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## Three new species of *Besleria* (Gesneriaceae) from the southeastern Brazilian Atlantic rainforest

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### Abstract

*Besleria* is a Neotropical genus of terrestrial herbs, shrubs and small trees growing in the understory of rainforests, with more than 160 recognized species, and is one of the larger and more diverse genera of Gesneriaceae. It belongs to the monophyletic tribe Beslerieae, and recent phylogenetic studies indicate that the genus is monophyletic. During field expeditions in the Brazilian Atlantic Rainforest, we collected specimens that could not be identified as any described species. After morphological analysis and comparison with related species, we assigned these specimens to three new species of *Besleria*. In this paper, we describe and illustrate *Besleria aurea*, *B. brevicalyx* and *B. diabolica* and provide data on their ecology, distribution and conservation status.

### Introduction

*Besleria* Plumier ex Linnaeus (1753: 619) include 160 to 200 species of terrestrial herbs, shrubs and small trees that grow in the understory of rainforests (Skog & Feuillet 2008, Berger *et al.* 2015). It is placed in the monophyletic tribe Beslerieae, that diverged about 30 million years ago within the subfamily Gesnerioideae (Zimmer *et al.* 2002, Perret *et al.* 2013, Weber *et al.* 2013). The genus has a Neotropical distribution, occurring in the Andes and the Amazon rainforest of Bolivia to Colombia, in Central America as far north as Mexico, and some species are endemic to the Brazilian Atlantic rainforest and to Caribbean Islands (Skog & Boggan 2007). In Brazil 18 species are currently known, occurring in the Amazon and Atlantic rainforests (Araujo *et al.* 2015).

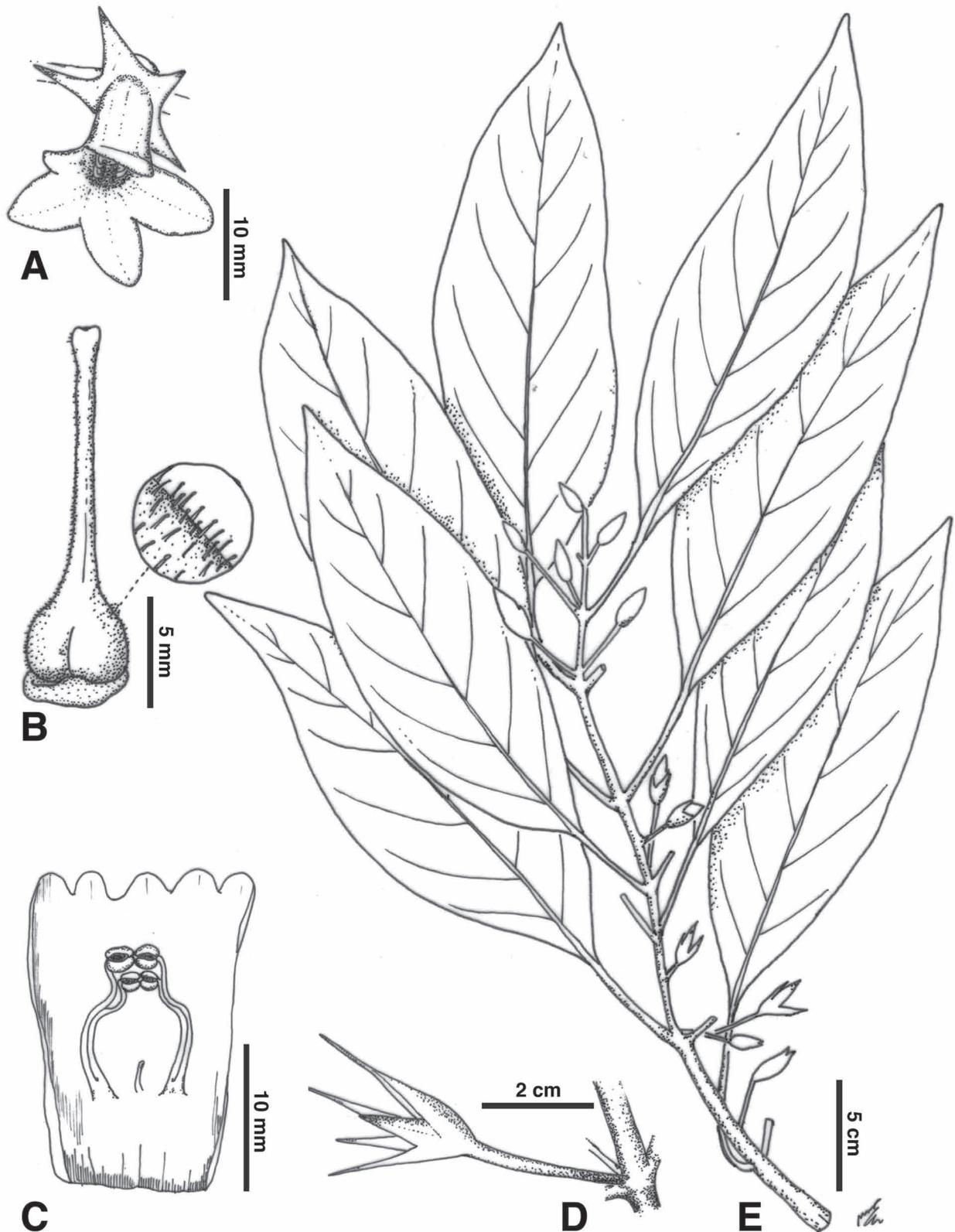
The revision of *Besleria* by Morton (1939) is the only one in existence to date. Wiehler (1975) segregated two sections of *Besleria*, and placed them into genus *Gasteranthus* Benth (1846: 233) on the basis of vegetative and fruit characters. According to molecular phylogenetic studies, *Besleria* (excluding *Gasteranthus*) is monophyletic and *Cremosperma* Benth (1846: 234) is its sister genus (Roalson & Clark 2006, Clark *et al.* 2010). These studies also demonstrated that sections proposed by Morton (1939) were not monophyletic. The circumscription of many species of *Besleria* is still unclear and the genus needs a thorough revision.

