

# *Mitracarpus semirianus* (Spermacoceae, Rubiaceae), an overlooked new species from the “campo rupestre” of Bahia, northeastern Brazil, with notes on *Mitracarpus lhotzkyanus*

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**Background and aims** – *Mitracarpus semirianus*, an overlooked new species from the “campo rupestre” of the Chapada Diamantina, in the state of Bahia, northeastern Brazil, is here described and illustrated. Specimens of the new species have been previously identified as *M. frigidus* or *M. lhotzkyanus*, with which its distinction is discussed. We also provide an updated description of the latter, with notes on its type specimens. In addition, we comment on the distribution, habitat, and preliminary conservation status of both *M. semirianus* and *M. lhotzkyanus*. We also provide an updated identification key to the species of *Mitracarpus* occurring in Brazil.

**Material and methods** – This study was based on fieldwork collections and observations and analysis of specimens deposited in herbaria. Preliminary conservation status assessments follow the IUCN Red List criteria.

**Key results** – *Mitracarpus semirianus* differs from *M. frigidus* and *M. lhotzkyanus* by its glabrous stems, winged at each angle, wing margin hirsute, glabrous leaf blades, and the oblongoid and slightly compressed seeds, with a smooth longitudinal groove dorsally and an inverted “Y”-shaped groove ventrally. The new species is assessed as Endangered according to the IUCN criteria. Furthermore, it is more likely that Riedel, not Lhotzky, collected the original material of the name *M. lhotzkyanus*. This species is glabrate, not completely glabrous, presenting a generally strigose indumentum on the stems, stipular sheaths, and leaf blades.

**Keywords** – Espinhaço Range; morphology; Rubioideae; Spermacoce clade; taxonomy.

## INTRODUCTION

*Mitracarpus* is nested within the Spermacoce clade in the tribe Spermacoceae (Kårehed et al. 2008). Such a clade comprises the genera that have been traditionally associated with the Spermacoceae before the expansion of the tribe’s circumscription due to molecular phylogenies

(e.g., Andersson & Rova 1999; Bremer & Manen 2000; Kårehed et al. 2008). In the context of the Spermacoce clade, *Mitracarpus* can be characterized by the 4-lobed calyx with lobes in opposite pairs of longer and shorter ones, salverform to infundibuliform corolla, capsules with circumscissile dehiscence, and seeds with a distinct ventral groove, which can be quadrangular, rectangular, “X” or inverted “Y”-

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shaped (Dessein 2003; Souza et al. 2010; Nuñez Florentin et al. 2017). Nevertheless, its species are commonly mistaken for related genera such as *Borreria* G.Mey., *Diodia* L., *Hexasepalum* Bartl. ex DC. (= *Diodella* Small), *Richardia* L., *Spermacoce* L., and *Staelia* Cham. & Schltld. mainly due to vegetative similarities. This is particularly the case for herbarium material.

*Mitracarpus* comprises ca 50 species and is widely distributed in Central and South America, with two centres of diversity, the “West Indies” and Central Brazil (Dessein 2003; Souza et al. 2010). Although morphologically cohesive and generally well-supported in phylogenetic studies (Dessein 2003; Kårehed et al. 2008; Salas et al. 2015), only a few species have been investigated (up to five spp.), hence its monophyly, as well as its relationship to the remaining genera in the Spermacoce clade are yet to be tested. Besides, the taxonomic literature regarding the genus is fragmented in the form of regional treatments (Schumann 1888; Borhidi & Lozada 2007; Souza et al. 2010) and descriptions of new species (Steyermark 1978; Cabral et al. 2009, 2013). Hence, a modern revision of *Mitracarpus* in its entirety is urgently needed since its species are generally poorly defined (Dessein 2003).

The analysis of herbarium vouchers and field expeditions carried out in the Chapada Diamantina, which is the northern portion of the Espinhaço Range, located in the state of Bahia (Colli-Silva et al. 2019), have revealed specimens that could not be assigned to any described species in *Mitracarpus*. Such specimens have been identified either as *Mitracarpus frigidus* (Willd. ex Roem. & Schult.) K.Schum., for the revision of the genus in Brazil (Souza et al. 2010), or *Mitracarpus lhotzkyanus* Cham., for the checklist of vascular plants of Catolés (Zappi et al. 2003), respectively. Nevertheless, detailed analysis of these materials, as well as fieldwork observations and new collections in the Catolés region, led to the conclusion that these specimens represent a new species that is here described.

The Catolés region in the Chapada Diamantina is characterized by the predomination of the “campo rupestre” vegetation, which is a montane, grassy-shrubby, fire-prone vegetation mosaic associated with rocky outcrops of quartzite, sandstone, or ironstone, along with sandy, stony, and waterlogged grasslands (Silveira et al. 2016). This region encompasses ca 880 km<sup>2</sup> in the municipalities of Abaíra and Piatã, and more than 1,700 species of vascular plants, of which many are endemic and known to be new to science ever since early investigations (Zappi et al. 2003). The most species-rich families in the region are the Compositae, Leguminosae, Melastomataceae, Orchidaceae, and Rubiaceae (Zappi et al. 2003).

During our investigation, we also noted that the current morphological concept of *M. lhotzkyanus* does not cover the entire variation we observed, and that there is controversy regarding its type. Hence, we also provide an updated description of this species with notes on type specimens of this name. The distribution, habitat, preliminary conservation status, and taxonomy of both species are discussed. We also provide an updated identification key to the species of *Mitracarpus* occurring in Brazil.

## MATERIAL AND METHODS

This study was based on fieldwork collections and observations and the analysis of specimens deposited in herbaria. The ALCB, ESA, HUEFS, MBM, SP, SPF, and UEC herbaria were visited in person, while B, BR, E, F, G, GOET, HAL, HBG, K, L, MO, MPU, NY, P, R, RB, S, US, VEN, W, and YU were consulted online (acronyms following Thiers continuously updated). We analysed type specimens of all names associated with *Mitracarpus frigidus*, including all the infraspecific taxa, treated as synonyms or as distinct taxa, to assure that the investigated materials did not correspond to any of those and indeed belong to a new entity (supplementary file 1). Our search for these names and types was primarily based on the Tropicos (Tropicos 2021) and IPNI (IPNI 2021) databases, as well as the taxonomic literature on the genus (Schumann 1888; Steyermark 1972; Borhidi & Lozada 2007; Cabral et al. 2009, 2013; Souza et al. 2010). We followed Systematics Association Committee for Descriptive Biological Terminology (1962) and Simpson (2010) for general morphological terminology. Additionally, we followed Nuñez Florentin et al. (2017) for seed morphology.

A distribution map of both species treated here is presented. In general, we only used georeferenced records, but we used the coordinates of the municipalities of Cabo Frio, Niterói, and Rio de Janeiro, in the state of Rio de Janeiro, as proxies to complement the occurrences of *M. lhotzkyanus*. The extent of occurrence (EOO) and area of occupancy (AOO) were estimated using GeoCAT (Bachman et al. 2011), as preliminary conservation status was assessed by range size (B criterion), following the IUCN Standards and Petitions Committee (2019) recommendations.

We collected samples from herbarium material for scanning electron microscopy. These were fixed in formol-acetic acid-alcohol (FAA) and stored in 70% ethanol. The material was then critical-point dried, mounted on aluminium stubs with double-sided adhesive tape, and covered with 50 nm of gold in a Bal-Tec SCD 050 sputter coater. Samples were observed in a Jeol JSM 5800LV Scanning Electron Microscope, at 10kV, and imaged with SemAfore v.5.21 software at the “Laboratório de Microscopia Eletrônica”, Institute of Biology, the University of Campinas, São Paulo, Brazil.

