

Novelties in *Lepidaploinae* (Asteraceae, Vernoniaeae) from the easternmost campos rupestres of Minas Gerais, Brazil: two new species and a range expansion

Guilherme M. Antar^{1,*}, Carolina M. Siniscalchi², Paulo M. Gonella³,
Marcelo Monge⁴ & Benoit Loeuille⁵

¹Departamento de Botânica, Instituto de Biociências, Universidade de São Paulo, Rua do Matão 277, 05508-090, São Paulo, SP, Brazil

²Department of Biological Sciences, Mississippi State University, 295 E. Lee Blvd., P.O. Box GY, Mississippi State, MS 39762, USA

³Universidade Federal de São João del-Rei, Campus Sete Lagoas, Rodovia MG 424, km 47, Sete Lagoas, MG, 35701-970, Brazil

⁴Programa de Pós-graduação em Biologia Vegetal, Instituto de Biologia, Universidade Federal de Uberlândia, Rua Ceará s.n., Uberlândia, 34400-902, Brazil

⁵Departamento de Botânica, Centro de Biociências, Universidade Federal de Pernambuco, R. Prof. Nelson Chaves, s/n, CDU, 50670-420 Recife, Pernambuco, Brazil

*Corresponding author: guilherme.antar@gmail.com

Background – Recent collection efforts in Serra do Padre Ângelo, Pico da Aliança, and Sete Salões State Park, all located in the state of Minas Gerais, have uncovered many botanical and zoological novelties. The region is an outlying campos rupestres area inserted in the Atlantic Forest phytogeographic domain, with its flora mostly related to that of the core campos rupestres area in the Espinhaço Range. Three species of Asteraceae, one of the most representative families in the campos rupestres, have been recently described for the area. Here we report two new species from the genera *Lepidaploa* and *Lessingianthus* and one range extension in *Lessingianthus*, both from subtribe Lepidaploinae.

Methods – This study was based on specimens from the herbaria HUFU, MBML, SPF, UFP, and on field observations. Morphological observations and measures were taken following standard practices. Preliminary conservation assessments are based on field observations and spatial analyses (i.e. extent of occurrence, area of occupancy), following IUCN guidelines and criteria.

Results – Two new species are described: *Lepidaploa campirupestris*, related to *Lepidaploa aurea*, differing from the latter by leaf indumentum, pedunculate heads, and number of florets; and *Lessingianthus petraeus*, related to *Lessingianthus adenophyllus*, but differing by leaf position and leaf blade morphology. We also report a range extension for *Lessingianthus squamosus*, previously known only for the state of Espírito Santo, ca 200 km away. Our results shed light on the interesting biogeography of the region, which mostly contains components of other campos rupestres areas intermixed with typical inselberg vegetation. It also highlights the importance of compiling floristic inventories in poorly collected localities and the need for conservation strategies for this biodiverse region.

Keywords – Atlantic Forest; biodiversity hotspot; campos rupestres; Compositae; conservation; *Lepidaploa*; *Lessingianthus*; Serra do Padre Ângelo.

INTRODUCTION

Lepidaploinae S.C.Keeley & H.Rob. is a subtribe of Vernoniae (Asteraceae) composed of 14 genera with neotropical distribution, with the exception of the pantropical weed *Struchium* P.Browne (Keeley & Robinson 2009). The two largest genera in the subtribe are *Lepidaploa* (Cass.) Cass. and *Lessingianthus* H.Rob., together accounting for ca 75% of the diversity of the group (Monge et al. 2018; Ribeiro & Telles 2018). The delimitation of these two genera is nevertheless problematic, as it relies mostly on micromorphological characters, an issue derived from the circumscription changes in *Vernonia* Schreb., in which many species of *Lepidaploa* and *Lessingianthus* were once placed (Robinson 1999; Keeley & Robinson 2009). Broadly sampled phylogenies, as well as re-evaluation of morphology and anatomy, could improve the delimitation of these genera (Keeley et al. 2007; Loeuille et al. 2015a).