In the framework of a taxonomic, phylogenetic and biogeographic survey of *Besleria*, we found three undescribed species that are described here.

### Material & methods

During the examination of herbarium specimens, we found specimens that could not be assigned to any formally described species of *Besleria*. We carried out fieldwork in the Brazilian Atlantic forest to obtain more samples of these unidentified species. We searched for them in the following localities: Descoberto (Minas Gerais), Poço Parado (Rio de Janeiro), and Eldorado (São Paulo), Brazil, between September and November 2014. Living specimens were

photographed in the field. We deposited specimens in the G, INPA, HUFABC and SPSF herbaria. Some flowers were preserved in 70% ethanol and used for drawings of floral features. We performed morphological analyses using a stereoscopic microscope. The descriptive terminology follows Beentje (2010). Additional collections from the G, RB, CESJ, ESAB, HPL and INPA herbaria were also studied.



**FIGURE 1.** *Besleria aurea*. A. Calyx and corolla in frontal view. B. Pistil and nectary with a close up of the glandular indumentum. C. Corolla opened to show stamens and staminode. D. Calyx without corolla and pistil in lateral view. E. Habit (A–E from *I.G. Costa 230*).

## Taxonomy

### *Besleria aurea* I.G.Costa & G.E.Ferreira, *sp. nov.* (Fig. 1)

*Besleria aurea* is similar to *B. fluminensis* in its axillary inflorescence and having flowers with very long yellow conduplicate calyx lobes, however, it differs by having a yellow corolla (*vs.* yellowish-white), narrowly triangular calyx lobes at the base (*vs.* elliptic), and smaller leaf blades with entire margins (*vs.* with serrate margins).

**Type:**—BRAZIL. Rio de Janeiro: Campos dos Goytacazes, Conceição do Imbé, na Serra do Macaco, 16 July 2013, *I.G. Costa 230* (holotype RB!; isotype INPA!).

Terrestrial shrub, 1.5 m tall. Stems unbranched, subterete, up to 0.5 cm diam., strigose at the base, internodes 2.0–6.5 cm long. Leaves opposite, pairs subequal; petioles 2.6–6.7 cm long, green, puberulent; leaf blades elliptic to oblanceolate, 15–19 × 5.5–6.4 cm, apex and base attenuate, margin entire, membranaceous; adaxial surface green, glabrous; abaxial surface pale green, pilose, 5–6 pairs of secondary veins. Inflorescence axillary, cymose, epedunculate, with 1–5 flowers per node; pedicels terete, 2.0–2.1 cm long, green, puberulent. Calyx lobes 5, fused and imbricate at base, diverging from the corolla axis, slightly equal, lanceolate, 11–16 × 4–6 mm, apex attenuate, margin sparsely denticulate, yellow, puberulent. Corolla oblique in relation to calyx, 16–22 mm long, tube contracted at base, limb regular, 6 mm wide at the base, 4 mm wide at the narrowest point, throat 6.5 mm wide, ventricose, yellow, rarely vinaceous, glabrous outside and inside; lobes 5, patent, slightly equal, obtuse, 3–6 × 2–6 mm, margin entire, orange, glabrous. Nectary annular, 1 mm wide, glabrous. Stamens 4, included; filaments 7–9 mm, epipetalous, adnate, free portion of filaments arising at 5 mm from the base of the corolla, glabrous; anthers 2 × 2 mm, longitudinally dehiscent; staminode 2 mm long. Ovary ovoid, 4 × 4 mm, puberulous; style included in the throat, 11 mm long, puberulous; stigma bifid, puberulous. Fruit not seen.

