



Increasing the known floristic diversity of Brazilian inselbergs: two new species of *Mandevilla* (Apocynaceae) from Espírito Santo

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ABSTRACT

Two new species of *Mandevilla* endemic to inselbergs of the state of Espírito Santo, Brazil, are described. *Mandevilla alata* resembles *M. callista* but differs by having winged stems, shorter petioles, shorter pedicels, and a white corolla with a red throat. *Mandevilla ibitubana* resembles *M. grazielae* but differs by having short-petiolate leaves, a white corolla, and shorter anthers. Illustrations, a distribution map, conservation assessments and a key to species of *Mandevilla* growing on inselbergs in Espírito Santo are included.

Keywords: apocynoids, Ibituba, Mesechiteae, Santa Teresa, Pancas

Introduction

Inselbergs are Precambrian granitic and gneissic rock outcrops present on all continents, but more diverse in south eastern Brazil, Madagascar, and south western Australia (Burke 2003; Porembski 2007; Rabarimanarivo *et al.* 2019). They have a rich and endemic flora from ecological isolation and extreme microclimatic and geomorphological conditions (Safford 1999). In Brazil, most inselbergs are found in Espírito Santo, northern Rio de Janeiro, north eastern Minas Gerais, and southern Bahia (Ab'Saber 1967; Paula *et al.* 2016; Campos-Rocha *et al.* 2018). A few inselberg formations are also known from north eastern Brazil (Sales-Rodrigues *et al.* 2014; Maia *et al.* 2015).

The flora of Espírito Santo, Brazil, is poorly known. Major collecting efforts have been made recently, but many regions are still unexplored. Recent studies of inselbergs and forest from the area have led to the description of several narrowly endemic species (Kollmann 2008; Leme *et al.* 2008; 2010; Leme & Kollmann 2009; Versieux & Wanderley

2010; Silva *et al.* 2014; Goldenberg & Kollmann 2015; Meyer *et al.* 2016; Campos-Rocha *et al.* 2018; Meyer *et al.* 2018; Chautems *et al.* 2019).

Apocynaceae are highly diverse in Brazil, with around 760 species reported (Koch *et al.* 2015). In the last fifteen years, as a result of floristic, taxonomic or phylogenetic studies, several endemic species and genera have been described (e.g., Konno *et al.* 2006; Sales *et al.* 2006; Rapini & Farinaccio 2010; Rapini & Pereira 2011; Farinaccio 2013; Espírito Santo *et al.* 2018 a; b; Scudeler *et al.* 2018; Pereira *et al.* 2019). *Mandevilla* (apocynoids, Mesechiteae) comprises ca. 180 neotropical species (Morales 2018). It is characterized by its leaf blade with colleters on the adaxial surface of the midvein, racemose inflorescence, and style head with five longitudinal ribs (Simões *et al.* 2004; 2006). In Brazil, ca. 72 species are known, of which twelve are endemic to inselbergs (Tab. 1).

During fieldwork led by the former Museu Augusto Ruschi and the Jardim Botânico do Rio de Janeiro two new species of *Mandevilla* restricted to inselbergs from Espírito Santo were found. The first has been collected on several

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inselbergs in Santa Teresa and Pancas, whereas the second is known from inselbergs near Ibituba, Baixo Guandu.

Table 1. *Mandevilla* species endemic to Inselbergs in Brazil. AL: Alagoas; BA: Bahia; ES: Espírito Santo; MG: Minas Gerais; PB: Paraíba; RJ: Rio de Janeiro; SP: São Paulo.

Species	State(s)
<i>Mandevilla alata</i> J.F.Morales & L. Kollmann *	ES
<i>Mandevilla crassinoda</i> (Gardner) Woodson	RJ
<i>Mandevilla dardanoi</i> M.F. Sales, Kin.-Gouv. & A.O. Simões	AL, PB, PE
<i>Mandevilla duartei</i> Markgr.	MG
<i>Mandevilla fistulosa</i> M.F. Sales, Kin.-Gouv. & A.O. Simões	BA, ES, MG
<i>Mandevilla grazielae</i> M.F. Sales, Kin.-Gouv. & A.O. Simões	ES, MG
<i>Mandevilla harleyi</i> M.F. Sales, Kin.-Gouv. & A.O. Simões	MG
<i>Mandevilla ibitubana</i> J.F.Morales & L. Kollmann *	ES
<i>Mandevilla lucida</i> Woodson	ES, RJ
<i>Mandevilla luetzelburgii</i> (Ross & Markgraf) Woodson	BA, ES, MG
<i>Mandevilla splendens</i> (Hooker) Woodson	MG, RJ,
<i>Mandevilla venulosa</i> (Müller Argoviensis) Woodson	RJ, SP