## TAXONOMIC TREATMENT

***Mitracarpus semirianus*** J.A.M.Carmo & Scatigna, **sp. nov.** (figs. 1, 2, & 3A–H) – Type: BRAZIL • Bahia, Abaíra, Catolés, Serra do Barbado; entre 13°17'27"S, 41°54'06"W e 13°17'50"S, 41°54'29"W; 1750–2035 m; 26 Feb. 1994; fl., fr.; *P.T. Sano et al. 14579*; holotype: SPF[SPF95452]; isotypes: ESA[ESA24323], HUEFS[HUEFS104475], MO[MO3151114].

**Diagnosis** – *Mitracarpus semirianus* is similar to *M. frigidus*, but differs by the glabrous stems (vs puberulent to glabrous in *M. frigidus*), winged at each angle (vs ribbed at each angle), wing margin hirsute (vs rib margin hirsute, strigose, or glabrous); elliptic, ovate, or narrowly ovate leaf blades,

glabrous (vs narrowly ovate, rarely linear leaf blades, hirsute, pubescent, strigose, or glabrous); terminal glomerules, rarely one axillary (vs terminal and axillary, rarely just terminal); oblongoid, slightly compressed seeds (vs oblongoid to globose seeds), with a smooth longitudinal groove dorsally and an inverted “Y”-shaped groove ventrally (vs cruciform depression dorsally and an “X”-shaped groove ventrally). *Mitracarpus semirianus* is also similar to *M. lhotzkyanus*, but differs by the stems winged at each angle (vs ribbed at each angle), wing margin hirsute (vs rib margin strigose to glabrous), leaf blades with strigulose and revolute margin (vs glabrous to strigose margin and slightly revolute near the base), and the oblongoid, slightly compressed seeds (vs oblongoid to ellipsoid seeds), with an inverted “Y”-shaped groove on the ventral surface (vs a rectangular groove on the ventral surface).

**Description** – **Subshrubs**, 0.8–1.2 m tall, decumbent to erect. **Stems** branched, internodes 0.4–5.5 cm long, 2–4 mm wide, fistulous, tetragonal, glabrous, winged at each angle, wings 0.5–1 mm wide, margin hirsute, bark peeling from older internodes. **Stipular sheaths** 1.6–4.2 mm long, glabrous, persistent, 5–7-fimbriate on each side of the stem, fimbriae 0.2–1 cm long, narrowly triangular to linear, glabrous. **Leaves** sessile, axillary brachyblasts forming fascicles; blades 1.5–6.5 × 0.5–1.8 cm, elliptic, ovate or narrowly ovate, chartaceous to succulent, glabrous, base attenuate to rounded, margin strigulose and revolute, apex acute and apiculate; secondary veins 2–3 on each side of the midrib, impressed on the adaxial surface, rarely conspicuous on the abaxial surface. **Inflorescences** terminal glomerules, rarely one axillary, 0.9–1.3 × 1.1–1.7 cm, hemispheric; peduncles 1–9 cm long, 1.5–2 mm wide, tetragonal, glabrous, winged at each angle, wings ca 0.5 mm wide, margin ciliate, trichomes stiff; bracts 4, rarely 2 when axillary glomerule present, 2 larger and 2 shorter, in opposite pairs, larger ones 2–3.7 × 0.7–1.3 cm, shorter ones 1–2 × 0.4–1 cm, ovate or narrowly ovate, coriaceous to succulent, glabrous, base rounded, margin strigulose at the base and revolute, apex acute and apiculate; bracteoles 2–2.6 mm long, filiform, translucent. **Flowers** sessile to subsessile, pedicels up to 0.5 mm long; hypanthium turbinate, 1–1.4 × 1.2–1.4 mm, glabrous. **Calyx** 4-lobate, 2 larger and 2 shorter, in opposite pairs, interspersed with colleters, larger ones 2.3–3.1 × 0.7–1.2 mm, narrowly ovate, glabrous, margin minutely ciliolate, shorter ones 1.2–2 × 0.3–0.7 mm, narrowly triangular, glabrous, margin minutely ciliolate. **Corolla** 4-lobate, hypocrateriform, white; tube 3.9–5 mm long, 1.5–2 mm wide, externally glabrous, sparsely to densely papillate, internally with a ring of trichomes near base; lobes 1–1.4 × 0.9–1.2 mm, ovate to narrowly ovate, apex apiculate, externally papillate, internally glabrous, preanthetic bud clavate. **Stamens** 4, exserted, filaments ca 0.2 mm long, anthers ca 0.9 mm long. **Style** included, 3–5 mm long, stigma bifid, stigmatic branches exserted, 1–1.3 mm long; nectariferous disk entire. **Capsules** circumscissile, 1.6–2.1 × 1.3–2.2 mm, turbinate to subglobose, glabrous, calyx lobes persistent. **Seeds** (1–)2, ca 0.9–1.1 × 0.6–0.8 mm, oblongoid, slightly compressed, smooth longitudinal groove on the dorsal surface, inverted “Y”-shaped groove on the ventral surface, the upper arm slightly bilobate to bilobate; testa foveolate.

**Distribution and ecology** – *Mitracarpus semirianus* is endemic to the Chapada Diamantina, in the state of Bahia, occurring in the municipalities of Rio de Contas, in the eastern strand of the “Serra das Almas”, and Abaíra, in the district of Catolés, in a locality called “Serra do Barbado” or “Pico do Barbado” (fig. 4 circles). This species occurs in the “campo rupestre” vegetation (fig. 2D), growing on patches of sandy soil associated with rocky outcrops, at elevations ranging from 1400 to 2035 m.

