



Novelties in South American *Garcinia* (Clusiaceae): Tying loose ends across biomes

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ABSTRACT

We present two taxonomic novelties in *Garcinia* (Clusiaceae): a new species to the Brazilian Atlantic Forest, *Garcinia bahiensis* Mouzinhos & L.Marinho sp. nov. ined., endemic to the hygrophilous forests of southern Bahia state, whose specimens were previously determined as *G. macrophylla* Mart.; and the redescription of *G. guacopary* (S.Moore) M.Nee, a species distributed in the transition areas between the Amazon and Cerrado domains that were neglected in previous studies. The taxonomic treatment consists of morphological descriptions, photographic plates, distribution maps, and morphological discussions with related species. Regarding *G. guacopary*, we present images of live specimens and their current known distribution for the first time, with a considerable range expansion, besides the designation of a lectotype. After *G. bahiensis* description, segregated from a broader *G. macrophylla* concept, *Garcinia* no longer shares species between the Amazon and Atlantic Forest domains.

Keywords: Atlantic Forest, bacuripari, new species, taxonomic novelty, typification.

Introduction

Garcinia L. (Clusiaceae: Garcinieae) is a pantropical genus with approximately 250 species, organized into 11 sections based on floral morphology (Gaudeul *et al.*, 2024). Neotropical *Garcinia* species are grouped into *Garcinia* sect. *Rheediopsis* Pierre, whose species have a unique floral pattern in pistillate and staminate flowers (Jones, 1980; Gaudeul *et al.*, 2024). New taxonomic perspectives have recently been presented in South America for the sect. *Rheediopsis*, highlighting new diagnostic characters, nomenclatural issues, and, consequently, new species (Mouzinhos *et al.*, 2022; 2023).

In Brazil, the taxonomy of *Garcinia* was based mainly on the morphology of the epicarp to delimit the species, with the epicarp being smooth or ornamented (muricate and equinate) (Planchon & Triana, 1860; van den Berg, 1979; Mouzinhos, 2022). Currently, 12 species are reported in Brazil, ten from the Amazon and two from the Atlantic Forest (Mouzinhos, 2022). Among the Brazilian species, eight species bearing smooth epicarp fruits are mentioned: *G. albuquerquei* (M.E.Berg) Bittrich, *G. apostoloi* Mouzinhos, *G. brasiliensis* Mart., *G. fluviatilis* Mouzinhos & L.Marinho, *G. guacopary* (S.Moore) M.Nee, *G. gardneriana* (Planch. & Triana) Zappi, *G. leptophylla* Bittrich, and *G. macrophylla* Mart. Of these species, *G. macrophylla* has a wide distribution

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and present commercial appeal due to the edible fruits (van den Berg, 1979; Muniz, 2024; Rabelo, 2012; Medellín-Zabala, 2015). However, Mouzinho (2022) reported that specimens attributed as *G. macrophylla* in Brazilian herbaria represented more than one taxon.

Here, we describe a new taxon for the Brazilian Atlantic Forest, *G. bahiensis* Mouzinho & L. Marinho sp. nov., whose specimens were also commonly determined as *G. macrophylla*. Furthermore, an unprecedented taxonomic treatment is presented for *G. guacopary*, a species with wide distribution in the Amazon, including ecotonal areas in the Cerrado limits, but neglected in previous treatments.

Materials and methods

Specimens from the CEPEC, IAN, INPA and NY herbaria were analyzed (acronyms follow Thiers, 2024) in addition to images available in databases such as SpeciesLink (<https://specieslink.net/search/>) and REFLORA (<http://reflora.jbrj.gov.br/>), especially collections of F, HUEFS, RB, UB, UEC and UESC. The terminologies used for vegetative characters were from Radford *et al.* (1974), venation terminology follows Ellis *et al.* (2019) and the shape of the floral parts and fruits follows Gonçalves & Lorenzi (2011), followed by the specific literature of Mouzinho (2022). Maps were prepared using the SimpleMappr online tool (Shorthouse, 2010). Preliminary conservation status was assessed through the GeoCAT application (Bachman *et al.*, 2011), based on the B criteria and the respective IUCN categories (see IUCN, 2012).

Results

Taxonomic treatment

Garcinia bahiensis Mouzinho & L. Marinho, sp. nov. (Figs. 1, 2, 3)

Type: Brazil, Bahia: Una, Ramal que liga a BA 265 (Rod. Una Rio Branco) à BR 101 (São José), a 8 km SW do cruzamento e a 20 km NW de Una em linha reta, 27 February 1978 (fr), S.A. Mori *et al.*, 9324 (Holotype: CEPEC [no. 13165]; Isotypes: NY [barcode NY00477266!], SPF [barcode SPF00230838 image!])

