

Amaioua longipedicellata (Rubiaceae, Gardenieae), a new species from the Brazilian Atlantic coast

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Background – Ongoing studies of Brazilian Rubiaceae revealed an undescribed species of *Amaioua* endemic to Atlantic Forest (*Restinga* and Semideciduous forest) of the state of Bahia, which is here described and illustrated, and its morphological characters are discussed and compared with those of similar species.

Methods – This study is based on examinations of herbarium specimens, samples preserved in 60% ethanol, field observations, and digital images. Herbarium specimens of the CAY, CEPEC, HBR, IBGE, K, MBM, NY, RB, U, UB, UFG, and US herbaria were directly studied. Additional images of herbarium specimens were studied online.

Results – *Amaioua longipedicellata* Delprete & J.G.Jardim is here described, illustrated and compared with the two most similar species, i.e., *A. glomerulata* (Lam. ex Poir.) Delprete & C.H.Perss. and *A. intermedia* Mart. A table comparing the morphological characters of these three species, and an appendix with selected specimens studied of *A. glomerulata* and *A. intermedia* are included.

Key words – *Duroia*, *Alibertia* Group, Neotropics, Bahia, Brazil, *Restinga*.

INTRODUCTION

According to several phylogenetic studies using morphological and molecular data (Persson 1996, 2000a, 2000b, Andreassen & Bremer 1996, Bremer & Eriksson 2009, Mouly et al. 2014) the tribe Gardenieae, as traditionally recognized, is paraphyletic, and its Neotropical genera are found in three groups: (1) *Alibertia* group, (2) *Randia* group, and (3) *Genipa*, positioned in a clade of mostly Paleotropical genera. Mouly et al. (2014), according to the molecular phylogenies obtained, described the new tribe Sherbournieae (where they included the Paleotropical genera *Atractogyne* Pierre, *Mitriostigma* Hochst., *Oxyanthus* DC., and *Sherbournia* G.Don), and resurrected the tribe Cordiereae, which corresponds to the *Alibertia* group. However, Persson & Delprete (2017) considered that in the phylogenies of Mouly et al. (2014)

the resolution between the two groups is low, and treated the formal recognition as tribes as premature; therefore, they preferred to call the latter ensemble of genera the *Alibertia* group, a delimitation and a name that is here maintained.

The molecular phylogenetic analyses of Cortés-B. et al. (2009) and Mouly et al. (2014) showed that the *Alibertia* group includes 12 genera. Persson & Delprete (2017) confirmed the same number of genera, and esteemed that the group includes about 110 species. In their monographic treatment of the *Alibertia* group, they provided an expanded discussion of the morphological features, phenology and ecology of the taxa of the group, along with the first part of the taxonomic revision, namely the genera *Agouticarpa* C.H.Perss., *Alibertia* A.Rich., *Cordia* A.Rich., *Melanopsidium* Colla, *Riodoceia* Delprete, and *Stenosepala* C.H.Perss.

Amaioua Aubl. (Aublet 1775) and *Duroia* L.f. (Linnaeus 1782) are unique within the *Alibertia* group, in having stipules as a conical apical cap, readily caducous, or rarely remaining on the stem and splitting on one side; these two genera are quite similar to each other and are frequently confused. They have been traditionally separated by the number of flowers per female inflorescence, although with overlapping ranges, being with 1–3(–5) flowers in *Duroia*, and with (1–)2–7 flowers in *Amaioua* (e.g. Steyermark 1974 Taylor et al. 2004, Delprete 2010, Persson & Delprete 2017). In the molecular phylogenies of Persson (2000a, 2000b), *Amaioua* and *Duroia* were found on a strongly supported clade, the former, represented by a single species, nested within the latter. Since the name *Amaioua* has priority over *Duroia*, if the two genera will eventually be treated as synonymous, the previous name is the one to be adopted. For the purpose of this study, we maintain the two genera separated and as currently delimited.

Ongoing studies of Brazilian Rubiaceae revealed an undescribed species of *Amaioua*, with fasciculate, 2–3-flowered, or rarely trichotomous, 3–9-flowered female inflorescences, and oblong-elliptic, 1.2–2.2 cm long berries, differing from similar species by the thin, long pedicels, among other characters. This new species is endemic to Restinga vegetation and semideciduous seasonal forest (Mun. Jequié) of the state of Bahia, coastal Brazil.

Restinga vegetation occurs on sandy deposits present along the Atlantic coast of Brazil, which accumulated during the Quaternary Period, when the sea level went through considerable fluctuations. Restinga is characterized by sandy or clay-sandy soils, poor in nutrients. Two main types are recognized: shrubby Restinga (“Restinga arbustiva”) and arboreal Restinga (“Restinga arborea”). Arboreal Restinga, where the present new species is found, is a forest formation composed by dense small trees and with a closed canopy (Thomas & Barbosa 2008). It is an edaphic formation related to the sandy Quaternary lowlands located between the sandy beaches and the first slopes parallel to the coast (Vinha et al. 1976).

Semideciduous seasonal forest is a vegetation type occurring in the transitional zone present between the Atlantic Forest and the Caatinga Biome. It is characterized by a well-marked dry season (winter season) and an intense rainy season (summer season). During the drastic dry season, a considerable portion of the trees (between 20% and 50% of the species) lose their leaves (Veloso et al. 1991). It is characterized by sandy-clay soils. According to Vinha et al. (1976), this forest is composed by dense patches of small trees averaging 10–12 m in height. According to the latter authors, this vegetation is strongly threatened by aggressive cattle ranching, which represent the principal cause of the disappearance of its last remnants.

MATERIAL AND METHODS

This study is based on examinations of herbarium specimens, samples preserved in 60% ethanol, field observations, and digital images. Herbarium specimens were studied either by visiting and/or through loans from the CAY, CEPEC, HBR, IBGE, K, MBM, NY, RB, U, UB, UFG, and US herbaria.