**Distribution and ecology:**—This species is currently found only in the type locality, in Campos dos Goytacazes, in the northern part of Rio de Janeiro state (Fig. 5). This area is rather neglected by plant collectors and new locations for this species are likely to be registered. The species was found in the understory of a humid forest covering slopes at the margin of a river, at about 400 m elevation; only a few individuals were observed.

**Phenology:**—Flowers are recorded from September to December.

**Conservation status:**—Endangered (EN) B1ab(i,iv), according to the IUCN criteria, based on the extent of occurrence estimated to be less than 5,000 km<sup>2</sup> in only one location (IUCN 2013).

**Taxonomic relationships:**—*Besleria aurea* shares a similar floral morphology with *B. fluminensis* Brade (1948: 73), having a yellow calyx with long acuminate lobes. However, it can be distinguished by different corolla colour, calyx lobes shape, leaf blade size and type of the margin (Table 1).

**Etymology:**—The name “aurea” refers to the bright yellow colour of both calyx and corolla (Fig. 4A). This species is the only one to have this colour pattern among all currently known Atlantic rainforest *Besleria* species.

**Additional specimens examined (paratypes):**—BRAZIL. Rio de Janeiro: Campos dos Goytacazes, Conceição do Imbé, Serra do Macaco, 10 May 2012, *M. Perret et al. 65* (G!, VIES!); same locality, 27 August 2012, *H. Lorenzi et al. 7182* (HPL!).

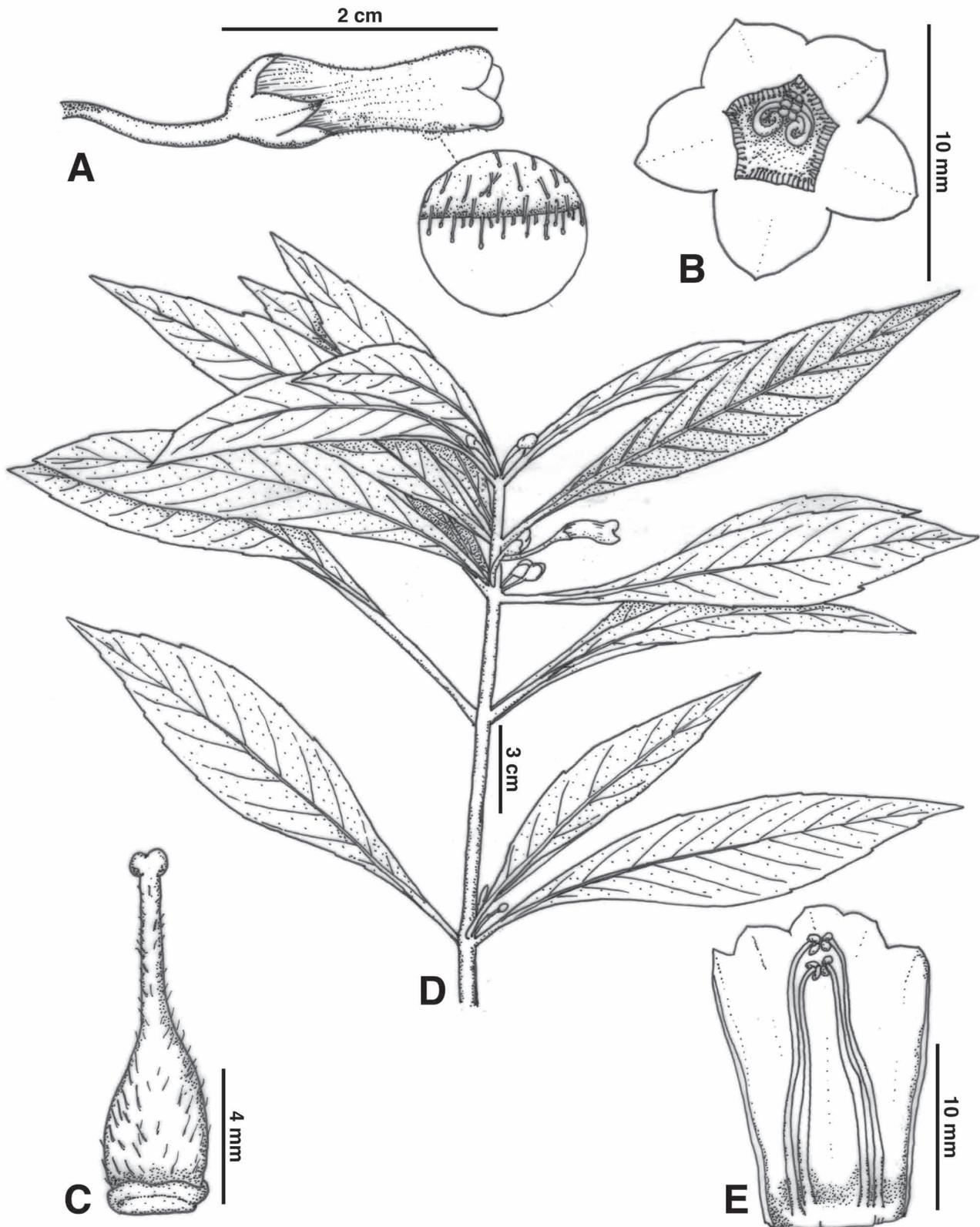
### *Besleria brevicalyx* G.E.Ferreira & Chautems, *sp. nov.* (Fig. 2)