* Described here

Materials and methods

This paper is part of the monograph of *Mandevilla* Lindl. and specimens from the following herbaria were consulted: A, AAU, ALCB, AS, ASE, ASU, B, BAB, BERA, BHCB, BIGU, BM, BOLV, BR, C, CAS, CAUP, CAY, CDMB, CEN, CEPEC, CGE, CHAPA, CHOCO, CICY, CIIDIR, CIMI, CM, COAH, COL, CR, CVRD, CUVC, CUZ, DPU, DS, DUKE, E, EAP, ECON, ENCB, ESA, ESAL, F, FCME, FCQ, FDG, FI, FI-W, FMB, FUEL, G, G-BOIS, G-DC, GB, GFJP, GH, HAL, HB, HBG, HERZU, HOXA, HRB, HRCB, HSB, HUA, HUCO, HUQ, HURB, IAN, IBGE, ICESI, INPA, IPA, JAUM, JE, JEPS, JPB, K, L, LAGU, LD, LE, LIL, LLANOS, LP, LPB, LZ, M, MA, MBM, MBML, MEDEL, MEXU, MG, MICH, MIRR, MHES, MO, MOL, NY, O, P, P-BA, P-HB, P-JU, P-LA, PEL, PMA, PORT, PR, PSO, Q, QAME, QAP, QCA, QCNE, QPLS, R, RB, RON, S, SI, SP, SPF, SPFR, STRI, SURCO, TEFH, TRIN, TULV, U, UB, UBT, UC, UCAM, UCOB, UDBC, UIS, UPS, UPTC, US, USE, USJ, USM, USZ, UVAL, W, WU, WAG, WIS, VALLE, VEN, VIC, XAL, Z, and ZT, acronyms according to Thiers (2018). Descriptions were made based on herbarium specimens, preserved flowers (alcohol 70 %), and fresh material. Data on distribution, habitat, and phenology were obtained from herbarium vouchers and field notes. Parts of the corolla tube are described following Morales & Fuentes (2004). The terminology for the morphological description follows Radford *et al.* (1974) and Stearn (2004). The conservation status was assessed by calculating the extent of occurrence (EOO) and the area of occupancy (AOO) with GeoCAT (Bachman *et al.* 2011) and applying the IUCN Red List Categories and Criteria, version 3.1 (IUCN 2017). The AOO was calculated based on a user defined grid cell of 2 km.

Results and discussion

Taxonomic treatment

***Mandevilla alata* J. F. Morales & L. Kollmann, sp. nov. Type:**—BRAZIL. Espírito Santo: Santa Teresa, Alto Perdido, 19°49'37"S, 40°44'23"W, 1/X/2010, L. Kollmann, R. Kollmann, 12061 (Holotype, MBML! [barcode MBML40557]; isotypes, MBML! [barcode MBML00004199, barcode MBML00004200], RB!).

Figs. 1, 2, 3.

Mandevilla alata J. F. Morales & L. Kollmann resembles *M. callista* Woodson, but differs by its winged stems (vs. subterete), petiole 18–30(–36) mm long (vs. 55–135 mm), pedicels 6–16(–20) mm long (vs. 23–52(–65) mm), corolla throat red (vs. white), and anthers 6.5–7.2 mm long (vs. 8–9 mm).

Woody vine; stems with well developed longitudinal wings, sparsely and inconspicuously puberulent, soon glabrescent; interpetiolar colleters up to 1.5 mm in young stems, fully developed in old stems, up to 1 cm long. Leaves opposite; petiole 18–30(–36) mm long; blade 4.5–13.5(–15) × 3.2–6.5(–8) cm, ovate to ovate-elliptic, apex acuminate to caudate, base cordate, membranaceous, sparsely puberulent when young adaxially, soon glabrescent, abaxially glabrous, except for the sparse indument near the base of petiole, slightly bullate, without domatia, not revolute, colleters numerous, along the midvein, clustered at the base of the midvein, and along the petiole costa, secondary and tertiary veins conspicuously impressed on both surfaces. Inflorescence axillary, sparsely and minutely puberulent, glabrescent, many-flowered (+20), peduncle 43–98 mm long, pedicels 6–16(–20) mm long; bracts 4–5.5 × 0.9–1.2 mm, linear-ovate to linear-elliptic, scarious; sepals 2.2–4.1 × 1.1–1.7 mm, ovate, unequal, caducous during the anthesis, minute, the apex acuminate, not reflexed, minutely puberulent, the colleter solitary, opposite to the sepal, subentire to irregularly lacinate; corolla infundibuliform; tube greenish white proximally, reddish-white distally, lobes white, internal part of the tube red, minutely puberulent, lower part of tube gibbous, the lower part 15–20 × 3–5.1 mm, the upper part 13–16 mm long, campanulate, 13–17 mm in diam. at the orifice, the apex of the floral bud obtuse to rounded; lobes 18–22 × 9–11 mm, obliquely obovate; stamens inserted at the base of the upper part of the corolla tube, anthers 6.5–7.2 mm long, glabrous dorsally, the base auriculate, the auricles rounded, style-head 3.2–3.5 mm long; ovary 1.8–2.1 mm long, minutely puberulent; nectary annular, slightly 5-lobed, 1/2–2/3 as long as the ovary. Follicles 19–23.5 × 0.4–0.9 mm, free, only united at the apex, sparsely and minutely puberulent, inconspicuously moniliform; seeds 10–12 mm long, minutely puberulent, coma 8–26 mm long, tan.