Additional images of herbarium specimens were studied through the following websites: Jstor Global Plants (<https://plants.jstor.org/>), Tropicos (<http://www.tropicos.org/>), and INCT – Herbário Virtual da Flora e dos Fungos (<http://inct.splink.org.br/>). Descriptions and measurements are based on dry herbarium specimens. All specimens cited have been examined, unless indicated by “n.v.” (not seen) after the herbarium acronym. The abbreviation “Mun.” in the specimens cited refers to the Brazilian municipalities. A preliminary extinction risk assessment of the new species was made using the IUCN Red List Categories and Criteria (IUCN 2012, 2017). Georeferenced specimen data were imported into GeoCAT (Bachman et al. 2011) to estimate the area of occupancy (AOO) and the extent of occurrence (EOO).

SPECIES DESCRIPTION AND DISCUSSION

Amaioua longipedicellata Delprete & J.G.Jardim, **sp. nov.**

The new species is most similar to *A. glomerulata* (Lam. ex Poir.) Delprete & C.H.Perss. (Delprete & Persson 2012) in the stipules densely antrorse-sericeous outside and glabrous inside, subcoriaceous leaf blades, female inflorescences fasciculate (rarely cymose, trichotomous in *A. longipedicellata*), and calyx with linear lobes; the former differs from the latter by the male inflorescences with a thin rachis (vs. stout in *A. glomerulata*), 3–9-flowered (vs. 15–35-flowered), female inflorescences fasciculate, 2–3-flowered, or rarely trichotomous, 3–9-flowered (vs. cymose, with 2–3 pairs of lateral branches, 6–24-flowered), female flowers pedicellate (vs. sessile), smaller corollas (vs. larger), infructescence fasciculate, with 2–3 fruits, or rarely cymose, with 3–9-fruits (vs. cymose, with 3–10(–13) fruits), and fruits pedicellate, oblong-ellipsoid (vs. sessile, ellipsoid). For additional differences see table 1. – Type: Brazil, Bahia, Mun. Una, Rod. BA-001, Ilhéus–Una, estrada para Pedras de Una, ca. 500 m da BR-001, restinga arbórea, tree ca. 6 m tall, leaves dark green and shiny above, pale green below, calyx pale green, corollas white, immature fruits green, 15°16'13"S, 39°02'58"W, 40 m, 11 Jan. 2016, J.G. Jardim & P.G. Delprete 6801, female fl, imm fr (holo-: CEPEC [fl, imm fr]; iso-: ALCB [imm fr], EAC [imm fr], MBM [imm fr], MBML [imm fr], UEC [imm fr], SPF [fl, imm fr], RB [fl buds, imm fr], HURB [imm fr]).

Shrub 2.4–4 m tall or **tree** 3.5–14 m tall; trunk to 15 cm at dbh; bark fissurate; young branches terete, subterete to laterally compressed, 2–3 mm thick, antrorse to spreading sericeous, later glabrate; bark pale brownish-gray, fissurate; wood white. **Stipules** an apical cap, conical, 8–22(–31) mm long, readily caducous, rarely remaining on the stem and splitting on one side, densely antrorse-sericeous outside, trichomes rust-brown, glabrous inside, with a basal portion with colleters inside, leaving a circular scar after falling off. **Leaves** opposite (rarely ternate in young plants), often clustered at branch tips; petioles 7–27 mm long, antrorse appressed-pubescent to glabrate; blades ovate to elliptic, 5–18 × 2.5–8 cm, obtuse at base, obtuse to acute and acuminate at apex, subcoriaceous (to thinly fleshy when fresh), glabrous and lucid above, glabrous below, margins not thickened, glabrous, flat (not revolute); secondary veins 5–8 on each side of midrib; domatia of sparse short trichomes present at secondary vein axils. **Male inflorescence** sessile to

Table 1 – Morphological comparison of *Amaioua glomerulata*, *A. intermedia* and *A. longipedicellata*.
Diagnostic characters are in **bold**.

	<i>A. glomerulata</i>	<i>A. intermedia</i>	<i>A. longipedicellata</i>
Leaf secondary veins on each side of midrib	6–10	(4–)5–7(–9)	5–8
Rachis thickness	Stout	Stout	Thin
Male inflorescence	Cymose, 1–3(–4)-branched, 15–35-flowered, each branch ending with a 3–many-flowered cymule	Cymose, trichotomous, 10–35-flowered, each branch ending with a 3–15-flowered cymule	Cymose, commonly trichotomous, 3–9-flowered, each branch ending with a 1–3-flowered cymule
Female inflorescence	Pedunculate, fasciculate, 6–24-flowered, with 2–3 short branches	Sessile to subpedunculate, fasciculate, 5–9-flowered	Sessile to subpedunculate, fasciculate, 2–3-flowered, or rarely trichotomous, 3–9-flowered , each branch ending with a 1–3-flowered cymule
Male pedicels	Absent or stout, to 4 mm long	Stout, 5–12 mm long	Thin, 9–12 mm long
Male calyx	3.5–4 mm long, lobed; lobes 1–3 mm long	4–6 mm long, truncate to undulate	4–6 mm long, lobed; lobes linear, 1–1.3 mm long
Male corolla	19–26 mm long; tube 8–10 mm long; lobes ligulate to narrowly triangular, 11–16 mm long	16–22 mm long; tube 8–10 mm long; lobes oblong-lanceolate, 8–12 mm long	11–12.5 mm long ; tube 6.5–7 mm long; lobes oblong-lanceolate, 4–5.5 mm long
Female pedicels	Absent	Stout, (2.5–)5–12 mm long	Thin, 7–12 mm long
Female calyx	3 mm long, lobed; lobes linear, 1–2 mm long	4–6 mm long, truncate to undulate	3.5–4.5 mm long, lobed; lobes linear, 0.7–1 mm long, sometimes alternate to smaller lobes (0.3–0.5 mm long)
Female corolla	12–15 mm long; tube 7–8 mm long, antrorsely golden-sericeous outside; lobes narrowly triangular, 5–7 mm long	17–23 mm long; tube 8–9 mm long, antrorsely golden-sericeous outside; lobes oblong-lanceolate, 9–14 mm long	10.5–13.5 mm long ; tube 5.5–7 mm long, densely antrorse white-sericeous outside; lobes oblong-lanceolate to lanceolate, 5–7 mm long
Infructescence	Sessile, subsessile or subpedunculate, fasciculate, with 3–10(–13) fruits	Sessile, subsessile or subpedunculate, fasciculate, with 5–9 fruits	Sessile or subsessile, fasciculate, with 2–3 fruits, or rarely trichotomous, with 3–9 fruits , each branch ending with a 1–3-fruited cymule
Fruit pedicels	Absent	Stout, (2.5–)3–22 mm long	Thin, 25–40 mm long
Fruit shape and size	Ellipsoid, 1.3–1.5 × 0.7–1.1 cm	Oblong to ellipsoid, 2.5–3.5 × 0.8–1.1 cm	Oblong-ellipsoid, 1.2–2.2 × 0.7–1 cm
Geographic distribution	Neotropics (from Mexico and Antilles to Peru)	Extra-Amazonian Brazil (from Bahia to Santa Catarina)	Northeastern Brazil (endemic to Bahia)

