazil (Poconé, Mato Grosso and Corumbá, Mato Grosso do Sul), and Paraguay (Puerto Casado, Alto Paraguay), which partially coincides with the riverbed of the Paraguay River and its tributaries (fig. 3).

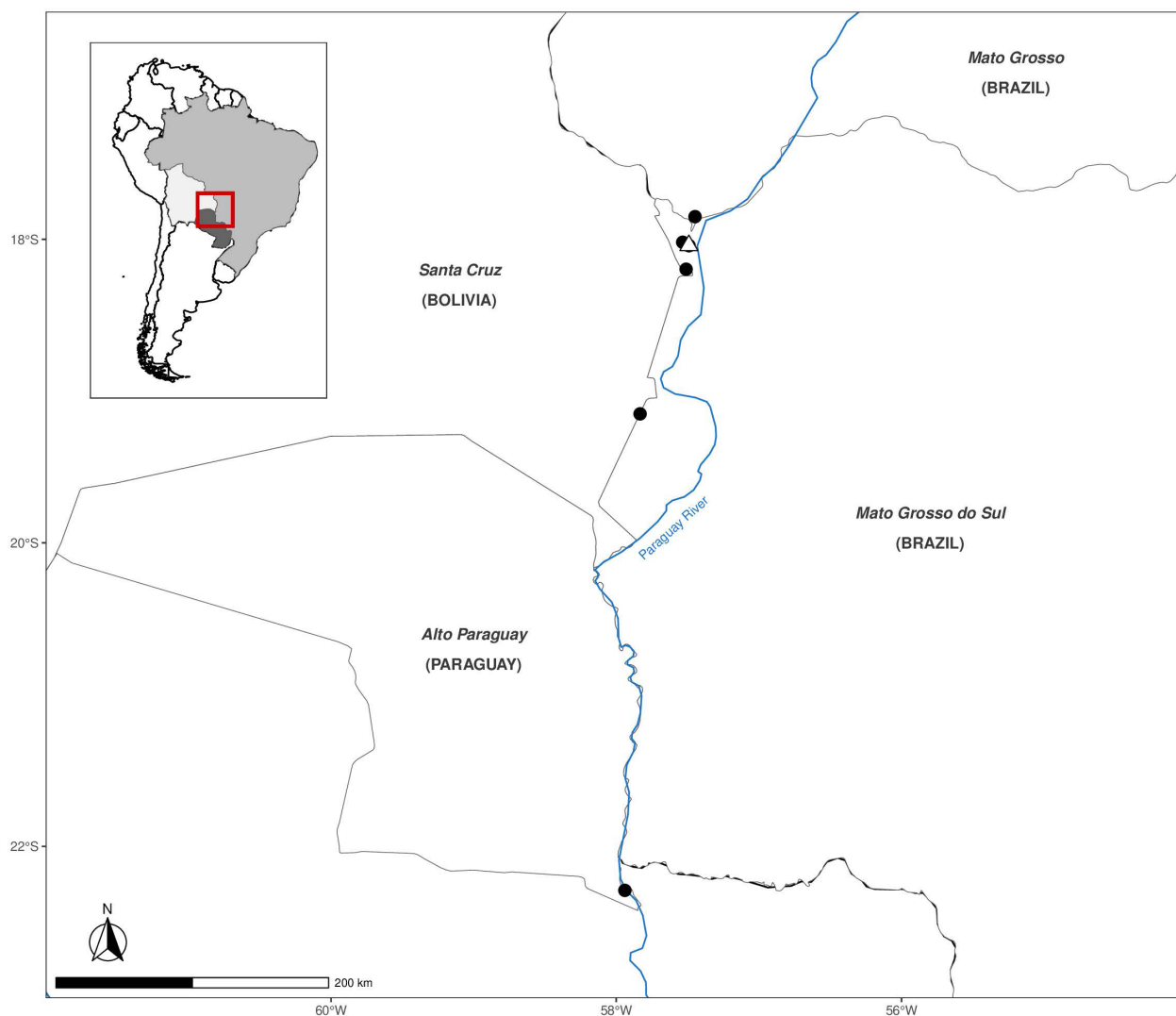


FIGURE 3. Geographical distribution of *Bernardia fluviatilis*. The white triangle indicates the type locality.

Etymology:—The specific epithet refers to the riparian habitat of this species.

Conservation assessment:—*Bernardia fluviatilis* is known from seven localities, of which most are difficult to access and only one is in a protected area (Pantanal Matogrossense National Park, municipality of Poconé, Mato Grosso State). The extent of occurrence (EOO) of *B. fluviatilis* was estimated to be 6,883.8 km², which qualifies it for the Vulnerable (VU) category, and the area of occupancy (AOO; grid cell area of 2 km²) was calculated to be 28 km², which qualifies it for the Endangered (EN) category. Thus, following the IUCN Red List categories and criteria (IUCN 2022), we believe that if a formal assessment was conducted *B. fluviatilis* would probably be classified as vulnerable [VU B1 a, b (i, ii)].