*Besleria brevicalyx* resembles *B. macahensis* in its short calyx, adherent to the corolla base, however, it differs by its 3-verticillate leaves (*vs.* opposite and decussate), longer yellow pedicel and shorter and green-keeled calyx lobes (*vs.* calyx shorter and purplish).

**Type:**—BRAZIL. Minas Gerais: Descoberto, Reserva Biológica da Represa do Grama, trilha do Bananal, 9 November 2014, *G.E. Ferreira et al. 292* (holotype INPA!; isotypes G!; RB!; HUFABC!).

Terrestrial shrub, 0.4–1.8 m tall. Stems branched, subterete, up to 0.4 cm diam., brown, glabrous, sericeous when young, internodes up to 3.0 cm long. Leaves 3-verticillate, equal in a whorl; petioles 2.2–4.1 cm long, green, pubescent; leaf blades oblanceolate, 12.0–20.5 × 3.4–5.6 cm, apex attenuate, base long-attenuate, margin distantly serrulate, membranaceous; adaxial surface green, puberulent; abaxial surface pale green, pubescent, 8–10 pairs of secondary veins. Inflorescence axillary, cymose, epedunculate or rarely very short peduncle, with 1–3 flowers per node; pedicels terete, 2.2–3.4 cm long, green, pubescent. Calyx lobes 5, lobes erect, adherent to the corolla base, dorsally keeled, slightly equal, lanceolate, 4–6 × 3–4 mm, apex acute to mucronate, margin entire, yellow-greenish, outside sparsely puberulous-glandular, inside glabrous. Corolla horizontal in relation to calyx, 16–18 mm long, tube contracted at base, limb regular, 6 mm wide at the base, 4 mm wide at the narrowest point, throat 7 mm wide, ventricose, whitish-

yellow, outside puberulous-glandular, inside glabrous; lobes 5, erect, slightly equal, semiorbicular,  $3 \times 3$  mm, margin entire, white, glabrous. Nectary annular, 0.2 mm wide, glabrous. Stamens 4, included in the throat; filaments 5–7 mm, epipetalous, adnate, free portion of filaments arising at 3 mm from the base of the corolla, glabrous; anthers  $1 \times 2$  mm, longitudinally dehiscent. Ovary ovoid,  $3 \times 4$  mm, puberulous; style included in the throat, 5–6 mm long, puberulous-glandular; stigma bifid, puberulous. Fruit not seen.



**FIGURE 2.** *Besleria brevicalyx*. A. Calyx and corolla in lateral view with a close up of the glandular indumentum. B. Corolla in frontal view. C. Pistil and nectary. D. Habit. E. Corolla opened to show stamens (A–E from G.E. Ferreira et al. 292).

**Distribution and ecology:**—This species occurs in Descoberto, Minas Gerais state (Fig. 5). It was collected in seasonal dry forest, of the Atlantic rainforest domain, occurring on sandy/ rocky banks of streams (Fig. 4D) at ca. 550–950 m elevation. Only a few plants were found at each collection point.