subsessile, cymose, commonly trichotomous, 3–9-flowered, each branch ending with a 1–3-flowered cymule; flowers long-pedicellate. Female inflorescence sessile to subsessile, fasciculate, 2–3-flowered, or rarely trichotomous, 3–9-flowered, each branch ending with a 1–3-flowered cymule; flowers long-pedicellate. Flowers strongly fragrant, reminding of gardenia scent. Male flowers: pedicels 9–12 mm long, thin; ovary lacking; calyx cupular, 4–6 mm long, 6–7-lobed, pale green, antrorse appressed-sericeous outside and inside, lobes linear, 1–1.3 mm long; corolla 11–12.5 mm long, white to yellowish-white, tube 6.5–7 mm long, densely antrorse white-sericeous outside, glabrous inside, lobes 6–7, oblong-lanceolate, 4–5.5 mm long, acute, sparsely white-sericeous outside, glabrous to sparsely white-sericeous inside; stamens included, sessile, inserted at median portion of the corolla tube; anthers narrowly oblong, tips almost at the same height of the corolla mouth, 4–4.5 mm long, apiculate; style not re-

ceptive, included, 6–6.5 mm long, glabrous, style branches 2, connivent, longitudinally ridged, 3–3.5 mm long. Female flowers: pedicels 7–12 mm long, thin; hypanthium oblong-turbinate, 3.5–4 × 1.5 mm, densely antrorse white-sericeous; calyx cupular, 3.5–4.5 mm long, 6–7-lobed, pale green, sparsely antrorse appressed-sericeous outside and inside, lobes linear, 0.7–1 mm long, sometimes alternate with small teeth 0.3–0.5 mm long; corolla 10.5–13.5 mm long, white to yellowish-white, tube 5.5–7 mm long, densely antrorse white-sericeous outside, glabrous inside, lobes 6–7, oblong-lanceolate to lanceolate, 5–7 mm long, acute, sparsely white-sericeous outside, glabrous to sparsely white-sericeous inside; stamens included, sessile, inserted at median portion of the corolla tube; anthers narrowly oblong, with tips below the corolla mouth, 4–4.5 mm long, apiculate; style receptive, included (sometimes with lobe tips barely above the corolla mouth), 4.5–7 mm long, glabrous, style branches