Lepidaploa comprises between 120 and 150 species (Keeley & Robinson 2009; Pruski & Robinson 2018) distributed from Mexico to north-eastern Argentina, with about a third of the diversity in Brazil, where 55 species are recognized (Marques et al. 2018b; Flora do Brasil 2020). The genus is currently circumscribed by the combination of *Vernonia* pollen types C, D, and G (sensu Keeley & Jones 1979), anther appendages mainly eglandular, style with basal node, ovary walls with cubic, druse, prismatic, and styloid crystals, and sessile, small capitula (Robinson 1990; Marques et al. 2018a). *Lessingianthus* comprises ca 135 species restricted to Central and South America, with most of the diversity in Brazil, where 114 species are recorded (Robinson 1988; Antar & Loeuille 2015; Pruski & Robinson 2018; Flora do Brasil 2020). The genus is currently circumscribed based on the combination of *Vernonia* pollen type B (sensu Keeley & Jones 1979), eglandular apical anther appendages, style usually without basal node, ovary walls with cubic or styloid crystals and medium or large capitula, often pedunculated (Robinson 1988, 1999; Dematteis 2006; Angulo & Dematteis 2014; Marques et al. 2018b).

Lepidaploa and *Lessingianthus* are particularly diversified in the campos rupestres, (herbaceous and shrubby vegetation found on quartzite and ironstone soils and outcrops in elevations above 900 m a.s.l.) with 49 and 23 species, respectively, found in this phytophysiognomy (Flora do Brasil 2020). Campos rupestres are recognized as one of the most diverse vegetation types in Brazil, with high levels of endemism (Colli-Silva et al. 2019). This vast biodiversity is currently threatened by opencast mining, wood extraction, agriculture, altered fire regimes, and invasive species; besides being largely undervalued by regional and national government and still lacking specific legislation for its protection (Silveira et al. 2016). Following a trend common to species-rich lineages from campos rupestres, many taxonomic novelties belonging to *Lepidaploa* and *Lessingianthus* have been published recently (e.g. Borges & Dematteis 2008; Dematteis & Angulo 2010; Ribeiro & Telles 2018), revealing an advance in the knowledge of campos rupestres biodiversity.

The core campos rupestres region is concentrated in the uplands of the Espinhaço Range (ER), a mountain chain

extending over 1000 km in a north-south axis along the central part of the states of Minas Gerais and Bahia, while smaller fragments are found in other mountain complexes surrounding the ER and further away in the state of Goiás and in the Amazon Forest domain (Silveira et al. 2016). Recent botanical exploration of mountain tops in eastern Minas Gerais have resulted in increasing numbers of new species and geographical records belonging to different plant families typically found in campos rupestres (e.g. Gonella et al. 2015; Loeuille & Pirani 2016; Lopes et al. 2016; Siniscalchi et al. 2016; Mello-Silva 2018; Andrino & Gonella 2021; Antar et al. 2021). These areas, namely Serra do Padre Ângelo, Pico da Aliança, and Sete Salões State Park, show floristic elements remarkably similar to those found in the ER, despite being located ca 200 km to the east (Siniscalchi et al. 2016). These three areas are entirely contained within the Atlantic Forest (Mata Atlântica) domain, differently from the ER, which is located in the transition among the Atlantic Forest, Cerrado, and Caatinga domains (Mello-Silva 2018). Therefore, a better understanding of the diversity in these areas might reveal a different plant community, resulting from this ecological and geographical isolation.

Three new Asteraceae taxa were recently described from these easternmost campos rupestres in Minas Gerais (Loeuille & Pirani 2016; Siniscalchi et al. 2016; Loeuille et al. 2019), revealing the potential for occurrence of new, narrowly endemic species from the family, which is one of the most representative in the campos rupestres (Campos et al. 2019; Colli-Silva et al. 2019). Several species of Asteraceae were recorded during field surveys of the flora of these areas, including specimens belonging to three distinct taxa of Lepidaploinae. After careful examination of this material, two are described as new species below. The third taxon was identified as *Lessingianthus squamosus* M.Monge & Semir, a recently described species known only from the state of Espírito Santo (Monge et al. 2018), thus representing an expansion of the geographical range and a new record for the state of Minas Gerais. In this work, we present descriptions for the new taxa, with illustrations, photographs, distribution maps, preliminary conservation status assessments, and comments on their ecology. Their affinities with other species are also discussed. We also include an amended description and comments on the morphological and ecological variation of the new populations of *Lessingianthus squamosus*, with an informal conservation status assessment.