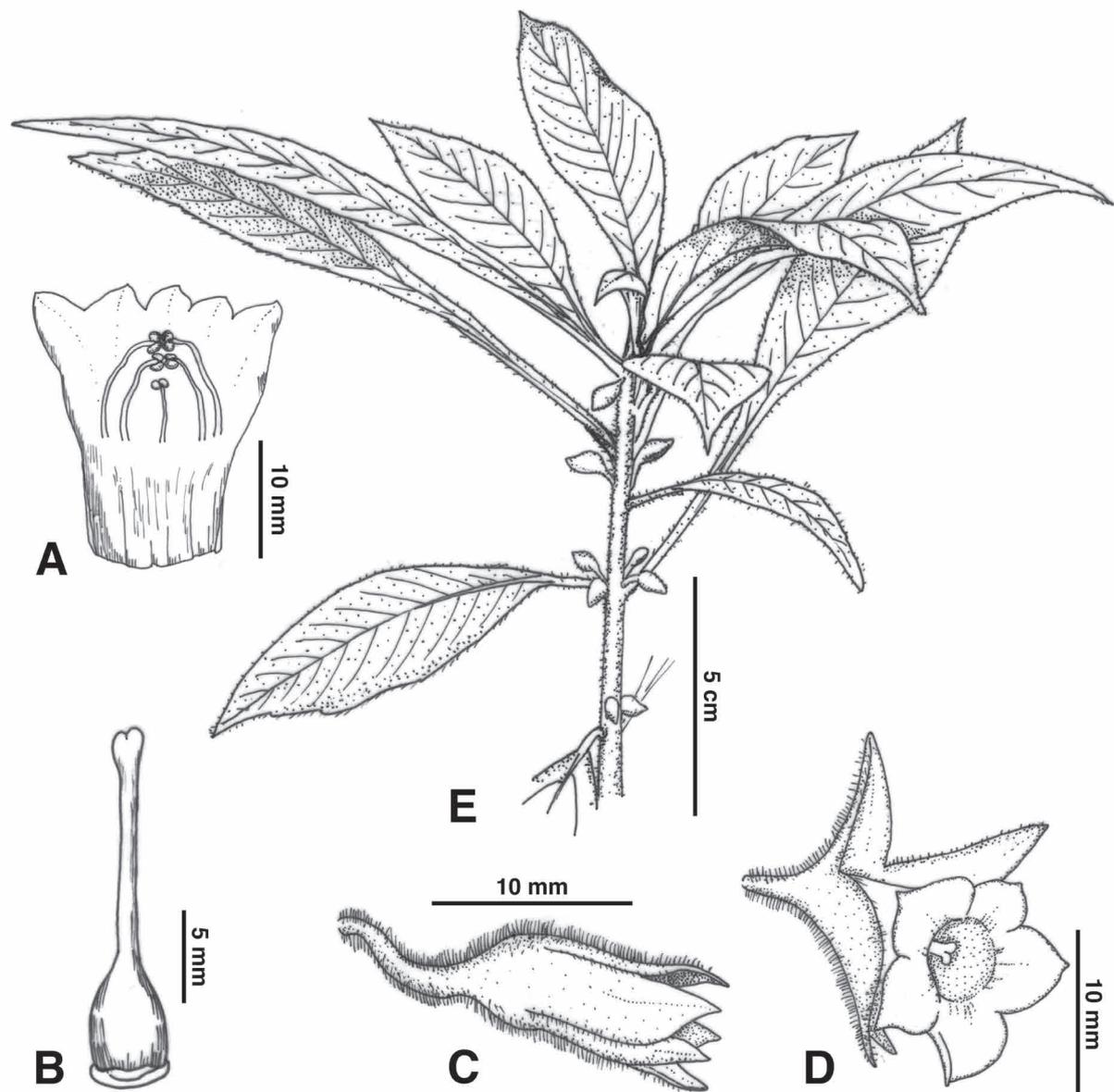
**Phenology:**—Flowers are recorded from January to October.

**Conservation status:**—Endangered (EN) B1ab(i, iv), according to the IUCN criteria, based on the extent of occurrence estimated to be less than 5,000 km<sup>2</sup> in only two locations (IUCN 2013).

**Taxonomic relationships:**—*Besleria brevicalyx* has characteristics similar to those of *B. macahensis* Brade (1948: 74), including fasciculate inflorescence, calyx closely adherent to the corolla base, calyx lobes 3–4 mm wide, and yellowish-white corolla. However, it differs from *B. macahensis* by its 3-verticillate leaves (vs. opposite), yellow pedicels (vs. purplish-yellow), and yellow calyx with green-keeled calyx lobes (vs. purplish-yellow). *Besleria brevicalyx* also has longer pedicels and shorter calyx lobes (Table 1). Additionally, *B. brevicalyx* occurs in Minas Gerais and Espírito Santo in sandy and rocky substrates in seasonal dry Forest, whereas *B. macahensis* is restricted to Rio de Janeiro state and occurs in substrates rich in organic matter in the Atlantic rainforest.

**Etymology:**—The name “brevicalyx” refers to the very short calyx lobes that are adherent to the corolla base.

**Additional specimens examined (paratypes):**—BRAZIL. Minas Gerais: Descoberto, Reserva Biológica da Represa do Grama, 18 May 2002, *A.V. Lopes et al.* 43 (CESJ!, G!); same place, 29 April 2000, *C.L. Faria et al.* 70 (CESJ!, G!).