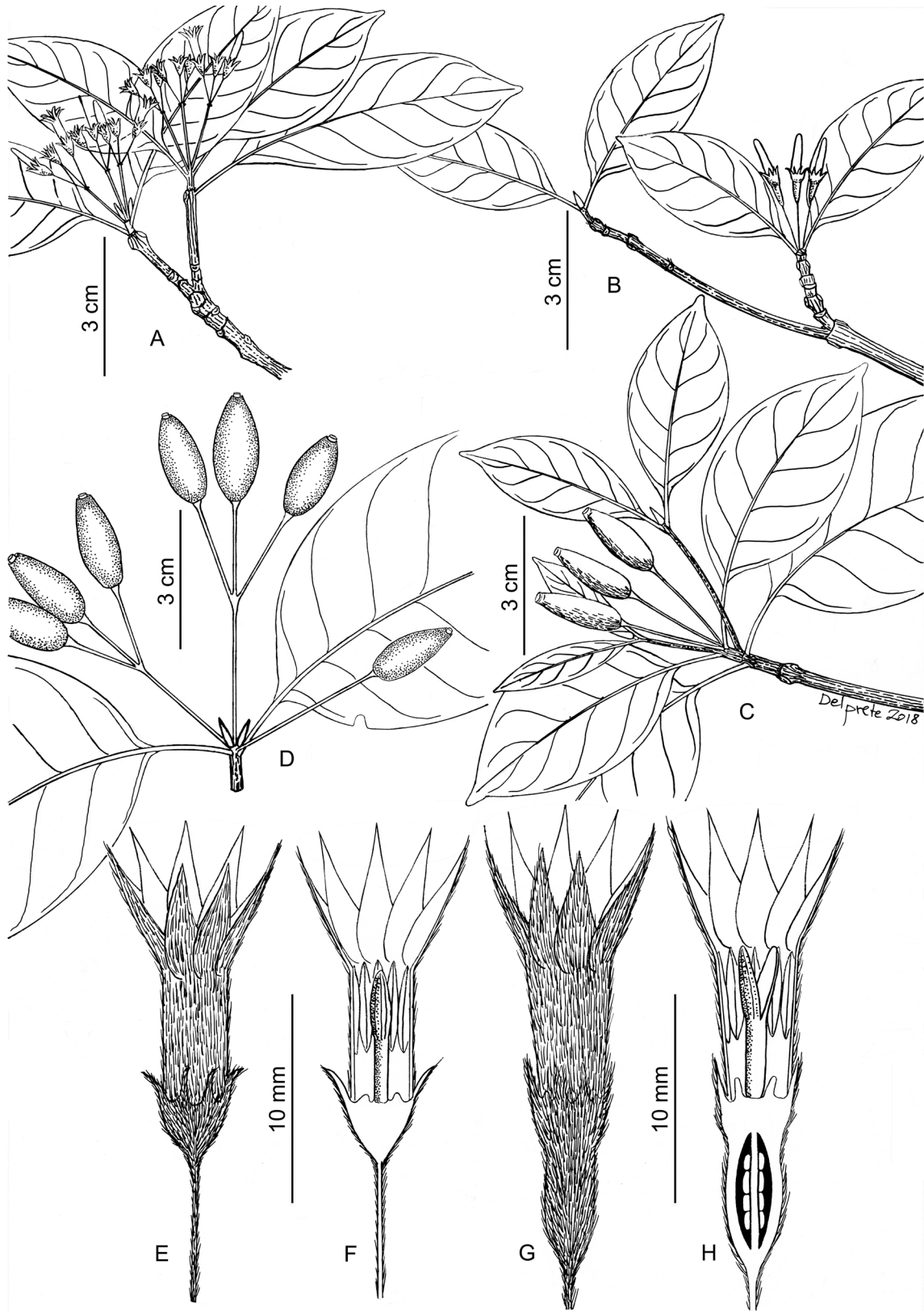


Figure 1 – *Amaioua longipedicellata*: A, branchlet with male inflorescence; B, branchlet with fasciculate female inflorescence; C, fasciculate infructescence with immature fruits; D, trichotomous infructescence with mature fruits; E, Male flower in anthesis; F, dissected male flower in anthesis; G, female flower in anthesis; H, dissected female flower in anthesis. A, E & F from Jardim & Delprete 6802 (CEPEC); B & C from Jardim & Delprete 6801 (CEPEC); D from photograph by J. Jardim (see fig. 2F); G & H from Jardim & Jardim 5447 (CEPEC). Illustration by Piero Delprete.

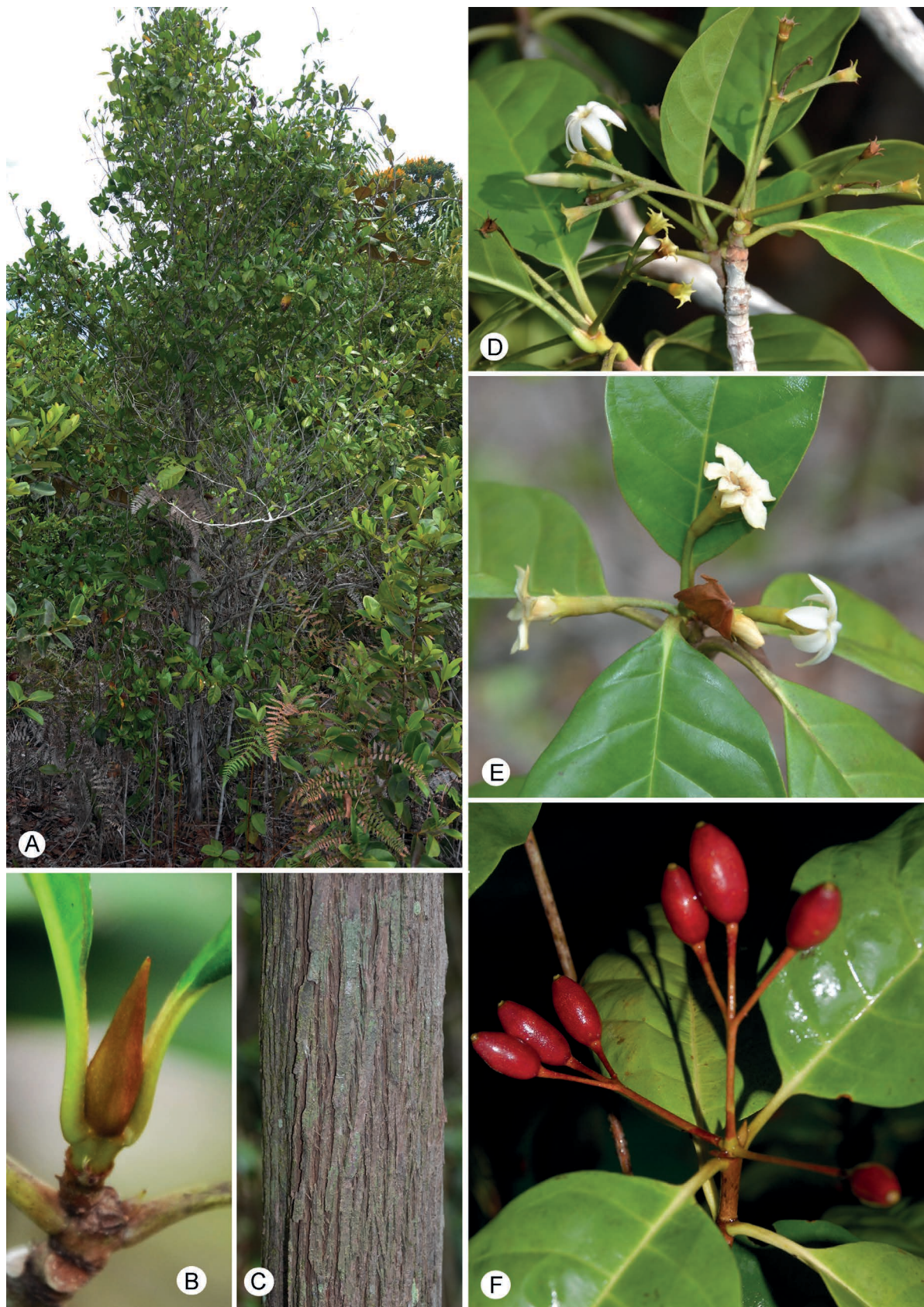


Figure 2 – *Amaioua longipedicellata*: A, habit (tree c. 5 m tall); B, stipule; C, fissurate bark; D, cymose male inflorescence; E, fasciculate female inflorescence; F, trichotomous infructescence with fruits at intermediate stage of maturity. Photos A–E by Piero Delprete. Photo F by Jomar Jardim.