Garcinia bahiensis is similar to *G. macrophylla* but differs by the arched secondary veins close to the margin of the leaf blade (*vs.* straight in *G. macrophylla*), staminate flower buds slightly apiculate (*vs.* non-apiculate in *G. macrophylla*), staminate flowers with oblong internal petals (*vs.* rounded-obovate in *G. macrophylla*), berries without a rostrum (*vs.* rostrate in *G. macrophylla*) and constricted stigma with undefined lobes (*vs.* tetra-pentalobed in *G. macrophylla*).

Trees up to 15 m tall; stems with brown fissured rhytidome; yellow exudate after cutting, slowly expelled in drops with a sticky texture; pink sapwood and yellow

heartwood; branches cylindrical, smooth; yellow exudate; petioles 12.8–25.2 (–27.7) mm long, transversely striated; dilatation of the base of the petiole evident, deltoids *in sicco*. Leaf blades 15.3–22 × 6–8.5 cm, chartaceous, discolorous, dark brown *in sicco*, shiny on the adaxial surface, elliptical to elliptical-ovate, apex attenuated, base attenuated to acute; secondary veins ≥ 20 pairs, arched to branched near the margin; inter-secondary veins parallel to the secondary ones, 2–3 pairs per intercostal area, reticulated near the margin; intramarginal vein inconspicuous; exudate canals inconspicuous. Inflorescence staminate axillary, fasciculate, bracteoles 2; pedicels 11.2–12.1 mm long, greenish. Flower buds 3–3.8 × 3–3.5 mm, greenish, globose, slightly apiculate. Staminate flowers with mild aroma; sepals 2, 3.9–4.2 × 2.8–3.3 mm, greenish, fleshy, deltoid; petals 4, white, chartaceous to membranaceous, concave, outer ones 4.8–5.8 × 2.2–3.6 mm, rounded-oblong, inner ones 6–6.7 × 2.1–3.2 mm, oblong; nectary disc ca. 3 mm diameter, light yellow, globose; stamens 20–25 per flower, arranged around the disc in 2 series; filaments 2.2–3 mm long, terete, hyaline; anthers ellipsoid, white, light yellow when senescent, thecae 0.38–0.53 × 0.25–0.34 mm. Inflorescence and pistillate flowers not seen. Berries with smooth epicarp; sepals, staminodes, and stigmas persistent; when mature 34–43 × 33.3–41.2 mm, orange, globose, rostrum absent; stigma constricted ca. 2 mm diameter, discoid, lobes not defined; pedicels 8–10 mm long. Seeds 2–3 ca. 19.5 × 9.6 mm, ellipsoid.

Etymology: The epithet was designated due to its known distribution being restricted to the state of Bahia (Brazil).

Suggested vernacular name: bacuri-da-Bahia (Mouzinho, T.M. 506).

Distribution and attributed conservation status: *Garcinia bahiensis* is endemic to Brazil and restricted to the southern part of the state of Bahia. The species occurs in areas called hygrophilous forests, corresponding to evergreen rainforest formations (*Floresta Ombrófila Densa*), according to the official Brazilian vegetation classification system (IBGE, 2012) (Fig. 4). The preliminary conservation status of *G. bahiensis* is Vulnerable (VU, B1a + B2a) based on the extent of occurrence (EOO) of 5,811 km² and the area of occupancy (AOO) of 28 km² (IUCN, 2012). Although restricted to southern Bahia, there are occurrences in protected areas such as the Serra do Conduru State Park (Uruçuca municipality) and a subpopulation observed in the Pedra do Sabiá Private Natural Heritage Reserve (Itacaré municipality).

Specimens examined (Paratypes): BRAZIL. Bahia: Rodovia Itabuna-Ilhéus, 05 April 1965 (fl ♂), R.P. Belém & M. Magalhães 668 (IAN!, UB image!); Mun. Almadina, Fazenda São José, Serra do Corcovado, 14°42'0"S, 39°38'0"W Alt: 400–850 m, 23 November 2014 (fl ♂), L.C. Marinho *et al.*, 918 (CEPEC!, HUEFS!); Mun. Camamu, Rodovia BA 650, Fazenda Zumbi dos Palmares, 14°0'68"S, 39°10'70"W, 12 November 2003 (fl ♂), J.L. Paixão *et al.*, 278 (CEPEC!, NY!); Mun. Igrapiúna, Reserva Ecológica das Plantações



Figure 1. Holotype CEPEC [no. 13165] of *Garcinia bahiensis* Mouzinhos & L. Marinho housed at the CEPEC herbarium.