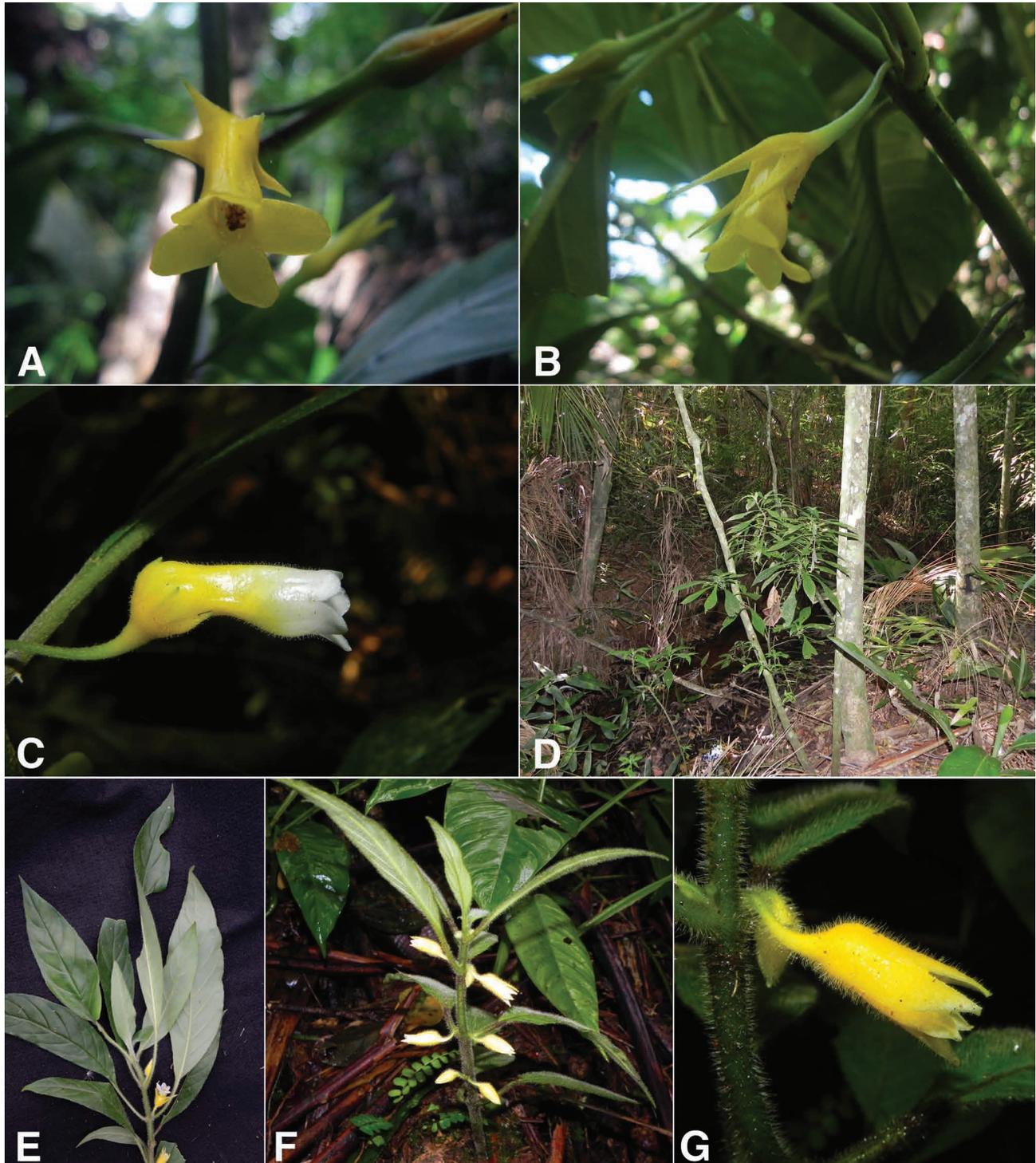


**FIGURE 3.** *Besleria diabolica*. A. Corolla opened to show stamens and staminode. B. Pistil and nectary. C. Calyx without corolla in lateral view. D. Calyx and corolla in frontal view. E. Habit (A–D from *E.R. Salviani & H. Lorenzi 1773* and E from *G.E. Ferreira et al. 271*).

*Besleria diabolica* G.E.Ferreira & Chautems, *sp. nov.* (Fig. 3)

*Besleria diabolica* is similar to *B. melancholica* in having flowers with reflexed, flat calyx lobes. However, *B. diabolica* differs by its longer leaf blades, usually fewer flowers per axil and by its narrower, lanceolate calyx lobes, with acute apices.

**Type:**—BRAZIL. São Paulo: Eldorado, Parque Estadual Caverna do Diabo, trilha do Araçá, nas margens do córrego, 29 September 2014, G.E. Ferreira *et al.* 271 (holotype INPA!; isotypes G!; HUFABC!; SPSF!).



**FIGURE 4.** Morphology and habitat of the new species of *Besleria*. A–B. *Besleria aurea*. A. Calyx and corolla in frontal view. B. Calyx and corolla in lateral view. C–D. *Besleria brevicalyx*. C. Calyx and corolla in frontal view. D. Habit and habitat. E–G. *Besleria diabolica*. E. Flowering branch. F. Habit. G. Calyx in lateral view. (A–B from I.G. Costa 230; C–D from G.E. Ferreira *et al.* 292; E from T. Flores *s.n.*, F–G from G.E. Ferreira *et al.* 271).