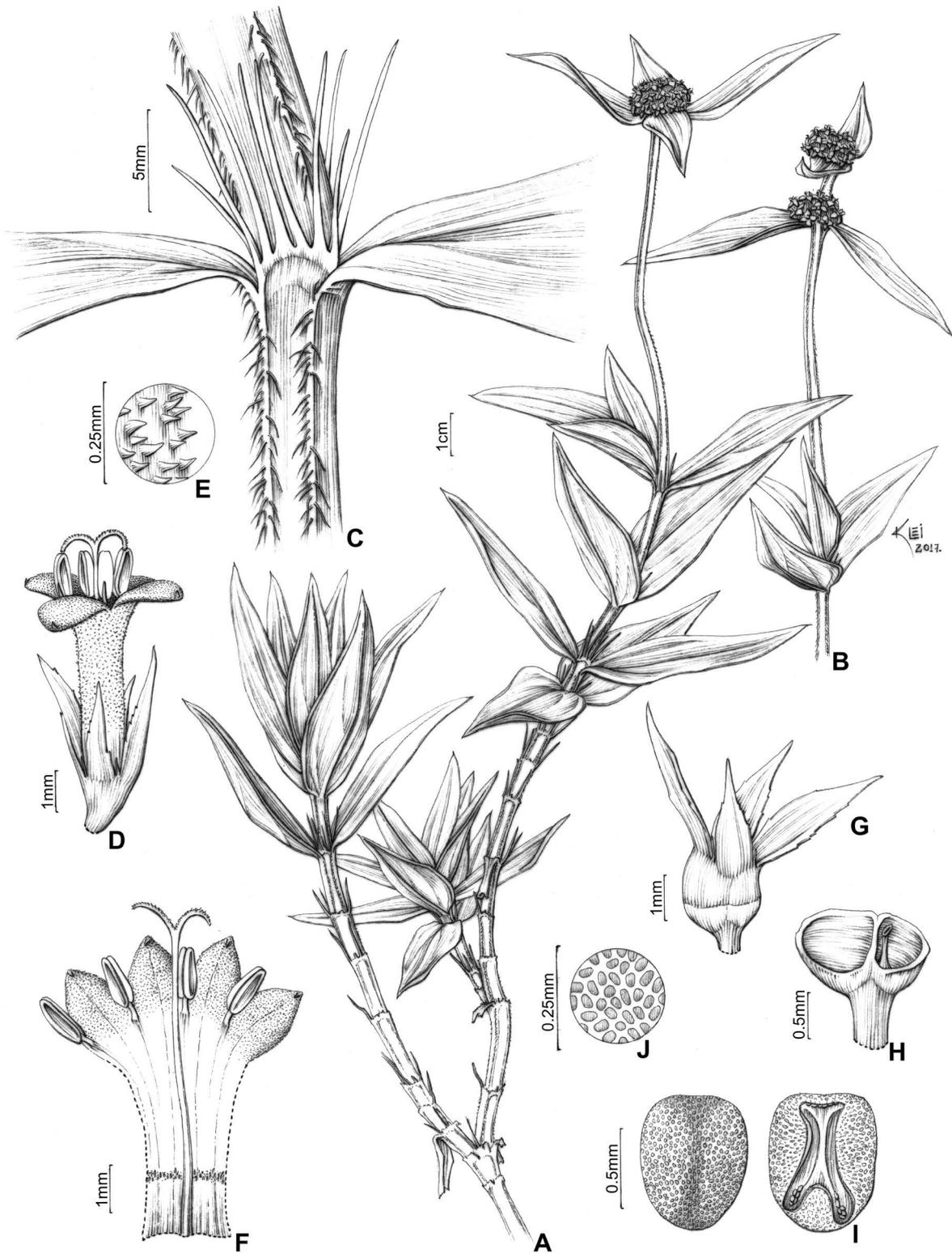
**Phenology** – Both flowering and fruiting specimens were collected from September to April.

**Etymology** – The specific epithet honours Professor João Semir, who worked at the University of Campinas (Unicamp) and passed away on the 8<sup>th</sup> of November 2018. Professor Semir dedicated his life to the study of plants. His invaluable contribution to science and society comes in the form of many theses and dissertations produced by his students, as well as works on the Brazilian flora, especially regarding the Compositae and the “campo rupestre”. He played a crucial role in the formation of generations of taxonomists at Unicamp and many other institutions, including the authors of this paper.

**IUCN conservation assessment (provisional)** – Endangered: EN B1ab(iii)+B2ab(iii). *Mitracarpus semirianus* is known from 5 herbarium specimens representing 5 occurrences. It occurs within the limits of the “APA da Serra do Barbado”, Bahia, an environmental protection area, which is a category of conservation unity of sustainable use, i.e. some degree of human occupation is expected. To our knowledge, this species does not occur within the limits of the “Parque Nacional da Chapada Diamantina”, which is a nearby conservation unit of integral protection. The new species was collected in two main localities, named the “Serra das Almas” and the “Serra do Barbado”, located in a somewhat isolated area of the Chapada Diamantina (fig. 4), the latter being the same site where the critically endangered species *Lapaea rubriflora* Scatigna & Souza is endemic (Scatigna et al. 2020). *Mitracarpus semirianus* presents EOO and AOO equal to 11.263 km<sup>2</sup> and 12 km<sup>2</sup>, respectively (kml file available as supplementary file 2). According to the IUCN Standards and Petitions Committee (2019), if EOO is less than AOO, it should be changed to make them equal and ensure consistency with the definition of AOO, which is an area defined within the EOO.

The habitat of the species is threatened by human interference on the native vegetation cover, due to the severe impacts caused by an ever-expanding irrigated, heavily mechanized, and agrochemical-based cropland system that has been developed in the region (Funch et al. 2009). Also, road construction and urbanization in the valley are noticeable on satellite images on Google Earth©. Therefore, the 5 occurrences represent two locations, and the species is preliminary assessed as Endangered EN B1ab(iii)+B2ab(iii), based on the EOO (less than 5000 km<sup>2</sup>) and AOO (less than 500 km<sup>2</sup>), number of locations (less than five), and an inferred continuing decline of the quality of the habitat.

**Additional specimens examined** – BRAZIL • Bahia, Abaíra, Campo entre Serra do Barbado e Serra de Itobira; 13°19'S, 41°54'W; 1800 m; 20 Nov. 1993; *W. Ganev* 2528;



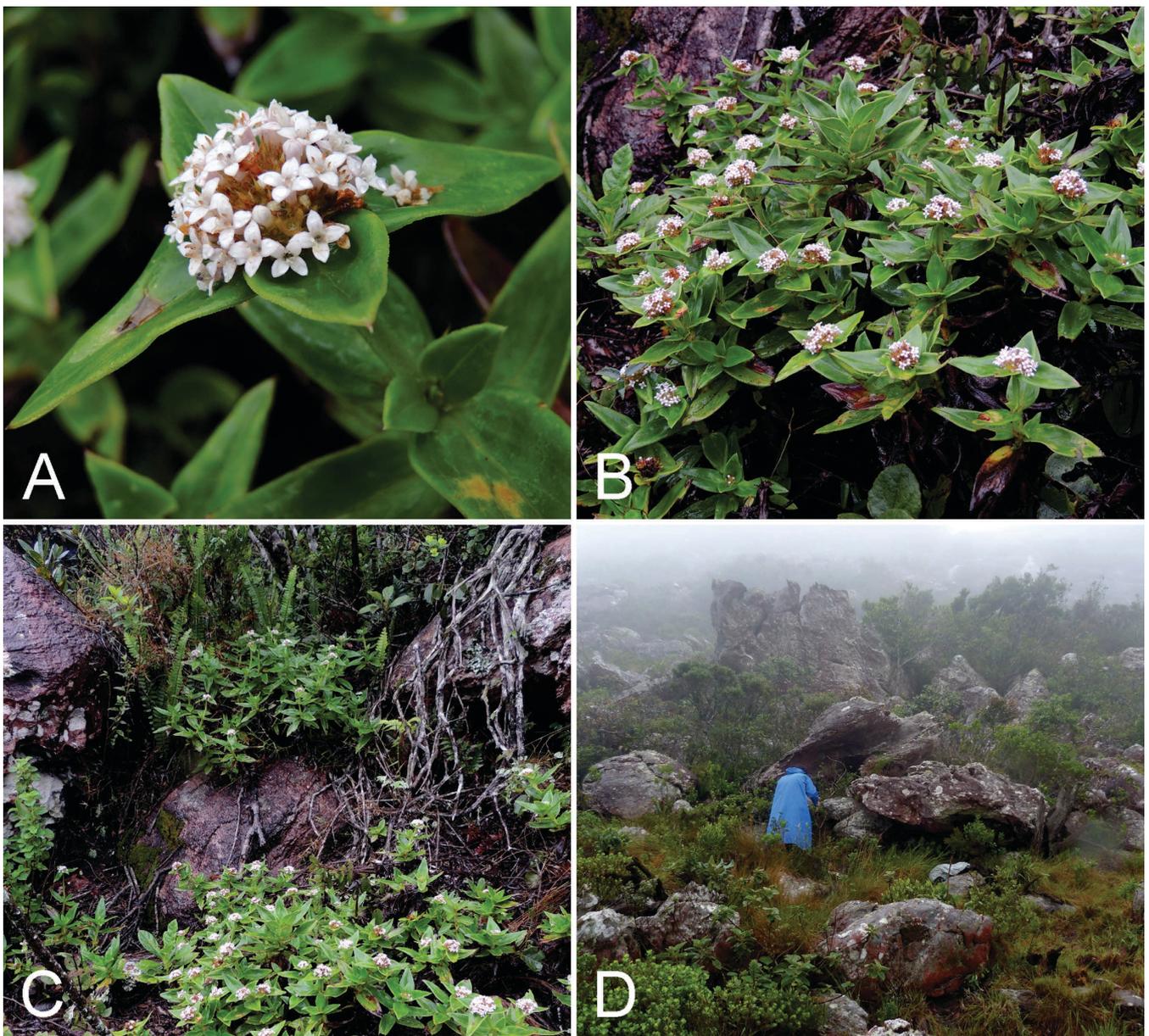
**Figure 1** – *Mitracarpus semirianus*. **A.** Branch portion with a terminal glomerule. **B.** Branch portion with terminal and axillary glomerules. **C.** Stem and stipule. **D.** Flower. **E.** Detail of the external surface of the corolla. **F.** Dissected corolla, with stamens, style, and stigma. **G.** Capsule. **H.** Inferior portion of a dehiscent capsule. **I.** Seed, dorsal (left) and ventral (right) views. **J.** Detail of the testa of the seed. From *J.A.M. Carmo & A.V. Scatigna 420*. Drawn by Klei Sousa.