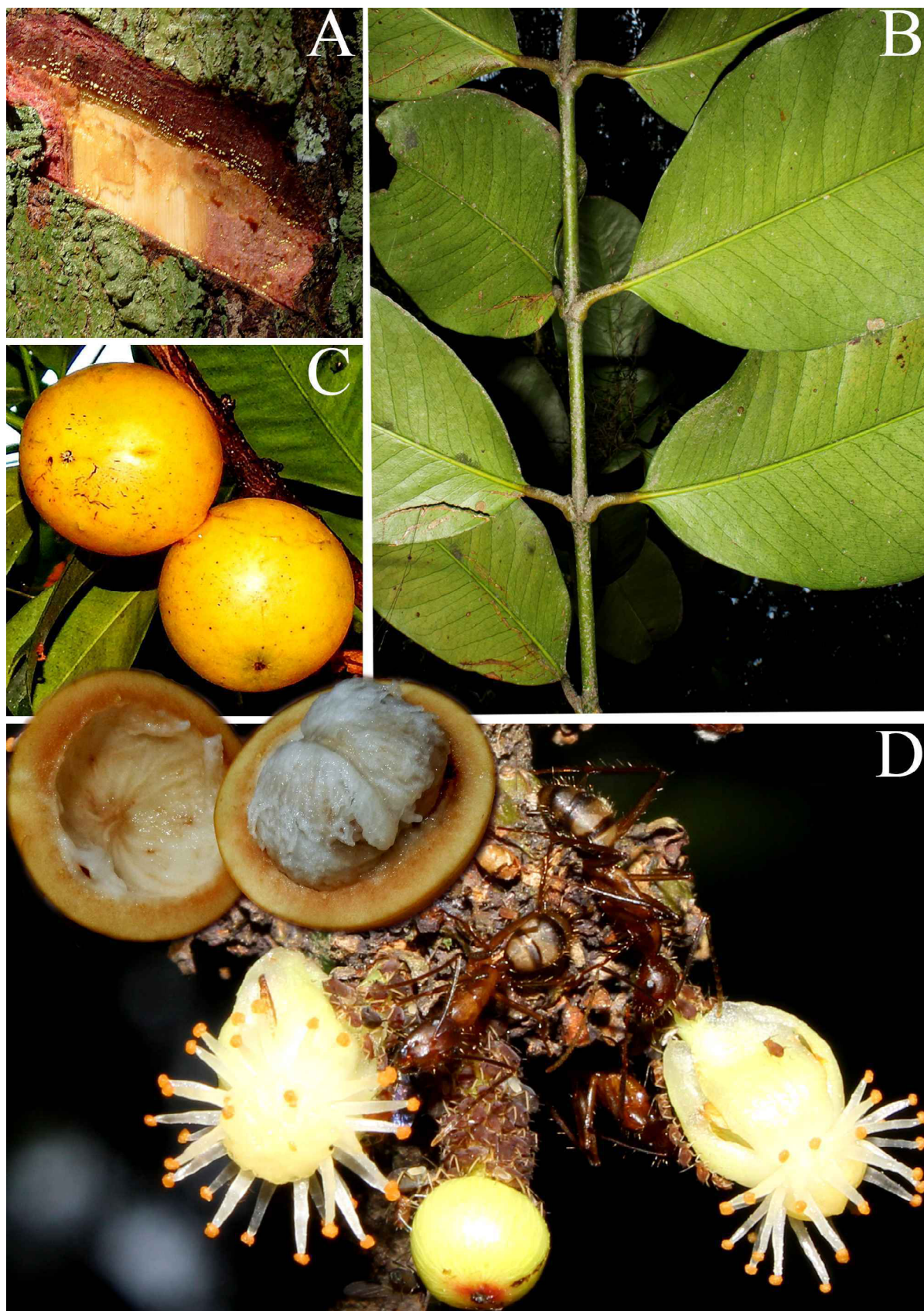


Figure 2. *Garcinia bahiensis*. **A.** Slashed trunk, exudate slowly expelled in drops. **B.** Branch showing the abaxial leaves surfaces. **C.** Fruits, in section showing information about the pericarp. **D.** Staminate inflorescence in fascicle, flowers visited by ants (*Campanotus* sp.). Images: A-C Alex Popovkin. B-D Thiago Mouzinho.