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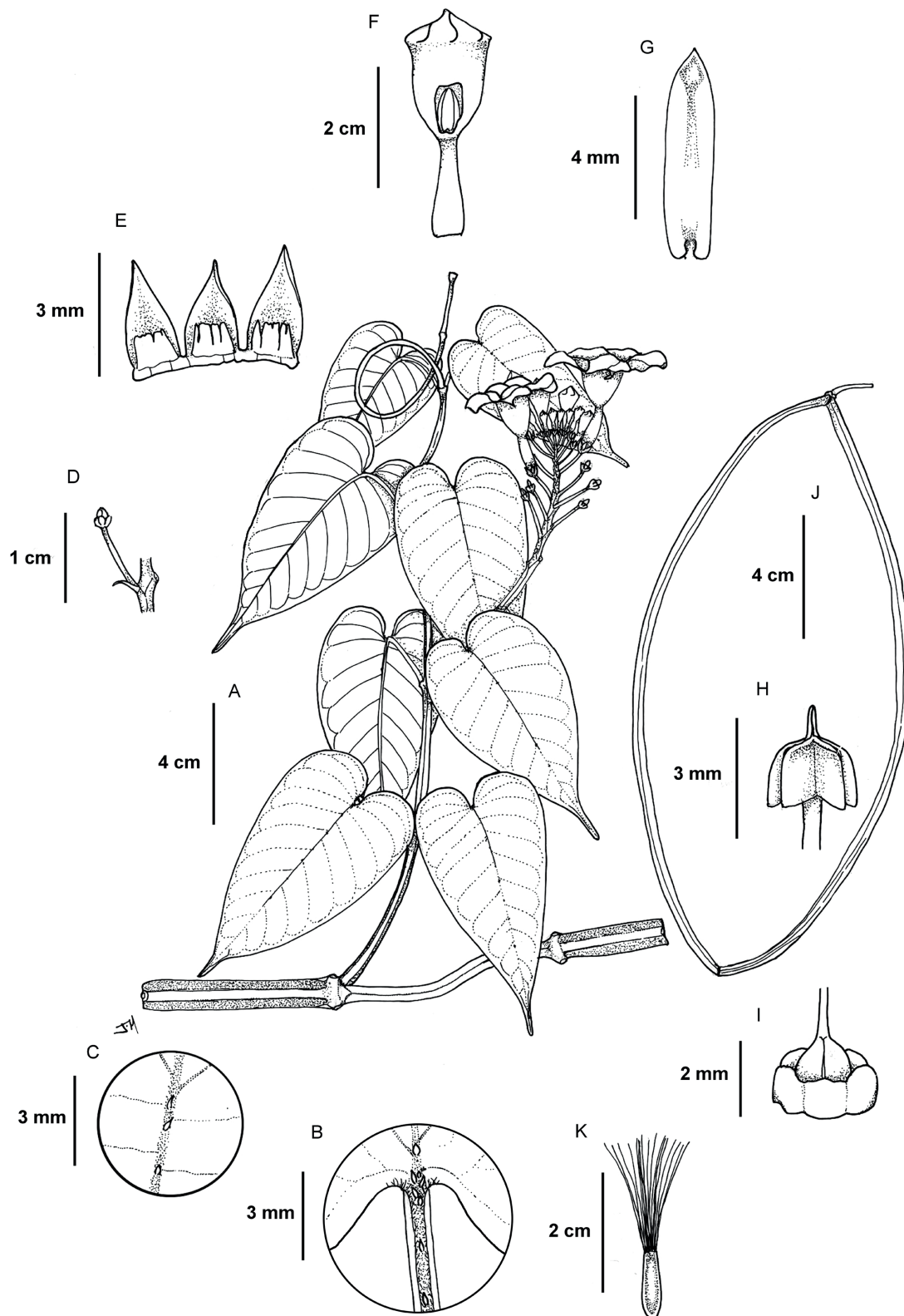
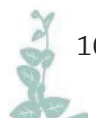


Figure 1. *Mandevilla alata*. **A.** Branchlet with inflorescence. **B.** Detail of the leaf blade and petiole, showing the arrangement of the colleters. **C.** Detail of the adaxial surface of the leaf blade, showing the colleters along the midvein. **D.** Calyx, pedicel, and floral bract. **E.** Adaxial view of three sepals, showing the colleters at the base. **F.** Corolla tube partially open, showing the anthers. **G.** Anther, dorsal view. **H.** Style-head. **I.** Nectary and ovary. **J.** Follicles. **K.** Seed. (A-I from Kollmann & Kollmann 12061, MBML, J-K from Smith s.n., CR).