2, 2.5–3 mm long, reflexed when receptive. **Infructescence** sessile or subsessile, fasciculate, with 2–3 fruits, or rarely cymose, trichotomous, with 3–9 fruits, each branch ending with a 1–3-fruited cymule. **Berries** with pedicels 25–40 mm long, oblong-ellipsoid, $1.2\text{--}2.2 \times 0.7\text{--}1$ cm, obtuse at base, crowned by the permanent calyx, sparsely short white-sericeous and reddish at initial stage of ripening, dark purple and glabrate at full maturity. **Seeds** round in outline, $3\text{--}4 \times 4\text{--}5$ mm, convex on both sides, reddish-brown; testa papillose. Figs 1 & 2.

Distribution – Mostly found along the Brazilian Atlantic coast, in the state of Bahia (fig. 3).

Additional specimens studied (paratypes) – Brazil:
Bahia: Mun. Una, Reserva Biológica do Mico-Leão (IBAMA), entrada no km 46 da Rod. BA-001 Ilhéus–Una, $15^{\circ}09'S$, $39^{\circ}05'W$, 13 Sep. 1993, *Amorim et al.* 1346, imm

fr (CEPEC, NY); *ibid.*, 28 Nov. 1993, *Amorim et al.* 1561, fl (CEPEC); Mun. Maraú, 6 May 1966, *Belém & Pinheiro* 2041, fr (UB); Maraú, 12 Jan. 1967, *Belém & Pinheiro* 3075, fl (UB); Maraú, mata costeira, 13 Jan. 1967, *Belém & Pinheiro* 3107, fl (CEPEC, NY, UB); Mun. Valença, Estrada Valença-Guaibim, km 10, 8 Jan. 1982, *Carvalho & Lewis* 1126, fl (CEPEC); Mun. Maraú, Estrada Ubaitaba-Ponta do Mutá, entrocamento da estrada para Maraú, 3 Feb. 1983, *Carvalho & Plowman* 1416, fr (CEPEC, MBM, HUEFS, UB); Mun. Una, ca. 50 km S of Ilhéus, on road to Una, $15^{\circ}02'S$, $39^{\circ}01'W$, 20 m, 15 Nov. 1992, *Hind et al.* 43, imm fr (CEPEC); Mun. Una, Reserva Biológica do Mico-Leão (IBAMA), entrada no km 46 da Rod. BA-001 Ilhéus–Una, Picada do Marimbondo, $15^{\circ}09'S$, $39^{\circ}05'W$, 23 Feb. 1999, *Jardim et al.* 2022, imm fr (CEPEC); Mun. Una, Rod. BA-001 Una–Ilhéus, estrada para o povoado de Pedras de Una, 500–700 m da rodovia, $15^{\circ}16'12''S$, $39^{\circ}03'06''W$, 65 m, 23 Dec. 2008, *Jardim & Jardim* 5447, female fl (CEPEC); Mun. Ilhéus, Rod. Olivença para o distrito de Sapucaieira, ca. 6 km a partir da Igueja de Olivença, $14^{\circ}58'40''S$, $39^{\circ}02'07''W$, 50 m, 15 Apr. 2015, *Jardim* 6782, imm. fr (CEPEC, HUEFS, HUVA, MBML, RB, SP, UEC); Mun. Una, Rod. BA-001, Ilhéus–Una, estrada para Pedras de Una, ca. 500 m da BR-001, $15^{\circ}16'13''S$, $39^{\circ}02'58''W$, 40 m, 11 Jan. 2016, *Jardim & Delprete* 6802, male fl (ALCB, CEPEC, EAC, HUEFS, HURB, JPB, MBM, MBML, RB, SP, UEC, VIES); Mun. Itacaré, Campo Cheiroso, $14^{\circ}22'50''S$, $39^{\circ}02'23''W$, 9 Feb. 2011, *Lacerda & Daneu* 11, imm fr (CEPEC); Mun. Jequié, Fazenda Brejo Novo, a 10.5 km da Av. Otávio Mangabeira pela Exupério Miranda no Bairro do Mandacarù, $13^{\circ}56'55''S$, $40^{\circ}06'41''W$, 559 m, 1 Apr. 2004, *Macedo* 667, fl (CEPEC); Mun. Jequié, Fazenda Brejo Novo, a 10.5 km da Av. Otávio Mangabeira pela Exupério Miranda no Bairro do Mandacarù, $13^{\circ}56'55''S$, $40^{\circ}06'41''W$, 559 m, 19 Aug. 2004, *Macedo* 1243, old fl without corolla (CEPEC); Mun. Ilhéus, ramal para o fundo da Fazenda das Palmas onde faz limite com a Faz. de José Rocha, entrada do ramal em frente ao Condomínio Águas de Olivença, situada no km 8 da Rod. Olivença–Una (BA-001), 80 m, 10 May 2000, *Mattos Silva et al.* 4079, fr (CEPEC); Mun. Ilhéus, Fazenda Barra do Manguinho, ramal da Estrada no km 10 da Rod. Pontal–Olivença, lado direito, 3 km W da rodovia, 5 Feb. 1982, *Mattos Silva et al.* 1400, imm fr (CEPEC); Mun. Ituberá, Povoado do Rio do Campo, Faz. Agrícola Litorânea, margem do Rio Canguara, restinga arborea proxima à sede, 10 m, 13 Apr. 1994, *Mattos Silva & Rosa* 2969, fr (CEPEC); Mun. Ilhéus, road from Olivença to Maruim, 6.1 km W of Olivença, forest on N side of road, $14^{\circ}59'S$, $39^{\circ}03'W$, 1 May 1992, *Thomas et al.* 9076, fr (CEPEC, NY).