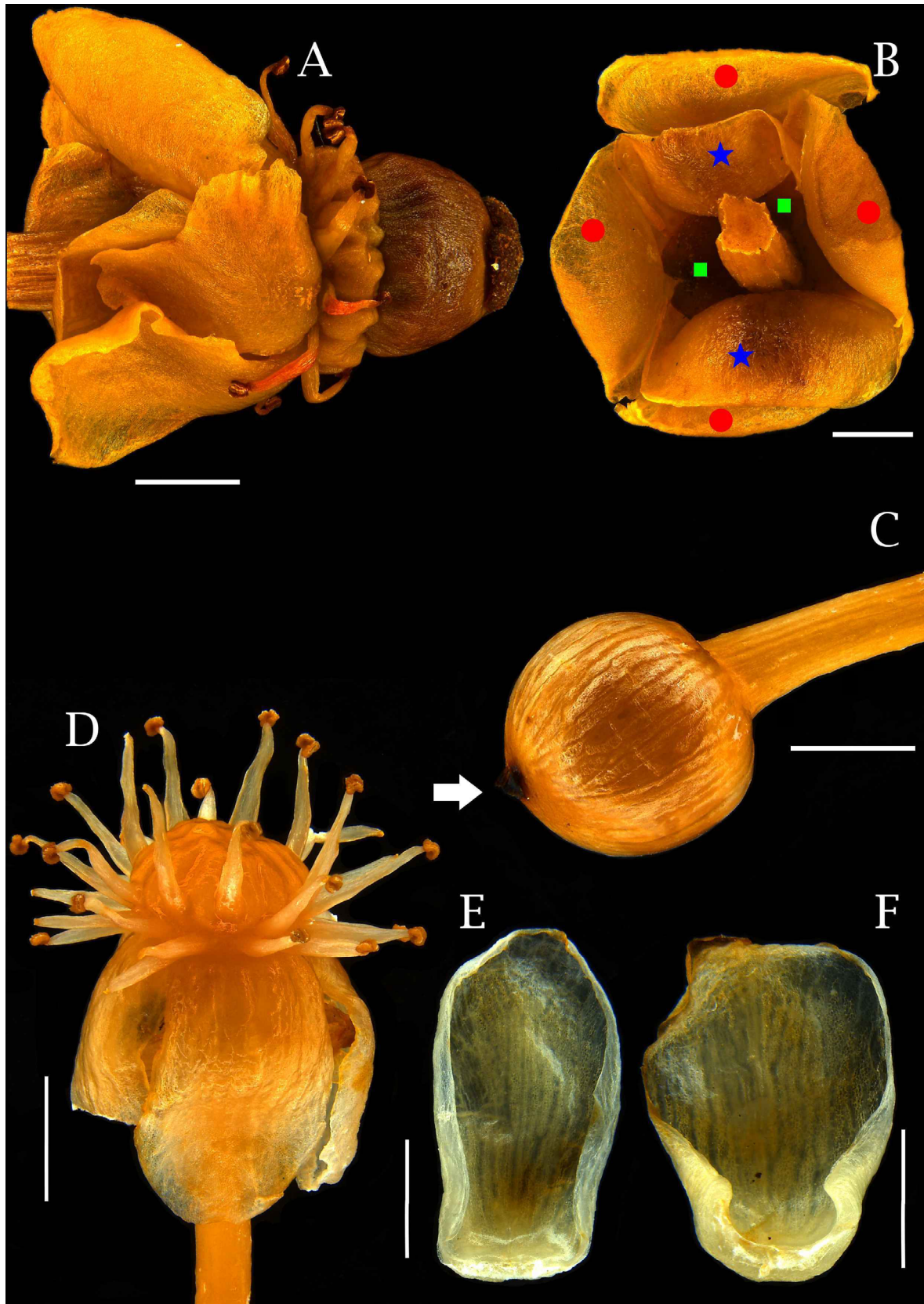


Figure 3. Floral morphology of *Garcinia guacopary* (preserved in alcohol). **A.** Pistillate flower. **B.** Organization of the perianth (abaxial view): sepals (green square), outer petals (blue star), and inner petals (red circle). Floral morphology of *Garcinia bahiensis* (preserved in alcohol). **C.** Staminate floral bud, arrow pointing to the apex. **D.** Staminate flower. **E.** Inner petal. **F.** Outer petal (scale = 2 mm). Images: Thiago Mouzinho.