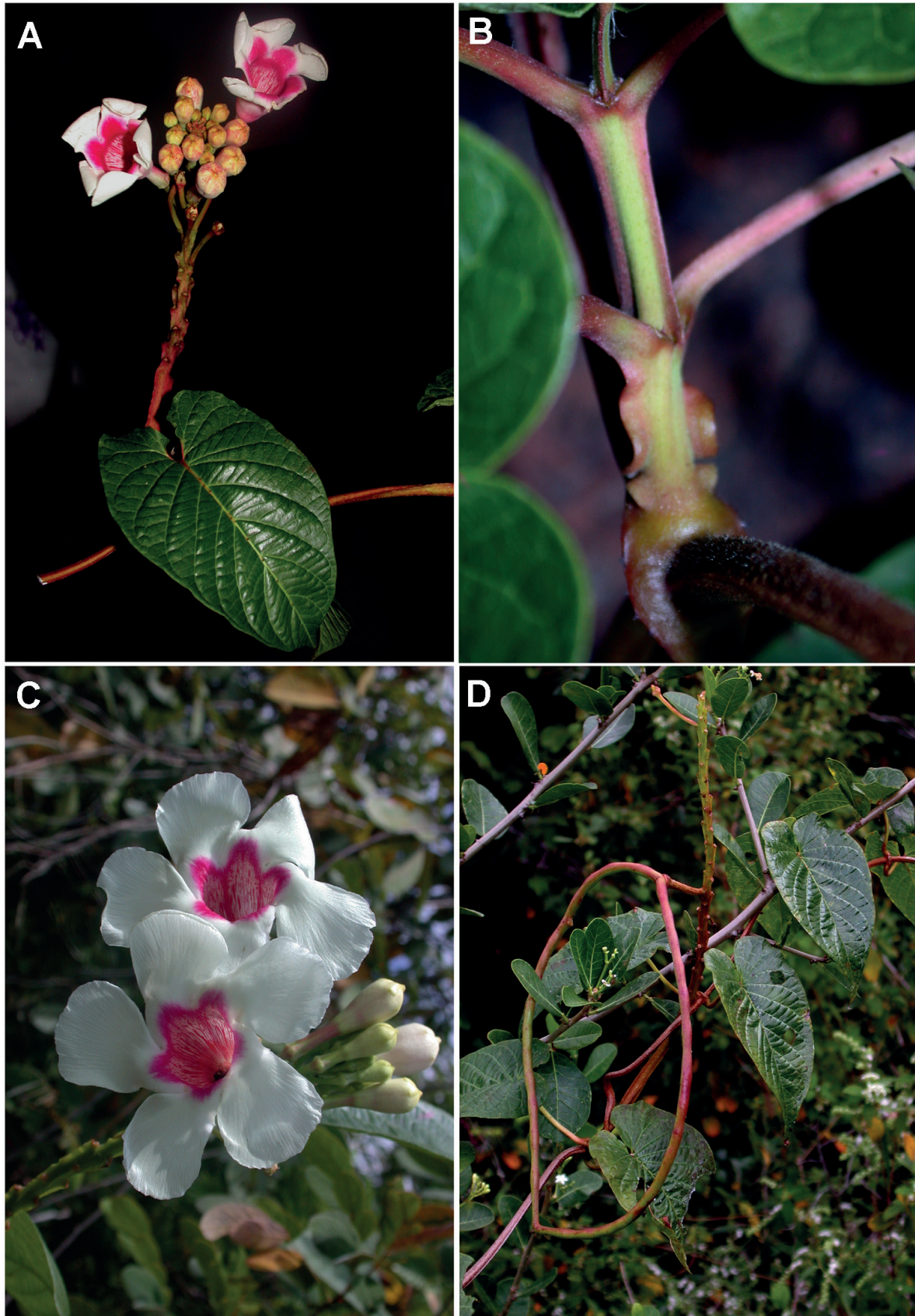


Figure 2. *Mandevilla alata* **A.** Inflorescence and leaf. **B.** Stem with longitudinal wings. **C.** Inflorescence with two flowers and buds. **D.** Branch with follicles.

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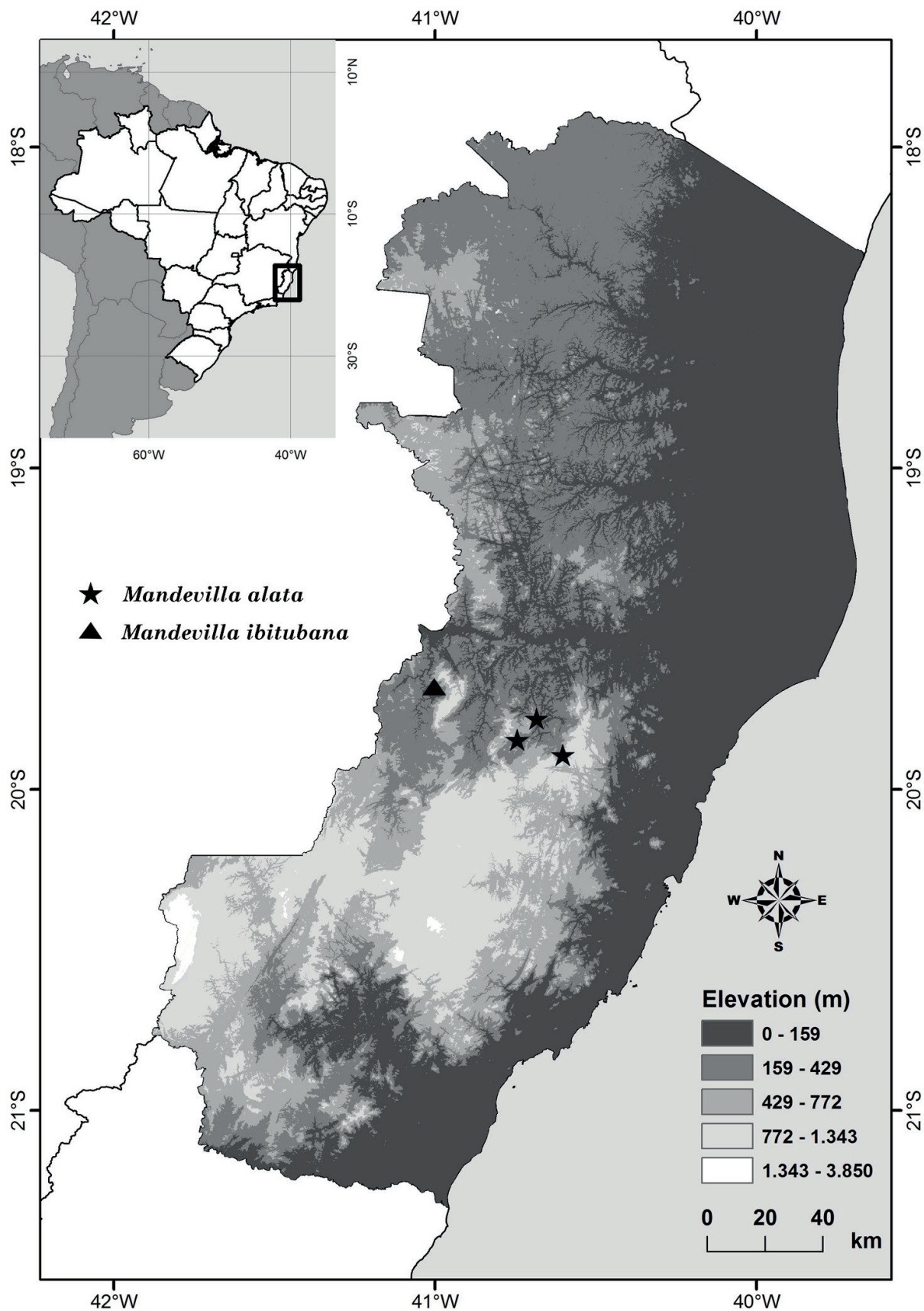