HUEFS, K [photo], SPF • Abaíra, Catolés, forquilha da serra; 13°17'27"S, 41°54'15"W; 19 Jan. 2016; *J.A.M. Carmo & A.V. Scatigna* 420; UEC • Abaíra, Pico do Barbado; 13°18'S, 41°54'W; 1950–2033 m; 28 Sep. 1993; *W. Ganev* 2266; HUEFS, K [photo], SPF • Catolés, Serra do Barbado; 13°17'S, 41°50'W; 30 Apr. 2006; *M.L. Guedes et al.* 12277; ALCB • Rio de Contas, Pico das Almas, Vertente leste, Trilho Faz. Silvina-Queiroz; 13°32'S, 41°56'W; 1400 m; 13 Nov. 1988; *R.M. Harley, T.B. Cavalcanti, M.C. Assis & F.S. Pires* 26137; SPF.

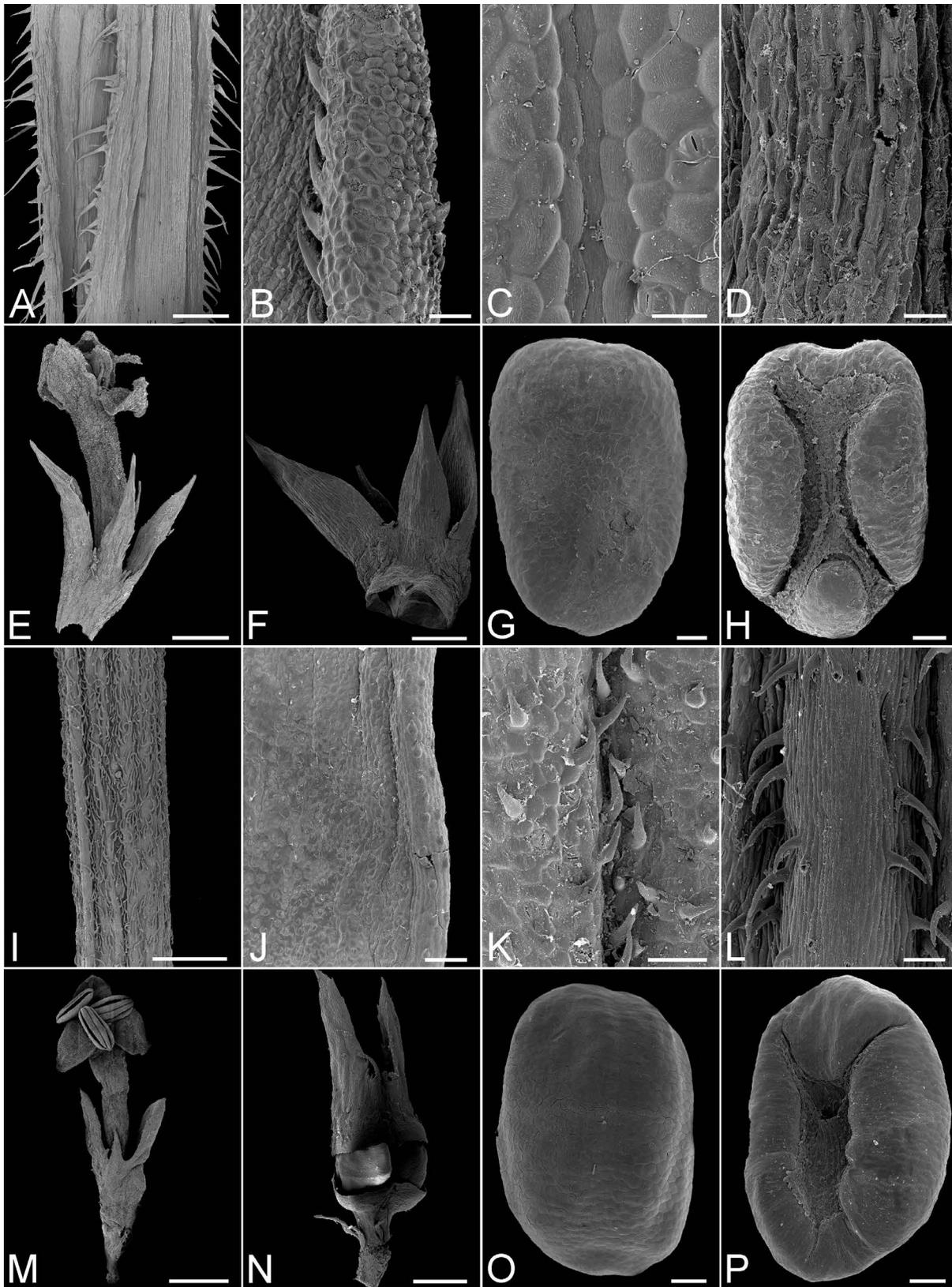
**Notes** – *Mitracarpus semirianus* specimens were collected in the region of Catolés and identified as morphologically related species. After a detailed re-examination of herbaria material and fieldwork, we concluded that it is indeed a species new to science. There has been a similar pattern

for other species in the Spermaceae, such as *Borreria catolensis* E.L.Cabral & L.M.Miguel, *Borreria diamantinae* R.M.Salas & E.L.Cabral (Cabral et al. 2011), *Hexasepalum zappiae* E.L.Cabral & Cabaña Fader (Cabaña Fader et al. 2016), and *Staelia catolensis* R.M.Salas & E.L.Cabral (Salas & Cabral 2012), which were recovered through re-examination of herbarium materials and are also endemic to the region of Catolés. This was also the case for *Lapaea rubriflora* in the Plantaginaceae family (Scatigna et al. 2020). These novelties found in Catolés attest to the uniqueness of this region in terms of its flora.

Specimens of *Mitracarpus semirianus* were previously identified either as *M. frigidus* or *M. lhotzkyanus*. Indeed, they share some similarities, such as being generally glabrous plants, with coriaceous to (semi-)succulent leaf



**Figure 2** – *Mitracarpus semirianus*. A. Inflorescence. B. Individuals. C. Habitat. D. General view of the site of collection. Photographs by João Carmo (A–C) and André Scatigna (D).