Habitat, ecology and phenology – This species grows in semideciduous seasonal forest and Restinga forest (“Restinga arborea-arbustiva”), commonly on white sand or sometimes on clay-sandy soil, or in transitional vegetation between Restinga forest and wet dense forest (“Floresta Ombrófila densa”), or in disturbed vegetation with selective logging and/or for the extraction of piassava palm (*Attalea funifera* Mart.); at 10–560 m altitude. Flowering specimens were collected in January, April, November and December. Specimens with immature fruits were collected in January,

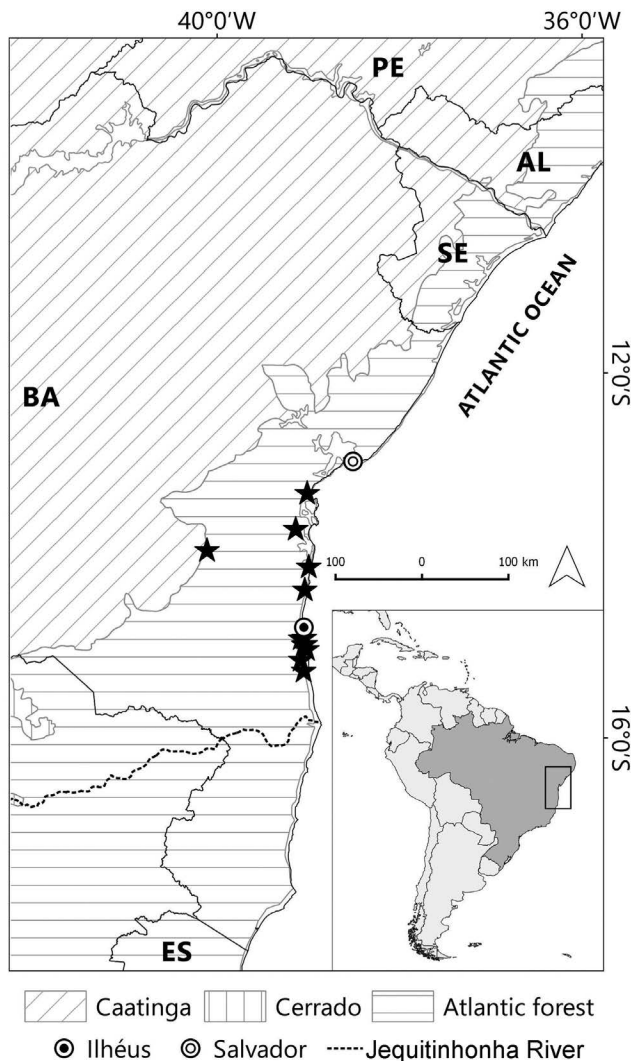


Figure 3 – Distribution map of *Amaioua longipedicellata*. Brazilian biomes are indicated by line patterns (see legends in figure). State boundaries are indicated by continuous lines. Abbreviations for Brazilian states: AL: Alagoas; BA: Bahia; ES: Espírito Santo; PE: Pernambuco; SE: Sergipe.

February, May, September and November, and with mature fruits in February, April and May.

Etymology – The specific epithet refers to the long, thin flower pedicels, which further elongate in the fruiting stage.

Conservation assessment – Vulnerable (VU), B1 a, b(i, ii, iii). The extent of occurrence (EOO) of this species has been calculated to be 13 318 km², which qualifies the species for the Vulnerable (VU) category, and the area of occupancy (AOO) was estimated to be 48 km², which qualifies it for the Endangered (EN) category (Bachman et al. 2011; IUCN 2012, 2017). Although three collections of *Amaioua longipedicellata* were made inside the Mico-Leão Biological Reserve, which is part of the Una Reserve, most collections were made in disturbed vegetation or inside large farms, within the Restinga vegetation domain, along the Atlantic coasts of the state of Bahia, Brazil. The species is known by 19 collections, but only from 10 localities (municipalities). It is extremely rare to find intact Restinga forest, and the few remnants are extremely scattered, as this vegetation is strongly impacted by numerous human activities, as selective logging, agriculture, housing construction, and extraction of piassava palm (*Attalea funifera* Mart.) for the production of fiber. Piassava extraction is commonly believed to be a non-timber forest product that could provide a commercial product with a minimum impact of the surrounding vegetation. However, this extraction is instead often accompanied by the almost complete obliteration of the surrounding vegetation, resulting in large areas where the natural vegetation has almost completely been destroyed and with sparse individuals of this palm on nearly denuded slopes of the Restinga biome. Therefore, due to the scattered areas still preserved in the region, and the rapid rate of deforestation of the much fragmented Restinga vegetation and semi-deciduous seasonal forests in the state of Bahia, we consider this species as Vulnerable [VU B1 a, b(i, ii, iii)] according to IUCN criteria (IUCN 2012, 2017).

Notes – *Amaioua longipedicellata* is also similar to *A. intermedia* Mart. by the subcoriaceous leaf blades, trichotomous male inflorescences, fasciculate female inflorescences (rarely trichotomous in *A. longipedicellata*), pedicellate male and female flowers, and pedicellate fruits; the former differs from the latter by the inflorescences with a thin rachis (vs. stout), male inflorescences commonly 3–9-flowered, each branch ending with a 1–3-flowered cymules (vs. 10–35-flowered, each branch ending with a 3–15-flowered cymule), female inflorescences fasciculate, 2–3-flowered, or rarely trichotomous, 3–9-flowered, each branch ending with a 1–3-flowered cymule (vs. fasciculate, 5–9-flowered), calyx with linear lobes (vs. truncate or undulate), male corollas 11–12.5 mm long, tube 6.5–7 mm long, lobes 4–5.5 mm long (vs. 16–22 mm long, tube 8–10 mm long, lobes 8–12 mm long), female corollas 10.5–13.5 mm long, tube 5.5–7 mm long, lobes 5–7 mm long (vs. 17–23 mm long; tube 8–9 mm long; lobes oblong-lanceolate, 9–14 mm long), fruits oblong-ellipsoid, 1.2–2.2 × 0.7–1 cm, with pedicels thin, 25–40 mm long (vs. oblong to ellipsoid, 2.5–3.5 × 0.8–1.1 cm, with pedicels stout, (2.5–)3–22 mm long).