Figure 3. Distribution map of *Mandevilla alata* and *M. ibitubana*.

Distribution and habitat: Endemic to Espírito Santo state, Brazil, growing on inselbergs at 200–750 m.

Phenology: Flowering in February, April, October, and December. Fruiting in January and October.

Etymology: the name refers to the winged stems, an unusual character in *Mandevilla*.

Conservation status: Endangered (EN). *Mandevilla alata* has an EOO of 670,803 km² and AOO of 24 km². As with many species of neotropical Apocynaceae, the actual population size is unknown. However, most of the populations of this species are located in areas without any kind of federal protection. The habitat where *M. alata* grows has been altered in recent years due to fire, which was confirmed during field work in 2010, 2014, and 2018. At least two populations were extinguished by fire in Pancas near Pedra Agulha. Based on its habitat restricted to Inselbergs, the low AOO and the fragmented and continuing decline of its habitat this species is classified as Endangered (EN) following the IUCN criteria B2a biii.

Observations: Few species in *Mandevilla* have winged stems (e.g., *M. anceps* Woodson, *M. angustata* (Steud.) J.F. Morales, *M. lancifolia* Woodson, *M. nerioides* Woodson) all of which grow on inselbergs in the Amazonian basin or quartzitic formations (Tepuis) of the Guayana shield in Colombia, Venezuela, Peru, and Brazil. *Mandevilla alata* is easily distinguished from these species by its petiolate leaves, with petioles usually more than 1.8 cm long (vs. 0.1–8 mm), inflorescences with peduncles 43–98 mm long (vs. 0–35 mm), and follicles 19–23.5 cm long (vs. 7–17 cm). Morphologically, *Mandevilla alata* resembles *M. callista* Woodson (1933: 700), but differs by its winged stems, shorter petioles, shorter pedicels, red corolla throat and smaller anthers. *Mandevilla alata* is restricted to Espírito Santo, whereas *M. callista* is known from Colombia to Bolivia, growing in wet forest from 300 m up to 1800 m of the Andes.

The discovery of a new *Mandevilla* of the “exothostemon” group from Espírito Santo was unexpected. This group of ca. 77 species was recognized as a subgenus by Woodson (1933) and as a section by Pichon (1948). However, these circumscriptions are not monophyletic (Simões *et al.* 2006). Most of the species have calyx lobes with a single colleter (sometimes deeply lacerated) and gibbous corolla tube. They are common in lowlands or middle elevations from Venezuela to Bolivia. In Brazil, they are most abundant in lowlands of the Amazonian basin. In Espírito Santo, only *M. hirsuta* (Rich.) K. Schum. and *M. scabra* (Hoffmanns. ex Rome. & Schult.) K. Schum., neither of which belongs to this group, have been reported. However, molecular studies are necessary to determinate the closest affinities of *M. alata*.

The region of Santa Teresa has been designated as one of the pilot areas of the Biosphere Reserve of Atlantic Forest in Espírito Santo, with many areas with high priority for biodiversity conservation (Mendes & Padovan 2000; Monge

et al. 2018; 2019). Inselbergs are particularly abundant, but many remain unexplored because they are accessible only by air (Sarhou *et al.* 2009) (Fig. 4). In Mandevilla alone, at least four additional undescribed species have been collected recently on inselbergs in Santa Teresa and surrounding areas. Other Apocynaceae described from Espírito Santo and adjacent states include *M. fistulosa* M.F. Sales, Kin.-Gouv. & A.O. Simões, *M. grazielae* M.F. Sales, Kin.-Gouv. & A.O. Simões, and *Rauvolfia capixabae* I. Koch & Kin.-Gouv.