**Figure 3** – Morphological comparison between *Mitracarpus semirianus* (A–H) and *M. lhotzkyanus* (I–P). *Mitracarpus semirianus*. A. Stem. B. Leaf blade margin. C. Primary vein, adaxial view. D. Primary vein, abaxial view. E. Flower. F. Superior portion of a dehiscent capsule. G. Seed, dorsal view. H. Seed, ventral view. *Mitracarpus lhotzkyanus*. I. Stem. J. Leaf blade margin. K. Primary vein, adaxial view. L. Primary vein, abaxial view. M. Flower. N. Dehiscent capsule. O. Seed, dorsal view. P. Seed, ventral view. From J.A.M. Carmo & A.V. Scatigna 420 (A–H) and A.V. Scatigna 1080 (I–P). Scale bars: A, E, F, I, M = 1 mm; B, J = 200 µm; C, D, G, H, K, L, O, P = 100 µm; N = 500 µm.

**Table 1** – Comparative table of the distinctive characters of *Mitracarpus frigidus* (based on its type specimen and its varieties, otherwise on Souza et al. 2010, whenever indicated), *M. lhotzkyanus*, and *M. semirianus*.

| Character      | <i>M. frigidus</i>  | <i>M. lhotzkyanus</i>  | <i>M. semirianus</i>   |
|----------------|---|--|--|
| Stems          | tetragonal, puberulent to glabrous, ribbed at each angle, ribs margin hirsute, strigose or glabrous                     | tetragonal, glabrate, densely strigose to glabrous, ribbed at each angle, ribs margin strigose to glabrous   | tetragonal, glabrous, winged at each angle, wings 0.5–1 mm wide, margin hirsute  |
| Leaf blades    | narrowly ovate, rarely linear, hirsute, pubescent, strigose or glabrous   | elliptic to narrowly elliptic or narrowly ovate, glabrous, with sparse trichomes along the depression of the midrib on the adaxial surface, midrib conspicuous and strigose on the abaxial surface | elliptic, ovate or narrowly ovate, glabrous  |
| Inflorescences | terminal and axillary glomerules, rarely just terminal, globose to hemispheric  | terminal glomerules, sometimes one axillary, hemispheric   | terminal glomerules, rarely one axillary, hemispheric  |
| Bracts         | 2 or 4  | 4, rarely 2  | 4, rarely 2  |
| Seeds          | oblongoid or globose, cruciform depression on the dorsal surface, “X” groove on the ventral surface (Souza et al. 2010) | oblongoid to ellipsoid, smooth on the dorsal surface, rectangular groove on the ventral surface, sometimes the angles expanding almost reaching the edge of the seed                               | oblongoid, slightly compressed, smooth longitudinal groove on the dorsal surface, inverted “Y” groove on the ventral surface |
| Distribution   | widely distributed in South America, occurring in Brazil, Colombia, French Guiana, and Venezuela (Souza et al. 2010)    | along the Brazilian coast, from Bahia to Rio de Janeiro  | endemic to the Chapada Diamantina, Bahia, northeastern Brazil  |

blades, and the corolla tube as long as or longer than the larger pair of calyx lobes. Nevertheless, these three species can be distinguished from each other, as discussed below. A summary of the distinctive characters of these species is presented in table 1.

*Mitracarpus frigidus* is one of the most glaring examples of an ill-defined species in the genus. It is widely distributed in South America, occurring in Brazil, Colombia, French Guiana, and Venezuela (Souza et al. 2010). Many infraspecific taxa have been recognized under *M. frigidus*, either as newly proposed varieties (Steyermark 1972) or based on previously described species (Schumann 1888). Most of these, however, have been relegated to synonymy (Souza et al. 2010), while some have been recognized as distinct species (Cabral et al. 2009; Souza et al. 2010). A summary of the type specimens of the names associated with *Mitracarpus frigidus*, including all of the infraspecific taxa, currently treated under its synonymy or as distinct species is presented in supplementary file 1.

In the last taxonomic revision of the species of *Mitracarpus* occurring in Brazil, Souza et al. (2010) treated most of the *M. frigidus* infraspecific names under the synonymy of *M. frigidus* and delimited this species in a broader sense. However, it might represent a species complex, which would probably require more lines of evidence other than morphology for the delimitation of entities, which is beyond the scope of the present contribution. In this sense, the current circumscription of *M. frigidus* (Souza et al. 2010), as well as *M. semirianus*, may serve as hypotheses to be tested in future investigations.

*Mitracarpus semirianus* can be distinguished from *M. frigidus* (sensu Souza et al. 2010) especially by the glabrous stems (vs puberulent to glabrous in *M. frigidus*),

winged at each angle, with the wings 0.5–1 mm wide (vs ribbed at each angle) and hirsute at the margin (vs rib margin hirsute, strigose, or glabrous), the elliptic, ovate, or narrowly ovate leaf blades, glabrous on both surfaces (vs narrowly ovate, rarely linear, hirsute, pubescent, strigose, or glabrous), terminal glomerules (vs terminal and axillary, rarely only terminal), oblongoid, slightly compressed seeds (vs oblongoid to globose), with a smooth longitudinal groove dorsally (vs cruciform depression dorsally) and an inverted “Y”-shaped groove ventrally (vs an “X”-shaped groove ventrally). Furthermore, the morphological features of the seed of *M. semirianus* are similar to those of *M. strigosus* P.L.R.Moraes, De Smedt & Hjertson (= *M. salzmannianus* DC.), which has also been recognized as a variety of *M. frigidus* (Schumann 1888). Nevertheless, *M. semirianus* is distinct by being subshrubs of usually taller (0.8–1.2 m) habit (*M. strigosus* is represented by herbs to subshrubs, up to 1 m, but usually shorter), having glabrous stems, winged at each angle (vs scabrous to pubescent stems, ribbed at each angle), glabrous leaf blades (vs scabrous to strigose), and terminal glomerules (vs terminal and axillary).

On the other hand, *Mitracarpus lhotzkyanus* Cham. is a relatively well-defined species. *Mitracarpus semirianus* can be distinguished from *M. lhotzkyanus* by the glabrous, winged stems, with hirsute wing margin (vs glabrate, densely strigose to glabrous ribbed stems, rib margin strigose to glabrous in *M. lhotzkyanus*; fig. 3A and 3I), glabrous leaf blades (vs with sparse trichomes along the depression of the midrib on the adaxial surface, midrib conspicuous and strigose on the abaxial surface; fig. 3C and 3K) with strigulose and revolute margins (vs glabrous to strigose margins and slightly revolute near the base), and the oblongoid, slightly compressed seeds, with an inverted “Y”-shaped groove on the ventral surface (vs oblongoid to ellipsoid seeds, with a