A comparison of morphological characters of *Amaioua glomerulata*, *A. intermedia* and *A. longipedicellata* is pre-

sented in table 1. Characters and measurements of these three species are based on observations of specimens from throughout their ranges. Selected herbarium specimens of *Amaioua intermedia* and *A. glomerulata* analyzed for this study are reported in appendix 1.

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REFERENCES

- Andreasen K., Bremer B. (1996) Phylogeny of the subfamily Ixoroideae (Rubiaceae). *Opera Botanica Belgica* 7: 119–138.
- Aublet J.B.C.F. (1775) *Histoire des plantes de la Guiane française*. Paris, Didot. <https://doi.org/10.5962/bhl.title.674>
- Bachman S., Moat J., Hill A.W., de la Torre J., Scott B. (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. In: Smith V., Penev L. (eds) *e-Infrastructures for Data Publishing in Biodiversity Science*. *ZooKeys* 150: 117–126. (Version BETA). <https://doi.org/10.3897/zookeys.150.2109>
- Bremer B., Eriksson T. (2009) Time tree of Rubiaceae: phylogeny and dating the family, subfamilies, and tribes. *International Journal of Plant Sciences* 170: 766–793. <https://doi.org/10.1086/599077>
- Cortés-B. R., Delprete P.G., Motley T.J. (2009) Phylogenetic placement of the tribe Retiniphyllae among the subfamily Ixoroideae (Rubiaceae). *Annals of the Missouri Botanical Garden* 96: 61–67. <https://doi.org/10.3417/2006198>
- Delprete P.G. (2010) Rubiaceae – Parte 1: introdução, gêneros A–H. In: Rizzo J.A. (coord.) *Flora dos Estados de Goiás e Tocantins*, vol. 40, part 1: 1–580. Goiânia, IRD/UFG, Universidade Federal de Goiás.
- Delprete P.G., Persson C. (2012) *Octavia sessiliflora* DC. and *Mussaenda glomerulata* Lam. ex Poir., two obscure taxa from French Guiana synonymous with members of the *Alibertia* group (Rubiaceae, Gardenieae). *Adansonia sér.* 3 34: 353–363. <https://doi.org/10.5252/a2012n2a9>
- IUCN (2012) IUCN Red List Categories and Criteria. Version 3.1. 2nd Edition. Prepared by the IUCN Species Survival Commission. Gland & Cambridge, IUCN. Available from <https://www.iucnredlist.org/resources/categories-and-criteria> [accessed 4 Dec. 2018].
- IUCN (2017) Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. Prepared by the Standards and Petitions Subcommittee. Available from <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> [accessed 4 Dec. 2018].
- Linnaeus C. Filius (“1781” [1782]) *Supplementum Plantarum*. *Brunsvigae* [Braunschweig], *Impensis orphanotrophi*. <https://doi.org/10.5962/bhl.title.555>

- Mouly A., Kainulainen K., Persson C., Davis A.P., Wong K.M., Razafimandimbison S.G., Bremer B. (2014) Phylogenetic structure and clade circumscriptions in the Gardenieae complex (Rubiaceae). *Taxon* 63: 801–818. <https://doi.org/10.12705/634.4>
- Persson C. (1996) Phylogeny of the Gardenieae (Rubiaceae). *Botanical Journal of the Linnean Society* 121: 91–109. <https://doi.org/10.1111/j.1095-8339.1996.tb00746.x>
- Persson C. (2000a) Phylogeny of Gardenieae (Rubiaceae) based on chloroplast DNA sequences from the rps16 intron and trnL(UAA)–F(GAA) intergenic spacer. *Nordic Journal of Botany* 20: 257–269. <https://doi.org/10.1111/j.1756-1051.2000.tb00742.x>
- Persson C. (2000b) Phylogeny of the Neotropical Alibertia group (Rubiaceae), with emphasis on the genus Alibertia, inferred from ITS and 5S ribosomal DNA sequences. *American Journal of Botany* 87: 1018–1028. <https://doi.org/10.2307/2657002>
- Persson C.H., Delprete P.G. (2017) The Alibertia group (Gardenieae – Rubiaceae) – part 1 (Agouticarpa, Alibertia, Cordiera, Melanopsidium, Riodoceia, and Stenosepala). *Flora Neotropica Monograph*, vol. 119. New York, New York Botanical Garden Press.
- Steyermark J.A. (1974) Rubiaceae. In: Lasser T., Steyermark J.A. (eds) *Flora de Venezuela*, vol. 9, parts 1–3. Caracas, Instituto Botánico, Ministerio de Agricultura y Cría.
- Taylor C.M., Steyermark J.A., Delprete P.G., Vicentini A., Cortés R., Zappi D., Persson C., Costa C.B., Anunciação E.A. (2004) Rubiaceae. In: Steyermark J.A., Berry P.E., Yatskievych K., Holst B.K. (eds) *Flora of the Venezuelan Guayana*, vol. 8: 497–847. St. Louis, Missouri Botanical Garden Press.
- Thomas W.W., Barbosa M.R.V. (2008) Natural vegetation types in the Atlantic coastal forest of Northeastern Brazil. *Memoirs of the New York Botanical Garden* 100: 6–21.
- Veloso H.P., Rangel Filho A.L., Lima, J.C.A. (1991) *Clasificación da Vegetação Brasileira, Adaptada a um Sistema Universal*. Rio de Janeiro, Fundação Instituto Brasileiro de Geografia e Estatística (IBGE).
- Vinha S.G. da, Ramos T.J.S., Hori M. (1976) Inventário Florestal. In: Gouveia J.B.S., da Vinha S.G. (eds) *Diagnóstico Socioeconômico da Região Cacaueira*, vol. 7: 10–212. Ilhéus, Bahia, Comissão Executiva do Plano da Lavoura Cacaueira and Instituto Interamericano de Ciências Agrícolas–OEA.
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Appendix 1 – Selected herbarium specimens of *Amaioua intermedia* and *A. glomerulata* analysed for this study.