Habitat, ecology, and phenology:—This new species grows in areas of seasonally dry forest, rocky outcrops, savannas (cerrados), forest savanna (cerradão), riverine forests, open disturbed areas, and transitional flooded zones associated with the riverbed of the Paraguay River and its tributaries in the Pantanal wetland. This distribution associated with a watercourse might be related to hydrochorous dispersal. *Bernardia fluviatilis* seems to be a pioneer species, since it has been documented growing in anthropized areas, as observed in the type locality where many individuals (ca. 50) of this species were found. It has been recorded with flowers and fruits in March, May, July, November, and December.

Taxonomic comments:—*Bernardia fluviatilis* resembles *Bernardia argentinensis* and *B. paraguariensis* by its stellate trichomes and spiciform, elongated, pedunculate staminate inflorescence, with flowers that are conspicuously pedicellate and have bifid styles. These three species belong to the same lineage (Carrión 2020). *Bernardia fluviatilis* is sympatric with *Bernardia paraguariensis* and both have a staminate inflorescence with cymules scattered along the inflorescence axis, but *B. fluviatilis* can be differentiated by its usual monoecy (vs. dioecy), young branches covered

with a sericeous (vs. velutine-tomentose) indumentum of simple (vs. stellate and simple) trichomes, membranaceous (vs. chartaceous) leaf blade with tertiary veins usually depressed (vs. prominent), and axis of the staminate inflorescence covered by a sericeous (vs. densely tomentose) indumentum of simple (vs. stellate and simple) trichomes. *Bernardia fluviatilis* can be differentiated from *B. argentinensis* by the characteristics mentioned in the diagnosis, and *B. argentinensis* is endemic to northwestern Argentina and the Boqueron Department in Paraguay, while *B. fluviatilis* occurs in border areas of Bolivia, Brazil, and Paraguay (Alto Paraguay Department) and follows the riverbed of the Paraguay River.

Additionally, we considered the possibility that the new species could belong to one of the varieties (Chodat & Hassler 1905) or forms (Pax & Hoffman 1914) described for *Bernardia paraguariensis*. Particularly, we considered *B. paraguariensis* var. *fruticosa* Chodat & Hassler (1905: 504) because it was described from a specimen collected on a riverbank, a similar habitat of the new species, but detailed observations of the type specimen of *B. paraguariensis* var. *fruticosa* demonstrated that it is conspecific with *B. paraguariensis*.

The label of the *Bernardi* 20410 specimen says the collection was made in Paraguayan territory: “Cerro Pedrera, circa Cerro Morriño, sed trans Riacho Navileque, 50–60 km N. Fuerte Olimpo, Alto Paraguay.” However, “Cerro Pedrera” maybe = “Morro da Pedreira” that is in the municipality of Corumbá and “Riacho Navileque” maybe = “Rio Nabileque” that is located on the border of the municipalities of Corumbá and Porto Murtinho, which are both completely within Mato Grosso do Sul State. Thus, this collection is probably from Brazil near the border of Paraguay. This possible mistake was also noted by Oliveira *et al.* (2013).

Key to *Bernardia* species with stellate trichomes in the southern half of South America (modified from Carrión *et al.* 2019)

1. Leaves coriaceous; staminate inflorescences subglobose, sessile, cymules congested along the axis; staminate flowers shortly pedicellate (pedicels not exerted over the bract at anthesis).....2
- Leaves membranaceous to chartaceous; staminate inflorescences spiciform, pedunculate, cymules scattered along the axis; staminate flowers conspicuously pedicellate (pedicel exerted over the bract at anthesis)3
2. Multi-stemmed subshrub, usually with leaves near the base of the stem; blades 2.2–4.5 cm wide, circular glands 2–14, on the abaxial surface, usually aggregated close to the blade base, sometimes near to the apex; stamens 7–11; pistillate bracts 2.5–4.5 × 2.2–3.8; pistillate sepals 2.6–3.5 × 1.6–2.8 *B. allemii* Carrión (2019: 828)
- Single-stemmed shrub, without leaves near the base of the stem; blades 0.5–2 cm wide, circular glands sometimes absent or with 1–2(–3) glands close to the blade base on the abaxial surface; stamens 5–8; pistillate bracts 1–2 × 1–2.5 mm; pistillate sepals 0.8–1.7 × 0.8–1.5 *B. gardneri* Müller Argoviensis (1874: 394)
3. Plants usually dioecious; young branches densely tomentose; blades chartaceous, with conspicuously prominent tertiary veins; staminate inflorescences 4–10(–16) cm long *B. paraguariensis*
- Plants usually monoecious; young branches sericeous; blades membranous, with imprinted to slightly prominent tertiary veins; staminate inflorescences 0.6–3 cm long4
4. Subshrub to shrub, 0.15–0.80 m tall; young branches densely sericeous, with simple or simple and stellate trichomes; staminate peduncle 5–25 mm long, densely sericeous, pubescent to tomentose; staminate cymules congested to slightly sparse along the axis; staminate pedicels with simple and/or stellate trichomes. Argentina and Paraguay *B. argentinensis*
- Shrub, 0.4–2 m tall; young branches sparsely sericeous, with only simple trichomes; staminate peduncle 3–6 mm long, sericeous; staminate cymules sparse along the axis; staminate pedicels usually glabrous. Bolivia, Brazil, and Paraguay *B. fluviatilis*

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