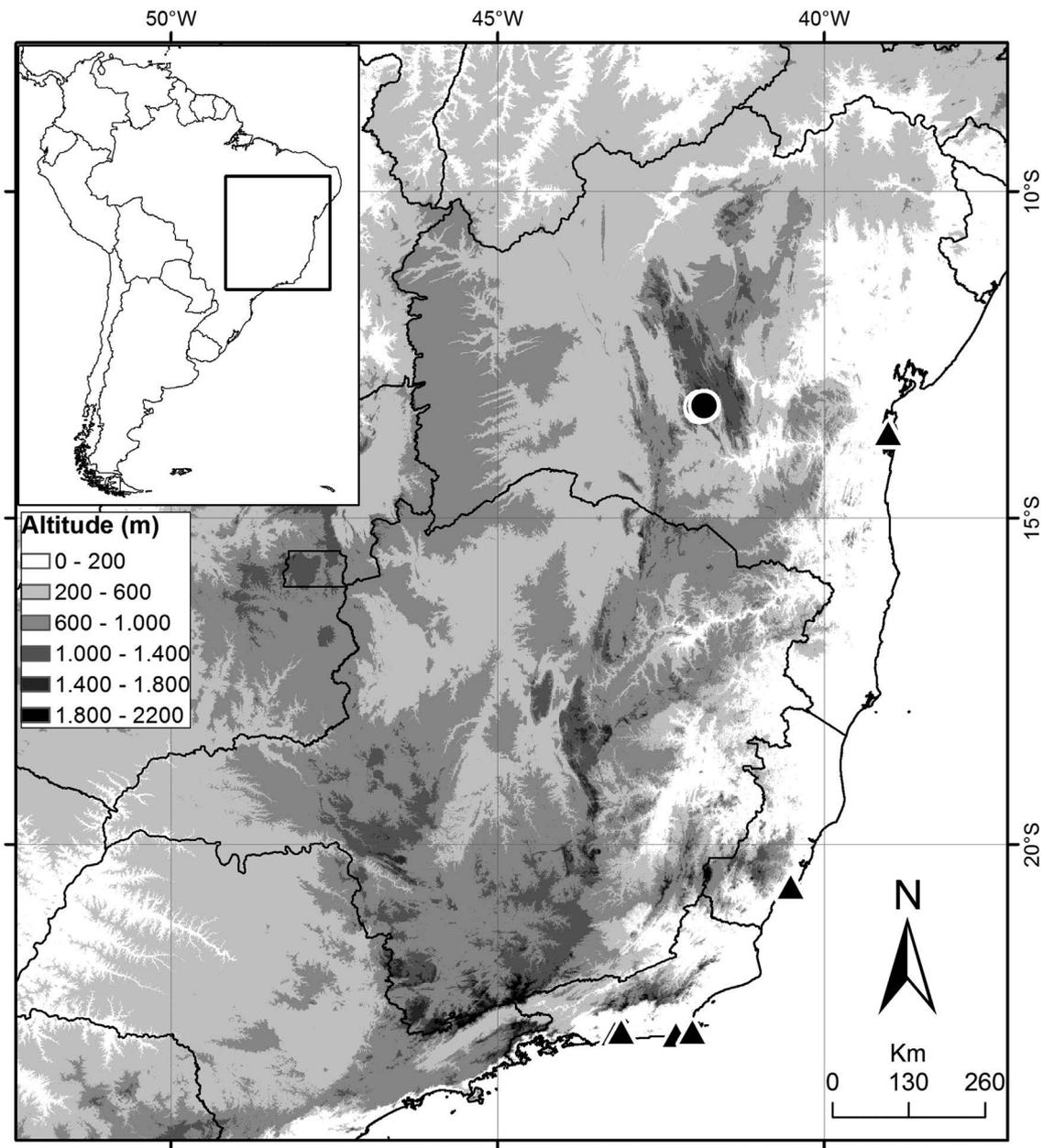
rectangular groove on the ventral surface; fig. 3G–H and 3O–P). Furthermore, *M. semirianus* occurs in the “campo rupestre” of the Chapada Diamantina, in the northern portion of the Espinhaço Range, while *M. lhotzkyanus* occurs in “restinga” vegetation along the Brazilian coast (fig. 4).

Also, *Mitracarpus polygonifolius* (A.St.-Hil.) R.M.Salas & E.B.Souza (= *Mitracarpus robustus* E.B.Souza & E.L.Cabral), another species that has been reported in Bahia, shares character states with *Mitracarpus semirianus* such as the winged stems, the chartaceous leaf blades, corolla tube equal or longer than the longest pair of calyx lobes, and seeds with an inverted “Y”-shaped groove on the ventral surface. Nevertheless, they can be distinguished from each other by the stem wings hirsute in *M. semirianus* (vs

stem wings puberulous to glabrous in *M. polygonifolius*), leaves with axillary brachyblasts forming fascicles (vs axillary brachyblasts absent), and inflorescences terminal glomerules, rarely one axillary (vs 4–8(–14) terminal and axillary glomerules).

***Mitracarpus lhotzkyanus*** Cham. (Chamisso 1834: 219) – Type: BRAZIL • Rio de Janeiro, Rio de Janeiro, in saxosis arenosisque maritimis; (Sep.–Oct.) Nov.–Dec. 1829; *L. Riedel s.n.*; lectotype: P[P03911687], **designated here**; isolectotypes: B† [F neg. 911], BR[BR0000005741564], K[K000447167], US[02555239], W[13722].

**Description** – Subshrubs, 15–30 cm tall, decumbent to erect. Stems branched, internodes 0.2–6.5 cm long, 1.5–2.5



**Figure 4** – Distribution map of *Mitracarpus semirianus* (circles) and *M. lhotzkyanus* (triangles). Map created using the application ArcMap v.10.7 in ArcGis Desktop (Esri 2019).

Key to the species of *Mitracarpus* occurring in Brazil (adapted from Souza et al. 2020)

1. Leaf blades dimorphic; inflorescences in axillary unilateral fascicles..... *M. diversifolius* E.B.Souza & E.L.Cabral
- 1'. Leaf blades monomorphic; inflorescences in terminal and/or axillary glomerules ..... 2
2. Corolla tube shorter than the longest pair calyx lobes ..... 3
- 2'. Corolla tube equal or longer than the longest pair of calyx lobes..... 9
3. Axillary brachyblasts forming fascicles present ..... 4
- 3'. Axillary brachyblasts forming fascicles absent ..... 5
4. Short herbs, with thin delicate roots; leaves chartaceous..... *M. microspermus* K.Schum.
- 4'. Subshrubs, woody at the base, with thick roots; leaves semisucculent ..... *M. anthospermoides* K.Schum.
5. Stems winged; calyx lobes of the shorter pair filiform ..... *M. brasiliensis* M.L.Porto & Waechter
- 5'. Stems wingless; calyx lobes of the shorter pair narrowly triangular ..... 6
6. Capsules glabrous; seeds with a cruciform depression on the dorsal surface..... *M. carajasensis* E.L.Cabral, Sobrado & E.B.Souza
- 6'. Capsules pilose on the superior half; seeds smooth on the dorsal surface..... 7
7. Plants 15–70 cm tall; corolla tube puberulous-papillate externally ..... *M. hirtus* (L.) DC.
- 7'. Plants 2–10 cm tall; corolla tube glabrous externally ..... 8
8. Plants prostrate; leaf blades pubescent, with thickened margins; corolla 2–2.4 mm long ..... *M. eritrichoides* Standl.
- 8'. Plants erect to decumbent; leaf blades hispid, with plane margins; corolla 1–1.2 mm long ..... *M. parvulus* K.Schum.
9. Leaf blades coriaceous, base cordate, auriculate, attenuate or truncate..... 10
- 9'. Leaf blades herbaceous, chartaceous or semisucculent, base attenuate, cuneate, acute, rounded or oblique..... 13
10. Margins of the leaf blades whitish; seeds with reticulate testa ..... *M. albomarginatus* E.B.Souza
- 10'. Margins of the leaf blades the same colour as the remaining blade; seeds with papillate testa..... 11
11. Herbs decumbent or prostrate; margins of the leaf blades plane ..... *M. pusillus* Steyererm.
- 11'. Herbs erect; margins of the leaf blades thickened ..... 12
12. Leaf blades hispid; stamens with the anthers slightly included in the corolla tube..... *M. recurvatus* Standl.
- 12'. Leaf blades glabrous to pubescent along the primary vein; stamens completely included in the corolla tube..... *M. steyermarkii* E.L.Cabral & Bacigalupo
13. Seeds with a quadrangular or rectangular ventral groove..... 14
- 13'. Seeds with an “X” or inverted “Y”-shaped ventral groove ..... 16
14. Stems pilose; leaf blades pilose; corolla puberulent and papillate externally..... *M. megapotamicus* Kuntze
- 14'. Stems strigose to glabrous; leaf blades glabrous or sparse trichomes along the midrib; corolla glabrous externally..... 15
15. Leaf blades narrowly ovate to linear; glomerules axillary..... *M. froesii* (Sucre) E.L.Cabral & E.B.Souza
- 15'. Leaf blades elliptic to narrowly elliptic or narrowly ovate; terminal glomerules, sometimes axillary . *M. lhotzkyanus* Cham.