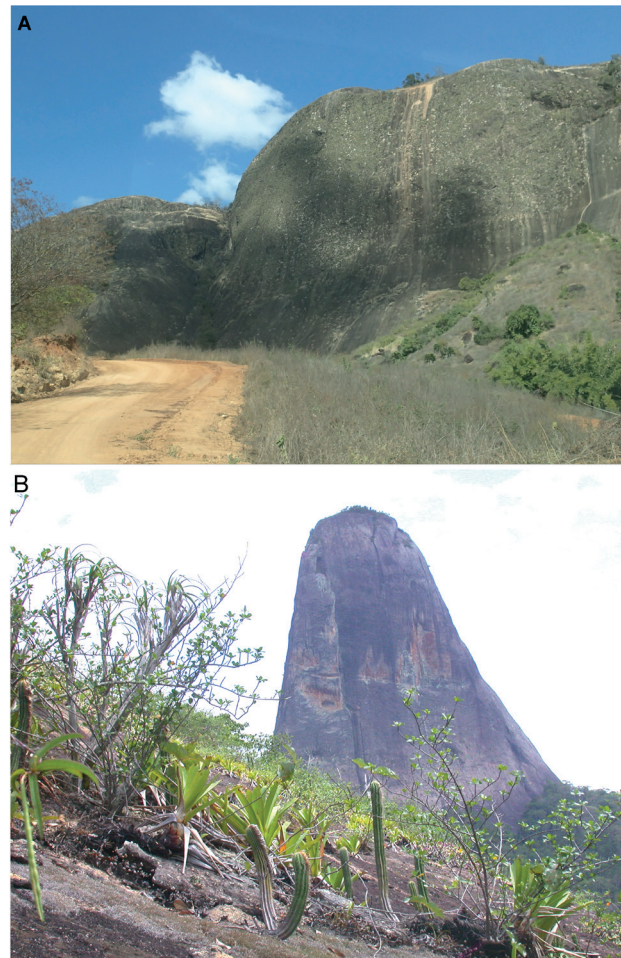


Figure 4. Inselbergs in Espírito Santo, Brazil (photos: J.F. Morales). **A.** Ibituba. **B.** Pancas.

Paratypes: BRAZIL. Espírito Santo: São Roque de Canaã, Pedra do Pionte (São Bento), 28/II/2004, *Fontana et al.* 754 (CR, MBML), 16/X/2004, *Fontana et al.* 949 (MBML); Santa Teresa, Vale do Canaã, 3/XII/1998, *Kollmann et al.* 1196 (MBML, UEC), 21/XI/2008, *Kollmann et al.* 11334 (CR, MBML); Santa Teresa, Alto Perdido, fazenda Montanhosa, terrenos dos Bridge, 14/IV/2007, *Kollmann, et al.* 9624 (CR, MBML), 14/IV/2007, *Kollmann et al.* 9623 (MBML); Santa Teresa, Vale do Canaã, 21/XI/2008, *Kollmann et al.* 11332 (CR, MBML); Lajinha, Pancas, 7/X/2007, *Smith s.n.* (CR).

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***Mandevilla ibitubana* J.F. Morales & L. Kollmann, sp. nov. Type:**—BRAZIL. Espírito Santo: Baixo Guandu, Ibituba, 19°41'32,26"S, 40°44'23"W, 13/IV/2013, L. Kollmann, A.P.Fontana, A.C.Lima, R.Gribel & M.Lemes 12660 (Holotype MBML (barcode MBML00045741)!, isotypes CEPECI, CR!, RB!)

Figs. 2, 3, 5, 6.

Mandevilla ibitubana J.F. Morales & L. Kollmann resembles *M. grazielae* M.F. Sales, Kin.-Gouv. & A.O. Simões but differs by subsessile leaves, with petioles 3–5 mm long (vs. 6–11 mm), corolla white (vs. purple), and anthers 3.9–4.2 mm long (vs. 6–7 mm).

Shrub 1–1.5 m; stems without wings, moderately to densely puberulent, glabrescent with age; interpetiolar colleters up to 0.5 mm in young stems, caducous or not evident in old stems. Leaves opposite; petiole 3–5 mm long; blade 3.4–6.7 × 1–3.1 cm, ovate to ovate-elliptic, apex acuminate, base slightly cordate, membranaceous, densely puberulent on both surfaces, not bullate, without domatia, not revolute, colleters numerous, clustered at the base of the midvein adaxially, secondary and tertiary veins conspicuously impressed abaxially, slightly impressed adaxially. Inflorescence axillary or terminal, minutely puberulent, 3–6-flowered, peduncle 6–17 mm long, pedicels 4–9 mm long; bracts 1.2–1.3 × 0.5–0.8 mm, narrowly ovate, scarious; sepals 2.1–3.2 × 0.9–1 mm, narrowly ovate to narrowly ovate-elliptic, equal, caducous during the anthesis, minute, the apex acute, slightly reflexed, minutely and inconspicuously puberulent, colleters alternate with the sepals, 1–2, entire; corolla hypocrateriform; white, internal part of the tube cream, glabrous, corolla tube straight, 16–17 mm long, 1.4–2.3 mm in diam. at the orifice, the apex of the floral bud acute; lobes 14–16 × 10–12 mm, obliquely obovate; stamens about the middle of the tube length, anthers 3.9–4.2 mm long, glabrous dorsally, the base auriculate, the auricles rounded, style-head 1.7–1.8 mm long; ovary 2.8–3 mm long, glabrous; nectaries five, as long as the ovary. Follicles 3–4.5 × 1.5–3.2 mm, free, only

united at the apex, minutely puberulent, inconspicuously moniliform; seeds 6–7 mm long, glabrous or glabrescent, coma 8–26 mm long, tan.

Distribution and habitat: Endemic to Espírito Santo, Brazil, growing on Inselbergs, at 200–400 m. Flowering and fruiting April, June, and July.

Etymology: the name refers to the type locality.

Conservation status: Critically endangered (CR), based on criteria B1ab + B2ab iii,iv. Only two populations are known (AOO = 8 km²), and they are restricted to Inselbergs and are represented by only a few individuals. No additional populations were found in other inselbergs in the Ibituba region, during recent field work in 2015 and 2018. Future surveys will probably reveal additional populations in other areas, but based on the current evidence, this species is assessed as CR on the IUCN Red List.