Amaioua intermedia

Brazil: Bahia: Uruçuca, estrada de Serra Grande para Uruçuca, mata da torre do celular, 14°29'59"S, 39°06'54"W, 380 m, 18 Mar. 2004, *Fiaschi et al.* 2052, female fl (CEPEC, NY); Camacã, RPPN Serra Bonita, 9.7 km W de Camacã na estrada para Jacareci, ramal para a RPPN, ca. 6 km da entrada, 15°23'30"S, 39°33'55"W, 850 m, 18 Mar. 2005, *Fiaschi et al.* 2859, fr (CEPEC, NY). **Distrito Federal:** Reserva Ecológica do IBGE, Córrego Monjolo, 15°57'S, 47°53'W, 25 Sep. 1989, *Alvarega & Oliveira* 463, fr (IBGE); Bacia de São Bartolomeu, 24 Jan. 1980, *Herlinger et al.* 3192, male fl (IBGE, NY); Parque Municipal do Gama, cachoeira do parque, 10 Mar. 1972, *Herlinger* 11218, fr (UB [2]); Fazenda Água Limpa (UnB Field Station), near Vargem Bonita, 27 Oct. 1976, *Ratter et al.* 3853, fr (NY, UB [2]). **Goiás:** Mun. Formosa, Lagoa Feia, floresta sempreverde na beira da lagoa (do lado da cidade), 15°34'15"S, 47°18'16"W, 930 m, 27 Dec. 2007, *Delprete & Silva* 10551, fl (CAY, RB, UFG). **Minas Gerais:** Itabirito, Condomínio Aconchego da Serra, 20°15'S, 43°57'W, 15 Apr. 1999, *Lombardi & Stehmann* 2742, imm fr (NY). **Paraná:** Guaraqueçaba, Rio do Cedro, 14 Dec. 1967, *Hatschbach* 18130, female fl (MBM, MO). **Rio de Janeiro:** Itatiaia, Parque Nacional do Itatiaia, Maromba, trilha para a Cachoeira Itaporani, 22°28'00"S, 44°34'44"W, 1050 m, 11 Sep. 1995, *Silva Neto et al.* 778, imm fr (CEPEC, K, NY). **Santa Catarina:** Presidente Nereu, Sabiá, 600 m, 26 Dec. 1953, *Reitz & Klein* 1412, fl (HBR, NY, US); Ibirama, Horto Florestal I.N.P., 300 m, 2 Mar. 1954, *Reitz & Klein* 1664, fr (HBR, NY, US).

Amaioua glomerulata

Mexico: Chiapas: Mun. Las Margaritas, W side of Laguna Miramar E side of San Quintín, 16°23'39"N, 91°17'48", 350 m, 11 Feb. 1973, *Breedlove* 33144, fr (MO, NY). **BELIZE:** Belize District, Belize Zoo, savanna plot immediately behind zoo, mile 31 on Western Highway, 15 m, 18 Jun. 1993, *Walker & Meadows* 157, fl (NY); along Manatee (or Coastal) Highway, 5.1 miles SE of turnoff from Western Hwy, at La Democracia, 1 Jun. 1996, *Nee* 46894, fl (MO, NY).

Honduras: Atlántida: Campamento Quebrada Grande, ca. 10 km SW of La Ceiba, base of N slope of Pico Bonito, from camp to 2 km E of camp, 15°42'N, 86°51'W, 80–180 m, 10 May 1993, *Liesner* 26181, fr (MO). **NICARAGUA:** Comarca de El Cabo, Río Leicus, 28 km SW of Waspan, 66 m, 25 Aug. 1965, *Molina* 15200, female fl (NY).

Guatemala: Izabal, Sto. Tomás de Castilla, ca. 30 km SW of town, Sinai, 15°39'N, 88°35'W, 15 Mar. 1988, *Marshall et al.* 396, fr (MO, NY).

Panama: Panama: Las Perlas, San José Island, 19 Jul. 1967, *Stimson* 5328, male fl (NY).

Cuba: Isle of Pine, San Pedro and vicinity, 12 Feb.–22 Mar. 1916, *Britton & Wilson* 14300, fl (MO, NY).

Trinidad and Tobago: Aripo Road, 17 Dec. 1926, *Broadway* 6443, fl (MO).

Colombia: Chocó: Riosucio, Parque Nacional Los Catiós, near Tilupo, 250–260 m, 30 May 1976, *Forero et al.* 1698, fr (MO).

Venezuela: Zulia: Ditrío Colón, forested slopes at the settlement of Río de Oro along Río de Oro, along Venezuelan-Colombian Border, 9°18'N, 72°29'W, 30–150 m, 26 Jun. 1980, *Davidse et al.* 18634, male fl (MO, VEN).

Guyana: Kanuku Mountains, Rupunini River, Crabwood Creek, 29 Jun. 1995, *Jansen-Jacobs et al.* 4278, fr (CAY, GB, NY); Rupunini District, Kuyuwini Landing, Kuyuwini River, 10 Oct. 1992, *Jansen-Jacobs et al.* 2832, imm fr (CAY, MO, NY, U).

Suriname: Mapane Creek, area near camp 8, 21 Jan. 1956, *Schulz* 7548 (NY, U).

French Guiana: Sinnamary, Brigandin, 26 Mar. 1993, *Puig* 12055, imm fr (CAY); basse Crique Courouaie (affluent du basse Approuague), a 5 km amont des Deux Fourches, 15 Jan. 1970, *Oldeman* B-2766, imm fr (CAY).

Brazil: Amazonas: Manaus, Estrada Taruma, near Ponta Negra, 10 Jan. 1967, *Prance* 3922, fr (MO, NY).

Peru: San Martín: Mariscal Cáceres, Distrito Tocache Nuevo, Puente Palo Blanco (Río Tocache), 10 km W of Tocache Nuevo, on road to Puerto Pizana, 08°14'S, 76°35'W, 550–650 m, 12 Dec. 1981, *Plowman et al.* 11342, fl (MO).