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|---|--|
| 16. Seeds with an inverted “Y”-shaped ventral groove .....  | 17   |
| 16'. Seeds with an “X”-shaped ventral groove .....  | 19   |
| 17. Cespitose herbs, prostrate or decumbent; leaf blade margins glabrous and thickened.....   |  |
| ..... <i>M. eichleri</i> K.Schum.   |  |
| 17'. Erect or ascending herbs or subshrubs; leaf blade margins scabrous or strigulose, revolute or plane ..   |  |
| .....   | 18   |
| 18. Subshrubs 0.8–1.2 m tall; stems glabrous, winged at each angle; leaf blades glabrous; terminal glomerules.....  | <i>M. semirianus</i> J.A.M.Carmo & Scatigna            |
| 18'. Herbs to subshrubs, up to 1 m tall; stems scabrous to pubescent, ribbed at each angle; leaf blades scabrous to strigose; terminal and axillary glomerules..... |  |
| ..... <i>M. strigosus</i> P.L.R.Moraes, De Smedt & Hjertson   |  |
| 19. Seeds with a cruciform depression on the dorsal surface .....   | 20   |
| 19'. Seeds smooth on the dorsal surface .....   | 25   |
| 20. Axillary brachyblasts forming fascicles absent; corolla tube glabrous externally.....   |  |
| ..... <i>M. baturitensis</i> Sucre  |  |
| 20'. Axillary brachyblasts forming fascicles present; corolla tube puberulent or papillate externally.....  | 21   |
| 21. Leaf blades semisucculent, 0.5–2 mm wide; stipular sheath 1–3-fimbriate .....   | <i>M. rigidifolius</i> Standl.                         |
| 21'. Leaf blades chartaceous or coriaceous, 2–20 mm wide; stipular sheath 3–12-fimbriate .....  | 22   |
| 22. Stipular sheath 3-fimbriate; corolla lobes papillate internally .....   |  |
| ..... <i>M. schininianus</i> E.L.Cabral, W.A.Medina & E.B.Souza   |  |
| 22'. Stipular sheath 4–12-fimbriate; corolla lobes glabrous internally .....  | 23   |
| 23. Leaf blades narrowly elliptic to elliptic .....   | <i>M. buiquensis</i> E.B.Souza & Zappi                 |
| 23'. Leaf blades narrowly ovate to linear.....  | 24   |
| 24. Subshrubs up to 200 cm tall; stems winged; corolla puberulent papillate externally.....   |  |
| ..... <i>M. frigidus</i> (Willd. ex Roem. & Schult.) K.Schum.   |  |
| 24'. Herbs up to 40 cm tall; stems wingless; corolla glabrous externally.....   |  |
| ..... <i>M. fernandesii</i> E.L.Cabral, Sobrado & E.B.Souza   |  |
| 25. Seeds with semicircular depressions on the dorsal surface.....  |  |
| ..... <i>M. longicalyx</i> E.B.Souza & Sales  |  |
| 25'. Seeds smooth on the dorsal surface .....   | 26   |
| 26. Subshrubs 70–200 cm tall; stems winged; terminal glomerules with two bracts .....   |  |
| ..... <i>M. polygonifolius</i> (A.St.-Hil.) R.M.Salas & E.B.Souza   |  |
| 26'. Herbs or subshrubs 7–50 cm tall; stems wingless; terminal glomerules with four bracts.....   | 27   |
| 27. Stems and leaves glabrous; corolla glabrous externally .....  | <i>M. nitidus</i> E.B.Souza & Zappi                    |
| 27'. Stems and leaves pilose; corolla papillate or puberulent externally .....  | 28   |
| 28. Stems pubescent; calyx lobes of the longest pair 2–2.5 mm long; corolla papillate externally; capsules pilose on the superior half.....                         | <i>M. federalensis</i> E.L.Cabral, Sobrado & E.B.Souza |
| 28'. Stems hispid to villous; calyx lobes of the longest pair 3–4 mm long; corolla puberulent externally; capsules glabrous .....                                   | <i>M. eitenii</i> E.B.Souza & E.L.Cabral               |

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mm wide, fistulous, tetragonal, glabrate, densely strigose to glabrous, ribbed at each angle, margin strigose to glabrous, bark peeling from older internodes. Stipular sheaths 1.7–2.3 mm long, strigose, persistent, 5–7-fimbriate on each side of the stem, fimbriae 0.4–1.8 cm long, narrowly triangular to linear, glabrous. Leaves sessile, axillary brachyblasts forming fascicles; blades 0.5–3.5 × 0.2–0.8 cm, elliptic to narrowly elliptic or narrowly ovate, coriaceous to succulent, adaxial surface glabrous with sparse trichomes along the depression of the inconspicuous midrib, abaxial surface glabrous, midrib conspicuous, strigose, base attenuate to cuneate, margin glabrous to strigose and slightly revolute near the base, apex acute and minutely apiculate; secondary veins 2–3 on each side of the midrib, inconspicuous on the adaxial surface, slightly conspicuous on the abaxial surface. Inflorescences terminal glomerules, sometimes axillary and lateral, 0.6–0.8 × 0.7–1.3 cm, hemispheric; peduncles 1–9 cm long, 1–1.8 mm wide, tetragonal, densely strigose to glabrous, ribbed at each angle, margin strigose to glabrous; bracts 4, rarely 2 when axillary glomerule present, 2 larger and 2 shorter, in opposite pairs, larger ones 1.2–3.5 × 0.5–1.5 cm, shorter ones 0.8–2.7 × 0.4–1 cm, ovate or narrowly ovate, coriaceous to succulent, adaxial surface glabrous with sparse trichomes along the depression of the midrib, sparsely strigose to glabrous at the base, midrib strigose, base attenuate to cuneate, margin glabrous to strigose and slightly revolute near the base, apex acute and minutely apiculate; bracteoles 0.1–1 mm long, filiform, translucent. Flowers sessile to subsessile, pedicels up to 0.4 mm long; hypanthium turbinate, 0.4–1.3 × 0.5–1 mm, glabrous to sparsely strigose. Calyx 4-lobate, 2 larger and 2 shorter, in opposite pairs, interspersed with colleters, larger ones 1–1.8 × 0.3–0.7 mm, narrowly ovate, glabrous, margin minutely ciliolate, shorter ones 0.2–0.6 × 0.1–0.3 mm, triangular to narrowly triangular, glabrous. Corolla (3–)4-lobate, hypocrateriform, white; tube 1.3–3.6 mm long, 0.2–0.7 mm wide, externally glabrous, internally with a ring of moniliform trichomes near base; lobes 0.5–1.1 × 0.6–0.9 mm, ovate, apex acute to obtuse, externally glabrous, internally papillate, preanthetic bud clavate. Stamens (3–)4, reaching the throat, filaments ca 0.2 mm long, anthers ca 0.9 mm long. Style included, 2–3 mm long, stigma bifid, stigmatic branches included, 0.2–0.4 mm long; nectariferous disk entire. Capsules circumscissile, 0.7–0.9 × 0.9–1 mm, turbinate to subglobose, sparsely strigose at upper portion, calyx lobes persistent. Seeds (1–)2, 0.6–0.8 × 0.5–0.6 mm, oblongoid to ellipsoid, smooth on the dorsal surface, rectangular groove on the ventral surface, sometimes the angles expanding almost reaching the edge of the seed; testa slightly foveolate.