Terrestrial shrub, 0.8–1.5 m tall. Stems unbranched, subterete, 0.4–0.5 cm diam., green, hirsute, internodes 1.3–3.2 cm long. Leaves opposite and decussate, pairs subequal; petioles 3.2–5.5 cm long, green, hirsute; leaf blades elliptic to lanceolate, 16.0–22.5 × 3.2–6.0 cm, apex and base attenuate, margin distantly denticulate and ciliate, membranaceous; adaxial surface green, hirsute; abaxial surface pale green, hirsute, 6–9 pairs of secondary veins. Inflorescence axillary, cymose, epedunculate or rarely with a very short peduncle, with 1–3 flowers per node; pedicels terete, 1.2–1.7 cm long, green, hirsute. Calyx lobes 5, fused and imbricate at base, spreading, subequal, lanceolate, 1.0–1.4 × 0.3–0.4 cm, apex attenuate, margin entire, yellow, hirsute. Corolla oblique in relation to calyx, 18–24 mm long, tube contracted at base, limb regular, 6 mm wide at the base, 5 mm wide at the narrowest point, throat 7 mm wide, ventricose, yellowish-white, glabrous outside and inside; lobes 5, reflexed, slightly equal, semiorbicular, 2 × 4 mm, margin entire, white, glabrous. Nectary annular, 0.5 mm wide, glabrous. Stamens 4, included in the throat; filaments 5–6 mm, epipetalous, adnate, free portion of filaments arising in the middle of the corolla tube, glabrous; anthers 1 × 2 mm, longitudinally dehiscent; staminode 0.4 cm long. Ovary ovoid, 4 × 5 mm, glabrous; style included in the throat, 11–15 mm long, glabrous; stigma bifid. Fruit not seen.

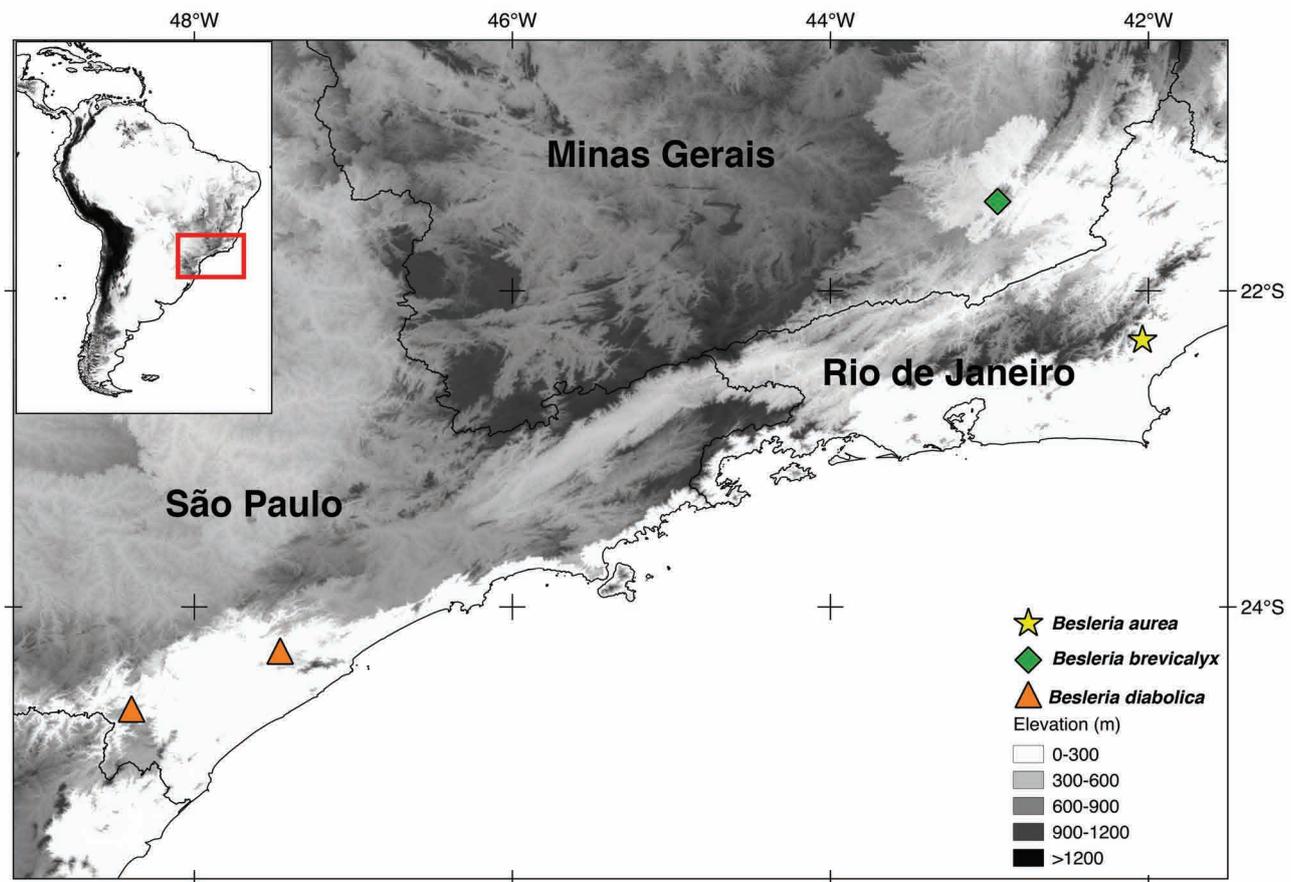


FIGURE 5. Distribution of the three new species of *Besleria* in eastern of Brazil.