Observations: *Mandevilla ibitubana* resembles *M. grazielae*, sharing similar erect habit, short-petiolate leaves, reduced and few-flowered inflorescences, caducous sepals, and small follicles. The sepals of both species are caducous, falling off during anthesis or even when flowers are in buds (Fig. 6). This feature is unusual in *Mandevilla* and reported only in *M. alata*, *M. grazielae*, and *M. ibitubana*. In *Mandevilla*, sepals are persistent, falling off or sometimes persistent during fruiting or even can be persistent on fruits. *Mandevilla ibitubana* is separated by its petioles 3–5 mm long (vs. 6–11 mm), hypocrateriform corolla (vs. infundibuliform), corolla lobes white (vs. purple), and anthers 3.9–4.2 mm long (vs. 6–7 mm).

Baixo Guandu is located just in the border between Minas Gerais and Espírito Santo states. Ibituba is a small town located ca. 20 km S of Baixo Guandu and surrounded by many inselberg formations (Fig. 4). Few collections have been made in this area, mostly in the last decade, but it is basically unexplored. Further fieldwork can reveal more novelties.

Paratypes: BRAZIL. Espírito Santo: Ibituba, 6 km E, road to Itaguaçu, 9/VII/2018, *Morais & Morales s.n.* (JAR).

Key to species of *Mandevilla* growing on inselbergs in Espírito Santo, Brazil

1. Woody vines 2
2. Stems conspicuously winged; leaf blades not bullate; sepals caducous during the anthesis; corolla white, the mouth red, the lower part of the tube gibbous; follicles conspicuously moniliform *M. alata*
- 2'. Stems not winged; leaf blades bullate; sepals not caduceus, persistent; corolla pink, the lower part of the tube not gibbous; follicles more or less continuous, not moniliform *M. luetzelburgii*
- 1'. Erect shrubs 3
3. Corolla yellow, the mouth 16–20 mm in diam.; leaf blade obovate to obovate-elliptic *M. fistulosa*
- 3'. Corolla purple, pink to white, the mouth 2–15 mm in diam.; leaf blade elliptic to ovate-elliptic 4
4. Sepals persistent; inflorescence longer than the subtending leaves *M. lucida*
- 4'. Sepals caducous during the anthesis; inflorescence shorter than the subtending leaves 5
5. Petioles 6–11 mm long; corolla infundibuliform; anthers 6–7 mm long *M. grazielae*
- 5'. Petioles 3–5 mm long; corolla hypocrateriform; anthers 3.9–4.2 mm long *M. ibitubana*