**Distribution and ecology** – *Mitracarpus lhotzkyanus* occurs along the Brazilian coast, from Bahia to Rio de Janeiro (fig. 4 triangles). It usually grows in association with sandy soils or rocky outcrops in “restinga” vegetation (Souza et al. 2010), at elevations up to 20 m.

**Phenology** – Both flowering and fruiting specimens were collected almost the entire year.

**IUCN conservation assessment (provisional)** – Least concern: LC. *Mitracarpus lhotzkyanus* occurs within the limits of the “APA Pratiği”, in the municipality of Ituberá, Bahia, and the “APA de Massambaba”, in Cabo Frio, Rio

de Janeiro. These APA are environmental protection areas, which is a category of conservation unity of sustainable use, i.e. some degree of human occupation is expected. Nevertheless, the IUCN Standards and Petitions Committee (2019) states that the criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it.

*Mitracarpus lhotzkyanus* was collected in at least six localities: in Ituberá, Bahia; in Guarapari, Espírito Santo; and Arraial do Cabo, Cabo Frio, Niterói, and Rio de Janeiro, in Rio de Janeiro (fig. 4). It presents EOO and AOO equal to 102627.455 km<sup>2</sup> and 28 km<sup>2</sup>, respectively (kml file available as supplementary file 3). Although the AOO would trigger an Endangered category, evidence suggests that this species is widely distributed along the Brazilian coast, from Bahia to Rio de Janeiro, in which we believe that there might be more areas supporting habitats suitable for its occurrence. Nevertheless, human activity such as urbanization will increase the loss of its habitat, but we do not expect this threat to *M. lhotzkyanus* to lead to a significant decrease of its EOO and AOO, neither to the decline of the number of subpopulations or mature individuals. Therefore, the wide distribution of *M. lhotzkyanus* allows us to consider the species as Least Concern (LC).

**Additional specimens examined** – BRAZIL – Bahia

• Ituberá: ca 16 km na rodovia Pradigi; 13°42'27"S, 39°0'53"W; 21 Jun. 2005; *J.G. Jardim et al. 4642*; HUEFS [photo]. – Espírito Santo • Setiba, Estrada do Sol, ES-060, Km 32; 26 May 1987; *O.J. Pereira et al. 906*; SP. – Rio de Janeiro • Arraial do Cabo, em direção a Cabo Frio; 22°57'S, 42°01'W, 20 m; 27 Nov. 1999; *D. Zappi et al. 479*; UEC • Restinga arbustiva de areia branca próxima pousada das Orquideas; 22°55'31"S, 42°16'15"W; 21 Feb. 2016; *A.V. Scatigna 1080*; UEC • Cabo Frio, Restinga de Cabo Frio; 9 Oct. 1968; *D. Sucre s.n.*; HUEFS [photo] • Niterói, Pedra de Itacoatiara; 12 Sep. 1982; *C. Farney 96*; HUEFS [photo] • Rio de Janeiro, Copacabana; 3 Oct. 1869; *A.F.M. Glaziov 2106*; R [photo] • Guanabara, Proximidade Recreio dos Bandeirantes; 28 Mar. 1964; *W. Hoehne 5686*; HUEFS, MBM, P [photo], RB [photo], SP, UEC • Pedra da Gávea, mesa no cume; 25 Nov. 1973; *P. Carauta 1604*; HUEFS [photo], RB [photo] • Restinga do Jacarepaguá; 1 Jul. 1958; *L.T. Eiten et al. 3974*; HUEFS, NY [photo] • 1 Jul. 1958; *D. Sucre s.n.*; HUEFS [photo] • Saquarema, Reserva Ecológica de Jacarepaguá; 26 Oct. 1993; *J.F. Fontella 3140*; HUEFS [photo], RB [photo] • Restinga de Ipitangas; 7 Mar. 1989; *A. Amorim 56*; HUEFS [photo].

**Notes** – In the protologue of this name, Chamisso (1834) cited “Brasilia, — —, N. 13, Spermaceo 24 decumbens, foliis lanceolatis subcoriaceis glaberrimis, floribus verticillatis albis. In saxosis arenosisque maritimis prope Rio Janeiro, Novemb. Decemb. 1829’ Lhotzky in schedula”. In the most recent revision of the genus for Brazil, Souza et al. (2010) cited the type as “*J. Lhotzky 13* (holotype: LE; isotype: K)”. Indeed, the name of Lhotzky is written on the label of a specimen deposited at B. However, on other specimens we have analysed, deposited in BR, K, P, US, and W, the gathering is attributed to Riedel; these specimens present the same description and year of collection, i.e. “In saxosis arenosisque maritimis prope Rio de Janeiro” and

“1829”, respectively. Lhotzky travelled to Brazil in 1830, arriving in Rio de Janeiro in 1831, whereas Riedel was collecting specimens in the city of Rio de Janeiro from April 1829 to May 1830, according to his itinerary (Urban 1906), thus matching the date and place of collection. Hence, it is more likely that Riedel, not Lhotzky, collected the original material of *Mitracarpus lhotzkyanus*.

We contacted the LE staff regarding the presumed holotype, as interpreted by Souza et al. (2010), but unfortunately it was absent in their collection. Furthermore, since there are duplicates of this material in various herbaria (syntypes) and the interpretation by Souza et al. (2010) as holotype would not characterize an inadvertent lectotypification, as it occurred after 1 January 2001 (Prado et al. 2015), we here designated a lectotype, the specimen in P, for the name *Mitracarpus lhotzkyanus*.

Moreover, it is possible that Chamisso (1834) did not dedicate the name to Lhotzky as if he had collected the type specimen of *Mitracarpus lhotzkyanus*, but as a compliment. As explained by Stearn in his *Botanical Latin* (Stearn 1986), in the “Epithets Commemorating Persons” section, these are used in adjectival or substantival forms, as attempts have been made to differentiate them, although with apparently little success. This could explain why Chamisso (1834) employed an adjectival epithet instead of a substantival one.

*Mitracarpus lhotzkyanus* has been described as a subshrub presenting glabrous stems, stipules, and leaves (Souza et al. 2010). Nevertheless, our analyses of new collections and micromorphological characters have shown that it is a glabrate species, presenting a generally strigose indumentum on the stems, stipular sheaths, and leaf blades, along the depression of the midrib on the adaxial surface, on the midrib on the abaxial surface, and margins of the leaves (fig. 3I–L).

#### SUPPLEMENTARY FILES

**Supplementary file 1** – Summary table of the names and type specimens associated with *Mitracarpus frigidus*.

<https://doi.org/10.5091/plecevo.84548.supp1>

**Supplementary file 2** – Extent of occurrence (EOO) and area of occupancy (AOO) of *Mitracarpus semirianus* estimated using GeoCAT.

<https://doi.org/10.5091/plecevo.84548.supp2>

**Supplementary file 3** – Extent of occurrence (EOO) and area of occupancy (AOO) of *Mitracarpus lhotzkyanus* estimated using GeoCAT.

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