**Distribution and ecology:**—*Besleria diabolica* is known from Eldorado and Miracatú, municipalities in the southern part of São Paulo state (Fig. 5). The vegetation type in this region is Atlantic rainforest of the Atlantic forest domain. The species usually occurs along banks of streams within forested areas at around 400 m elevation. Based on our own observations in the vicinity of the “Caverna do Diabo” state park only a few scattered individuals were seen, indicating a low population density.

**Phenology:**—Flowers are recorded from September to November.

**Conservation status:**—Endangered (EN) B1ab(i,iv), according to the IUCN criteria, based on the extent of occurrence estimated to be less than 5,000 km<sup>2</sup> in only two locations (IUCN 2013).

**Taxonomic relationships:**—This new species is somewhat similar to *Besleria melancholica* (Vellozo 1825: 260) Morton (1939: 446) in the shape and position of the calyx lobes, but it can be differentiated by the narrower calyx lobes (3–4 mm vs. 4–7 mm wide), which are lanceolate with acute apices (vs. oblong with obtuse apices). Inflorescences of *B. melancholica* may have many flowers, 5–6 (more commonly 2–4), while *B. diabolica* has 1–3 flowers per

inflorescence (Fig. 4G). Geographically, *B. diabolica* has a different distribution occurring only in southern São Paulo state, whereas *B. melancholica* is restricted to mountainous areas in Rio de Janeiro state.

**Etymology:**—The name “diabolica” is a reference to the first place where this species was found, around the “Caverna do Diabo” state park, which is located in the southern region of São Paulo state in Brazil.

**Additional specimens examined (paratypes):**—BRAZIL. São Paulo: Eldorado, nas proximidades da Caverna do Diabo, 11 November 2000, *E.R. Salviani & H. Lorenzi 1773* (HPL!, INPA!); Miracatú, perto de Pedro Barros, 30 Ago 1966, *J. Mattos s.n.* (RB!).

**TABLE 1.** Morphological comparisons of the three new *Besleria* and related species.

Traits/Species	<i>B. aurea</i>	<i>B. brevicalyx</i>	<i>B. diabolica</i>	<i>B. fluminensis</i>	<i>B. macahensis</i>	<i>B. melancholica</i>
Leaf arrangement	opposite	3-verticillate	opposite	opposite	opposite	opposite
Leaf blade size [cm]	15–19 × 5.5–6.4	12.0–20.5 × 3.4–5.6	16.0–22.5 × 3.2–6.0	18–30 × 7–15	11.5–16.0 × 4.2–6.0	11–16 × 3.9–7.1
Leaf blade indumentum, abaxial surface	pilose	pubescent	hirsute	puberulous	pilose	glabrous to hirsute
Leaf blade margin	entire	serrulate	distantly denticulate	serrate	entire	entire to serrate
Petiole length [cm]	2.6–6.7	2.2–4.1	3.2–5.5	3.0–18.0	3.0–4.5	2.7–6.5
Number of flowers per axil	2–5	1–3	1–3	2–6	2–6	2–6
Pedicel indumentum	puberulent	pubescent	hirsute	pilose	pilose	hirsute
Pedicel length [cm]	2–2.1	2.2–3.4	1.2–1.7	1.3–2.6	1.3–2.6	1.1–2.3
Calyx colour	yellow	yellow-greenish	yellow	yellow–purplish	yellow–purplish	yellow–greenish
Calyx lobes dorsally keeled	yes	yes	no	yes	no	no
Calyx lobes length [mm]	11–16	4–6	10–14	9–11	9–11	13–16
Calyx lobes width [mm]	4–6	3–4	3–4	2–4	3–4	4–7
Calyx lobe shape	lanceolate	lanceolate	lanceolate	elliptic	lanceolate	oblong
Calyx lobe apex	attenuate	acute with mucron	attenuate	acuminate	attenuate	attenuate
Calyx lobe positions	spreading	adherent	spreading	spreading	adherent	spreading
Calyx indumentum	puberulent	glabrous	hirsute	puberulous	glabrous	glabrous to hirsute
Corolla colour	yellow	whitish-yellow	yellowish-white	yellowish-white	yellowish-white	yellowish-white
Corolla length [cm]	1.6–2.2	1.6–1.8	1.8–2.4	1.9–2.1	1.9–2.1	1.6–2.2
Corolla lobe length [mm]	3–6	3	2	5–7	5–7	3–5

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