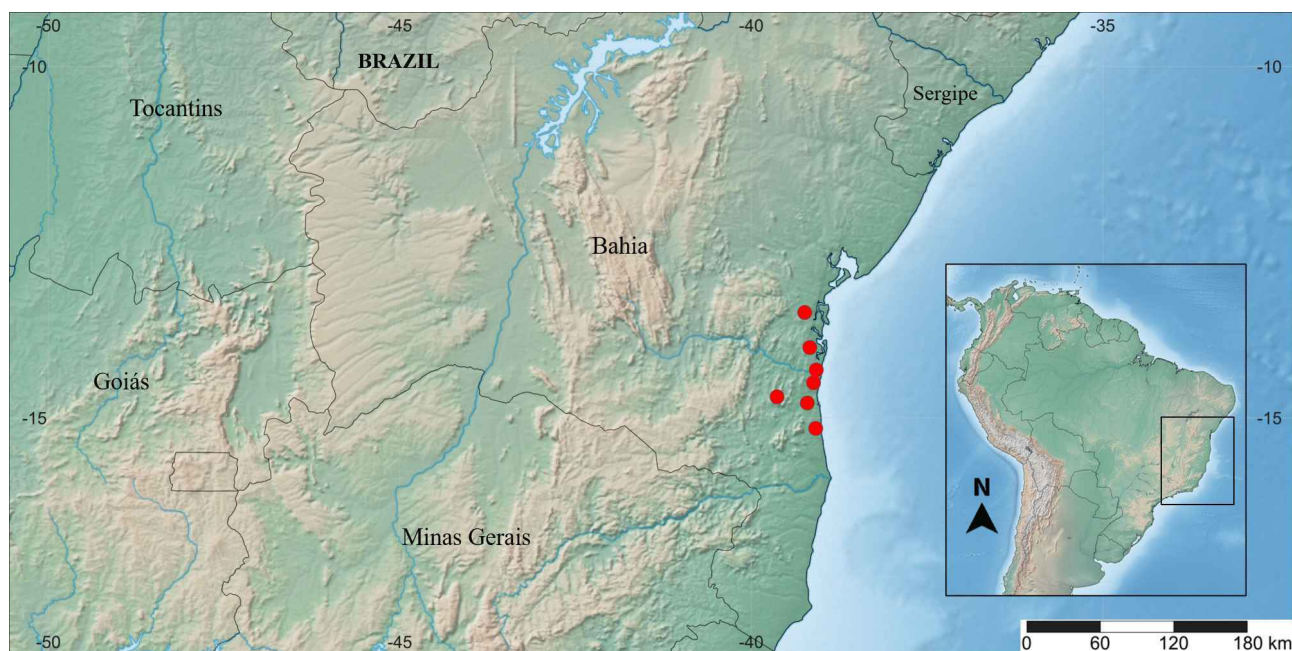


Figure 4. Distribution map of *Garcinia bahiensis* in Bahia state, Brazil.

Michellin da Bahia, 01 December 2010 (fr), J.L. Paixão & L. Rocha 1857 (CEPEC!, HUEFS image!, UESC image!); Mun. Itacaré, 14°19'09.2"S 39°04'54.0"W, Reserva Particular do Patrimônio Natural Pedra do Sabiá, 11 October 2023 (st), T.M. Mouzinho 506 (INPA!); Mun. Una, Reserva Biológica do Mico-Leão, 15°09'S, 39°05'W, 01 May 1996 (fr), J.G. Jardim *et al.*, 820 (CEPEC!, NY!); Mun. Uruçuca, Parque Estadual Serra do Conduru, 14°29'59"S, 39°6'54"W Alt: 380 m, 21 April 2004 (st), A.M. Amorim *et al.*, 3986 (CEPEC!); Mun. Valença, 13°29'59"S, 39°14'23"W, 04 September 2014 (st), M.G.C. Nogueira 353 (CEPEC!).

Notes: The specimens treated here as *Garcinia bahiensis* were previously identified as *G. macrophylla* (see the diagnosis). In relation to other species from the Atlantic Forest, *G. bahiensis* differs from *G. brasiliensis* due to the deltoid dilation of the base of the petiole (vs. oblong in *G. brasiliensis*), leaf blades with a chartaceous texture (vs. coriaceous), staminate flowers with oblong internal petals (vs. rounded) and concresced stigmas with undefined lobes (vs. trilobed). While in *G. gardneriana*, *G. bahiensis* can be recognized also by the deltoid dilation at the base of the petiole (vs. oblong in *G. gardneriana*), inconspicuous exudate canals (vs. conspicuous), globose fruits with an absent rostrum (vs. ovoid) (vs. ovoid with a rostrum).

Garcinia guacopary (S.Moore) M.Nee, Monogr. Syst. Bot. Missouri Bot. Gard. 127: 1271 (2014). (Figs. 3, 5, 6).

Type: Brazil, Mato Grosso: Santa Cruz [currently Barra do Bugres; see comments], September 1891 (fr), S.L. Moore 332 (**Lectotype, designated here:** BM [barcode BM000583029 image!]; isolectotype: NY [barcode NY00076032 image!]).

≡ *Rhedia guacopary* S.Moore, Trans. Linn. Soc. London, Bot. 4(3): 310 (1895).