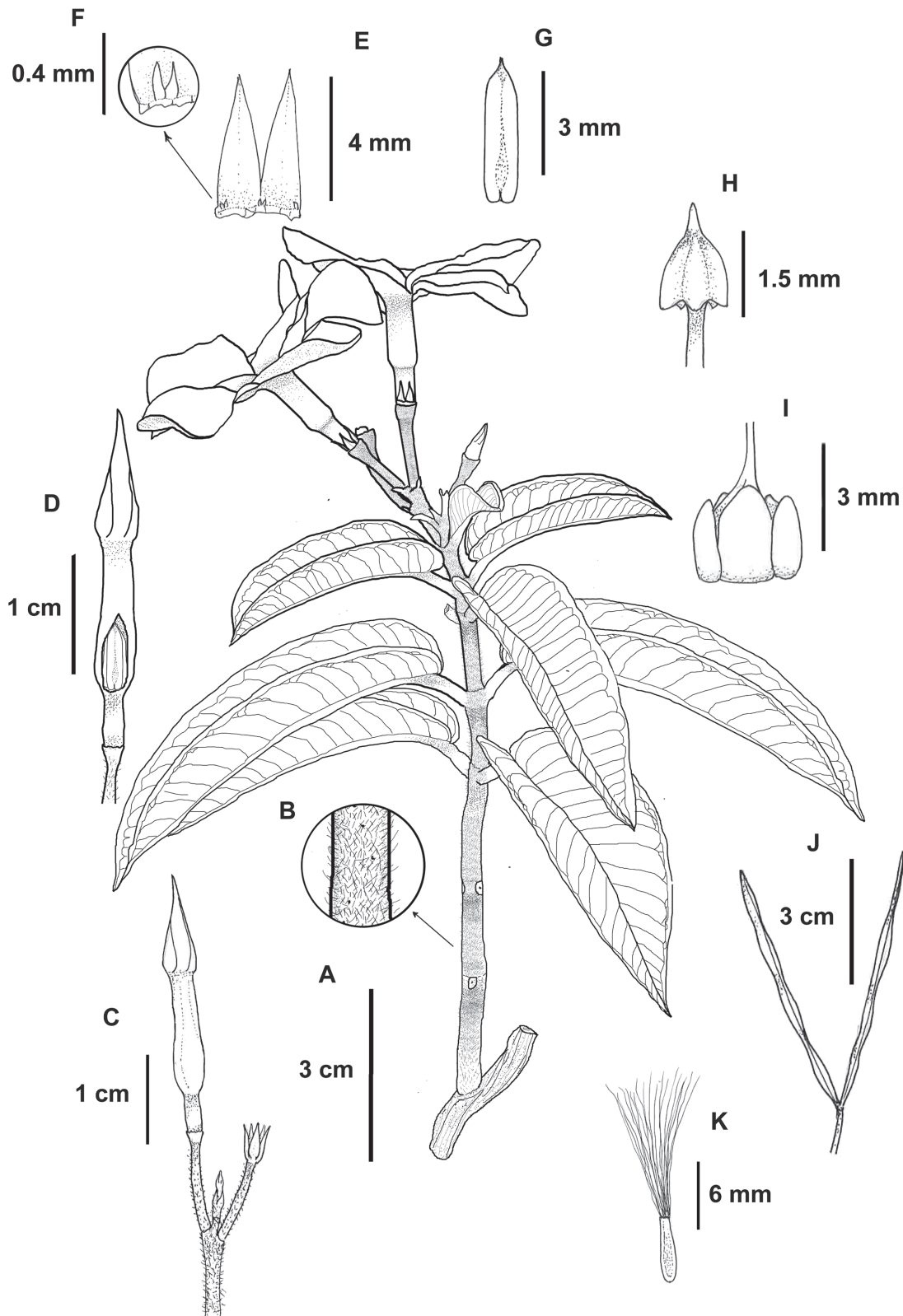


Figure 5. *Mandevilla ibitubana* **A.** Branchlet with inflorescence. **B.** Detail of the stem pubescence. **C.** Calices, pedicels, floral bracts, and floral bud. **D.** Open corolla tube, showing the position of anthers. **E.** Adaxial view of two sepals, showing the colleters at the base. **F.** Details of the colleters. **G.** Anther, dorsal view. **H.** Style-head. **I.** Nectaries and ovary. **J.** Follicles. **K.** Seed. (A-I from Kollmann *et al.* 12660, MBML, J-K from Morais & Morales *s.n.*, JAR).



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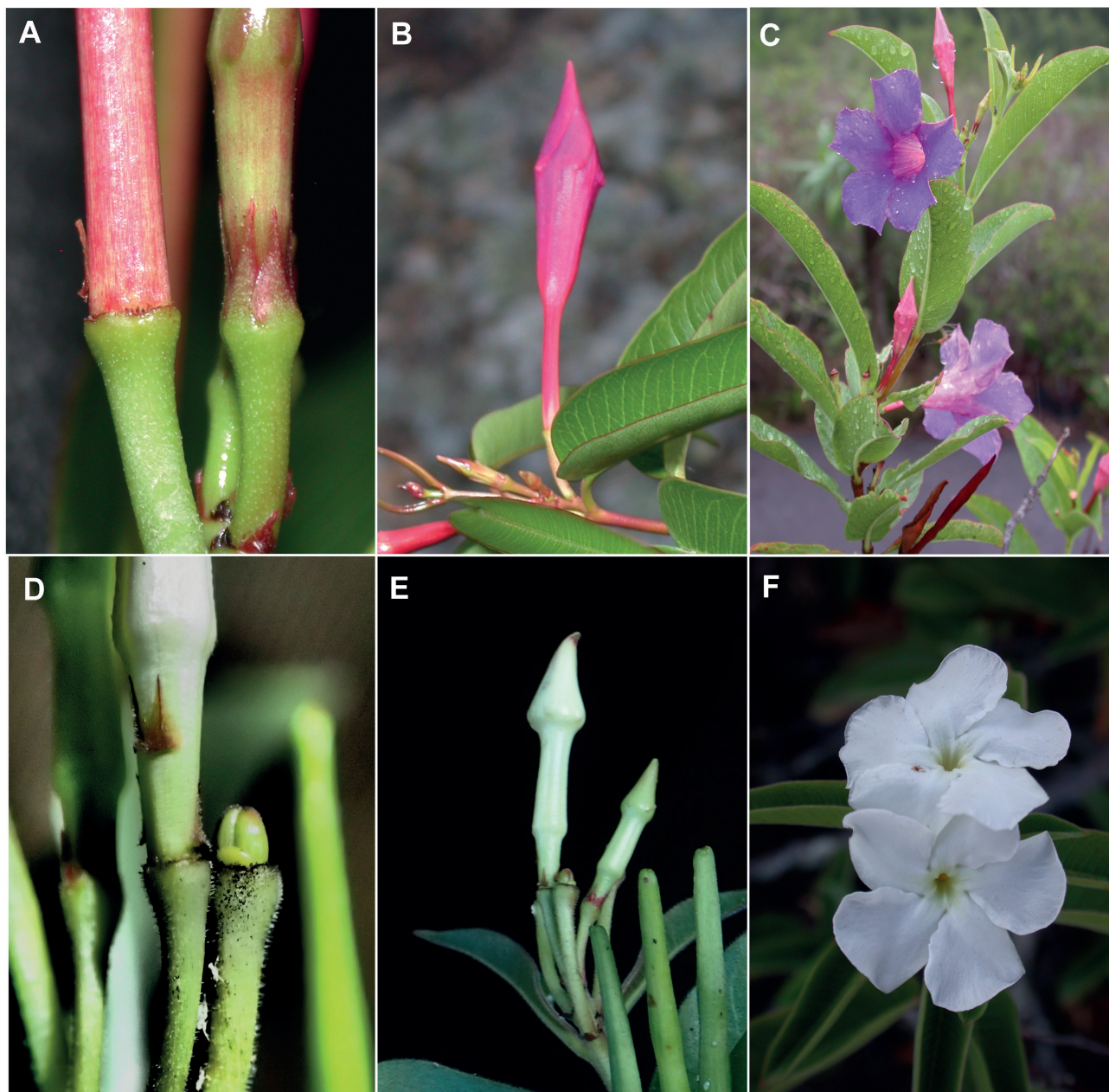


Figure 6. *Mandevilla grazielae* and *M. ibitubana*. **A, D.** Caducous sepals. **B, E.** Corolla bud. **C, F.** Corolla. (A-C, *M. grazielae*, D-F *M. ibitubana*; (photos: J.F. Morales)

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