Shrubs or trees up to 10 m tall; stem with brown fissured rhytidome; yellow exudate after cutting, expelled slowly in drops, sticky texture; pink sapwood and yellow heartwood. Branches cylindrical, smooth in sicco texture, with longitudinal striations; petioles 4.3–13.6 mm long, slightly transversely striated in sicco; dilation of the base of the petioles oblong in sicco; greenish-yellow exudate. Leaf blades 5.2–13.4 × 3–6.8, chartaceous, discolorous, greenish in vivo and generally brown in sicco, opaque on the abaxial surface in sicco, elliptical to elliptical-ovate, rarely obovate, apex acuminate-apiculate, base attenuated, slightly sinuous margin; secondary veins < 20 pairs, branched near the margin; inter-secondary veins parallel to secondaries; 2–3 pairs per intercostal area; intramarginal vein conspicuous; exudate canals inconspicuous. Inflorescences and staminate flowers not seen. Inflorescence pistillate axillary, fasciculate, bracteoles 2; pedicels 7.5–12.1 mm long, reddish in vivo. Flower buds ca. 4.5 × 3.7 mm, greenish, globose. Pistillate flowers with a mild aroma; sepals 2, 2.4–3 × 2.4–3.3 mm, greenish, concave, fleshy, rounded; petals 4–6, white with greenish nuances, chartaceous to membranaceous, concave, 2 outer petals 4.8–5.1 × 4–6.3 mm, rounded; 2–4 inner petals 6–6.8 × 4, 7–6.1 mm, obovate; nectary disc annular 4–4.4 mm diameter, yellow; staminodes ca. 15 per flower, arranged in 1 series; filaments 1.8–2.5 mm long, hyaline, terete; rudimentary anthers ellipsoid, yellow, rusty when senescent; thecae 0.49–0.54 × 0.27–0.38 mm; ovary 2.1–2.7 × 3.8–4.1 mm, green, globose; carpels 3, 3 locules 0.58–0.67 mm diameter in cross-section, 1 ovule per locule; stigma 2.3–3 mm diameter, white, slightly capitate, three-lobed. Berries with smooth epicarp, greenish-yellow exudate, abundant; sepals, staminodes, and stigmas persistent; when mature ca. 35 × 32 mm, yellow to orange, globose, epicarp with a



Figure 5. Lectotype (BM000583029) of *Garcinia guacopary* (S. Moore) M. Nee deposited in the BM herbarium.



slightly rigid texture, white endocarp, white mesocarp, taste acid-sweet; rostrum 2–3 mm long; concreted stigma ca. 3 mm diameter, three-lobed. *Seeds* 2–3, ellipsoid.



Figure 6. *Garcinia guacopary*. **A.** Leaf blade. **B.** Detail of the pistillate inflorescence. **C.** Ripe fruit. **D.** Pistillate flower and immature fruit. Images: Thiago Mouzinho.

Vernacular name: azedinho (como “azeidinho”; português) (Ratter 4456 – F).

Distribution and conservation status: *Garcinia guacopary* occurs in Bolivia (Departments of Beni and Santa Cruz) and Brazil (states of Maranhão, Mato Grosso, Mato Grosso do Sul, Pará and Tocantins). *Garcinia guacopary* is distributed in transition areas between the Amazon and Cerrado/Chaco in Brazil and Bolivia and the Bolivian Yungas and humid and seasonally dry forests, but always associated with rivers and small streams (Fig. 7). In the Bolivian Plant Catalog (<http://www.tropicos.org/Name/50295510>; Jørgensen *et al.*, 2014), there is a citation of specimens for the department of La Paz, but this occurrence cannot be confirmed, since the images of the specimens could not be accessed. The preliminary conservation status of *G. guacopary* was assessed as Least Concern (LC) based on the broad range of occurrence (EOO) of 957,946 km² and area of occupancy (AOO) of 32 km² (IUCN, 2012).

Specimens examined: BOLIVIA. Beni: Estación Biológica del Beni, 14°45'S, 65°40'W Alt: 200 m, 30 September 1988 (fl/ fr), D.E. Williams 714 (NY image!); Santa Cruz: Toledo, 14°42'S, 61°09'W Alt: 160 m, 09 June 1994 (fr), R. Guillén & V. Choré 1776 (F image!). BRAZIL. Maranhão: Mun. Monção, 08 October 1987 (st), C. Monteiro *et al.*, 22 (HUEFS image!, RB!); Mato Grosso: Mun. Barra do Garças, 12 June 1966 (fl ♀), D.R. Hunt 5965 (NY!); Mun.

São Félix do Araguaia, 11°34'S, 50°43'W, 07 October 1985 (fr), W. Thomas *et al.*, 4253 (NY!); Rio Tapirapê, 27 October 1978 (fr), N.T. Silva 4910 (NY!); Mato Grosso do Sul: Mun. Corumbá, Fazenda Santa Tereza, 18°16'28"S, 57°25'15"W, 28 September 2010 (fr), G. Martinelli 16612 (RB! SPF image!); Pará: 03°53'S, 49°41'W, 01 November 1981 (fr), D.C. Daly *et al.*, 1146 (NY!); *ibidem*, 14 November 1981 (fr), D.C. Daly *et al.*, 1327 (NY!); *ibidem*, 07 April 2023 (fl/fr), T.M. Mouzinho 331 (IAN!, INPA!); Tocantins: Parque Nacional do Araguaia, 10°30'S, 50°30'W (fr), J.A. Ratter *et al.*, 4456 (NY!); Mun. Caseara, Parque Estadual do Cantão, 09°15'13"S, 49°50'53"W, 15 January 2000 (fr), P.E. Nogueira *et al.*, 655 (UEC image!); Mun. Formoso do Araguaia, 11°27'56"S, 49°42'04"W, 07 October 2008 (fr), R.C. Mendonça *et al.*, 6153 (UEC image!).

Notes: In taxonomic revisions for Brazil (van den Berg, 1979; Mouzinho, 2022) *Garcinia guacopary* was not treated. In the current monograph of the genus for the Flora of Brazil (Muniz, 2024), *G. guacopary* was considered as not validly published.

Specimens of *G. guacopary* from the Amazon were commonly determined as *G. brasiliensis*. However, *G. brasiliensis* is restricted to the Atlantic Forest domain (Mouzinho *et al.*, 2022). Among the Amazonian species with smooth epicarps, *G. guacopary* is similar to *G. fluvialis* Mouzinho & L. Marinho but differs by the leaves with apiculate apex (*vs.* non-apiculate in *G. fluvialis*), conspicuous intramarginal vein (*vs.* inconspicuous), capitate stigma (*vs.* discoid), rostrum present (2–3 mm) (*vs.* absent), and a coneresced trilobate stigma (*vs.* lobes not defined).

The organization of the six petals reported for pistillate flowers in *G. guacopary* is not by the floral pattern that corresponds to other *Garcinia* species in the neotropical region, as mentioned in the studies of Jones (1980), van den Berg (1979), Sweeney (2008), Medellín-Zabala (2015), Mouzinho (2022), and Gaudeul *et al.* (2024). These studies indicated that neotropical species had a homogeneous morphology, with four petals, rarely five (Gaudeul *et al.*, 2024), being one of the morphological characteristics that distinguished them from other related African species (*e.g.* *G. commersonii* [Planch. & Triana] Vesque), which have five petals. Mouzinho (2022) elucidated the organization of the corolla in *Garcinia* as external and internal petals, being structured in pairs and decussate. In contrast, in the pistillate flowers of *G. guacopary*, there are 4 to 6 petals; these are organized into 2 external and 4 internal (Fig. 6). Considering it is a genus of dioecious plants, it is essential to investigate the staminate flowers of *G. guacopary*, not presented in this treatment, as well as to investigate in depth the evolution of floral morphology in a phylogenetic context, work that is in progress (Mouzinho, 2022).

The syntypes cited by Moore in the protologue of *G. guacopary* (Moore 332, 365, and 467; Moore, 1895) are all deposited at the BM herbarium, where most of his

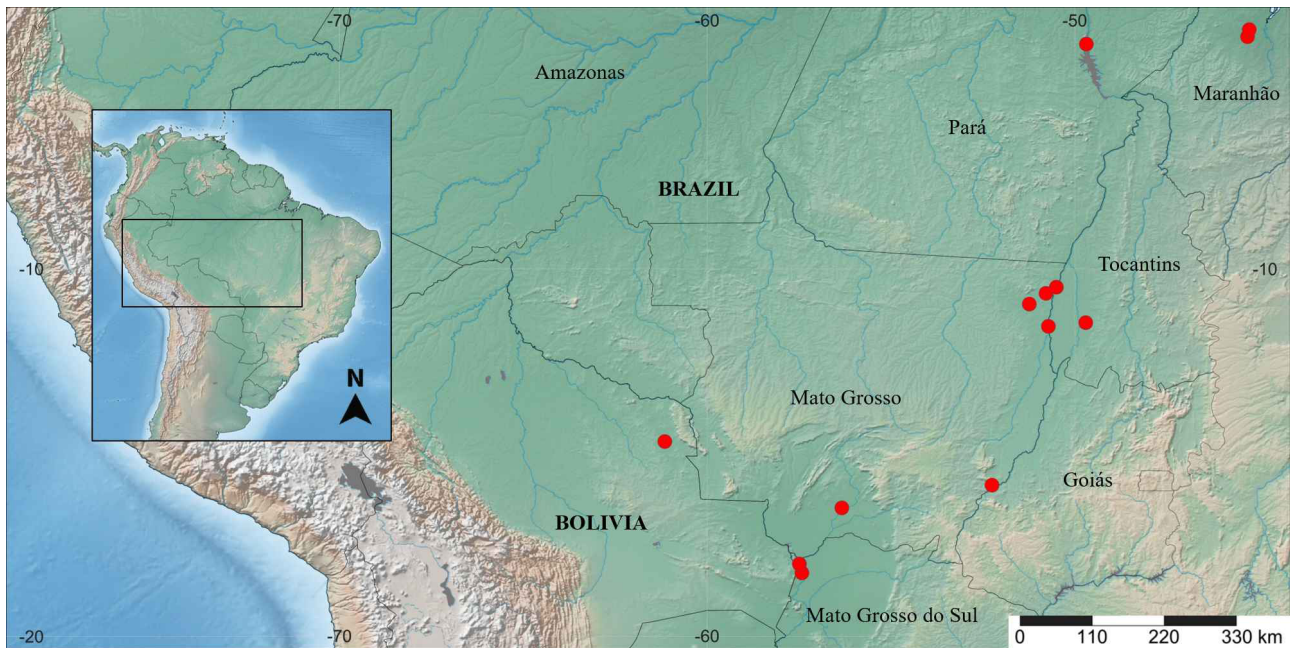


Figure 7. *Garcinia guacopary* distribution map.

collections are housed. The tree branchlets representing the three collections are all mounted on the same sheet but have their own label and barcode. The collection Moore 332 (BM000583029) is the only one bearing reproductive parts (fruits) attached to the branchlet and the only one with a known existing duplicate (NY00076032) and therefore is here chosen as the lectotype. It is important to notice that, although the name was previously cited to Bolivia (<http://www.tropicos.org/Name/50295510>; Jørgensen *et al.*, 2014) and neglected in treatments and floras from Brazil, the type is from the Brazilian state of Mato Grosso, reported to the village of “Santa Cruz” which is nowadays the municipality of Barra do Bugres and where the Bugres river flows into the Paraguay River. The collections from Moore are reported along the village of Santa Cruz, in the margins of the Paraguay River; to avoid confusion, the collections of Moore do not refer to the municipality of Santa Cruz de la Sierra in Bolivia, and no record is known to Paraguay thus far.

Discussion

In the treatments available for Brazil, the genus *Garcinia* had joint species between the Brazilian Amazon and Atlantic Forest domains, based on the species *G. brasiliensis*, *G. gardneriana*, *G. macrophylla*, and *G. madruno* that were considered to be widely distributed in the country (see van den Berg, 1979 and Muniz, 2024). However, studies have revealed that this wide distribution may correspond to taxa whose limits must be reevaluated, in the light of new morphological characters and from collections only recently available for analysis or capable of being accessed from high-resolution images. The proposal of *G. bahiensis*

in this work, as well as other taxa recognized as distinct in studies by Mouzinho *et al.* (2022; 2023), provide more accurate information on the biogeographic panorama of the genus in South America. In this context, a comprehensive taxonomic review of neotropical *Garcinia* species revealed that species previously treated as having a wide distribution, as occurs in other genera of Clusiaceae such as *Clusia* L. (e.g. *C. hoffmannseggiana* Schltdl., *C. nemorosa* G. Mey., *C. panapanari* [Aubl.] Choisy) and *Tovomita* Aubl. (e.g. *T. longifolia* [Rich.] Hochr and *T. mangle* G. Mariz) are in fact, taxa with a more restricted distribution. The redescription of the floral morphology of *G. guacopary*, a historically neglected taxon, emphasizes that the floral evolution of neotropical species must be better investigated, and the group may not be characterized by a homogeneous floral morphology as previously postulated (Jones 1980; Sweeney 2008; Medellín-Zabala 2015).

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INPA Herbarium Collection and its capabilities for Taxonomy Studies” (No. 31.18.0117.00). To the Research group “Taxonomia da Flora Amazônica” for support and access to the Plant Taxonomy Laboratory - INPA. To CNPq, for the funds granted to LLG (311416/2021-7, 408914/2023-8). To the curators Michael Hopkins (INPA), Jomar Jardim (CEPEC), and Helena Raiol Souza (IAN) for providing access to their respective collections. To the curators of the NY Herbarium Emily Sessa and Matthew Pace for granting the loans. To the Coordinator of the Living Collection of the Rio de Janeiro Botanical Garden, Marcus Nadruz, for the assistance and authorization in the collections in the Botanical Garden area. To Alex Popovkin for providing photos of *G. bahiensis*, to Luiz Adão for company in the field and access to his property in Belém (Pará), and to Lukas Daneu for assistance in the field in Bahia. To Sandra Knapp for providing access to literature and information about the types housed at BM herbarium.

Authors' Contributions

Thiago Mouzinho: Investigation; Methodology; Writing – original draft. Lucas Cardoso Marinho: Writing – review & editing. Leandro Lacerda Giacomini: Writing – review & editing; Funding acquisition; Project administration.

Conflict of Interest

The authors declare no conflict of interest

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