MATERIAL AND METHODS

Specimens were studied and collected in situ following traditional techniques (Mori et al. 2011) and deposited in the SPF herbarium. Further specimens from the herbaria HUFU, MBML, SPF, and UFP (acronyms according to the Index Herbariorum; Thiers continuously updated) were analyzed. A 10–60 × magnification stereomicroscope was used to analyze morphological features of the specimens. Measurements to elaborate the comparative tables were obtained from Flora do Brasil (2020), Nakajima (2000), and specimens analyzed at the SPF herbarium. The terminology used to describe two-dimensional shapes followed Hickey (1973), general morphology followed Beentje (2010) and

Harris & Harris (2001); specific Asteraceae terms followed Roque et al. (2009). The distribution map was produced in QGIS v.3.0.1 (QGIS Development Team 2018). Provisional conservation status assessments were based on range area, criterion B of IUCN (2012), through the estimated area of occupancy (AOO) and extent of occurrence (EOO), both simultaneously calculated with the GeoCAT tool (Bachman et al. 2011).

TAXONOMIC TREATMENT

Lepidaploa campirupestris Antar & Loeuille, **sp. nov.** (figs 1, 2) – Type: BRAZIL • Minas Gerais, Conselheiro Pena, Pico do Padre Ângelo, campo rupestres; 19°19'14.19"S, 41°34'43.83"W; 1503 m; 3 Aug. 2014; *B. Loeuille, C.M. Siniscalchi & C.T. Oliveira 891*; holotype: SPF[216074]; isotypes: K, RB, US.

Diagnosis – Species *Lepidaploae aureae* habitu, inflorescentiae fabrica et involucri bractearum serierum numero simile, sed foliis supra glabratis (non sericeis), capitulis pedunculatis (non sessilibus) et floribus 18–24 pro capitulo (non 33–45) differt.

Description – **Shrub** up to 1 m tall, erect, poorly branched; younger stems angulose, ribbed, villous with long simple trichomes and glandular punctate trichomes, older stems glabrescent, ± terete, ribbed, 3–4 mm diameter at base. **Leaves** alternate, simple, petiolate, petiole 1.2–3.5 mm long, increasing in length towards middle portion of stem; blade 1.8–4.0 × 1.0–1.7 cm, discolorous, chartaceous or membranaceous, elliptic to wide elliptic, rarely oblanceolate, base cuneate or rounded, rarely slightly cordate, sometimes asymmetrical, apex acute or acuminate with a swollen mucro ca 0.5 mm long, margins slightly revolute, serrate in upper part with 1–3 teeth, teeth acuminate, swollen, ca 0.5 mm long; venation semicraspedodromous, midrib prominent abaxially, slightly prominent to middle of blade, plane or slightly impressed adaxially, abaxial surface punctate, densely covered with sessile glands and scattered simple appressed trichomes, denser over veins, adaxial surface glabrous, rarely with few shiny, simple trichomes near base. **Inflorescence** seriate-cymose, with 6–15 capitula, inflorescence bracts foliaceous, 0.6–1.6 × 0.6–0.9 cm, sessile to subsessile, subinvolucral bracts absent. **Capitula** homogamous, discoid, subsessile to pedunculate, peduncle 0.5–3.0 mm long; involucre campanulate, 8.5–10.1 × 6.5–8.5 mm, 4–6 seriate; involucral bracts imbricate, mostly squarrose, apex long acuminate, outer involucral bracts subulate, 4.0–5.5 × 0.8–0.9 mm, brown, externally glabrescent with base pubescent with small glandular stipitate or sessile glandular trichomes, internally glabrescent with minute sessile glandular trichomes, margins ciliate, upper part scarious, dark brown, inner involucral bracts narrow ovate, piriform or elliptic, 6.8–7.7 × 1.6–2.1 mm, golden brown, externally with simple trichomes and sessile glandular trichomes, internally minutely pubescent with tiny glandular stipitate trichomes, margins inconspicuously ciliate, apex long acuminate, brown to dark brown; receptacle fimbriate, with few fimbriae, up to 0.2 mm. **Florets** 18–24, bisexual, fertile; corolla actinomorphic, deeply 5-lobed, lilac to purple, corolla tube

2.7–3.3 × 0.5–0.6 mm, pubescent with small sessile or short stipitate-glandular trichomes mostly near apex, corolla lobes 2.8–3.3 × 0.5–0.6 mm, apex acute, glabrescent with few glandular sessile or shortly stipitate trichomes becoming denser towards apex with sessile glandular trichomes; anthers calcarate 2.4–2.8 mm long, purple, apical anther appendages triangular, anther base shortly sagittate, acute; style shaft 5.5–6.6 mm long, violet, glabrous throughout except for pubescent upper 0.5 mm beneath style-arms, style base with basal node, glabrous, nectariferous disc present, style arms 0.8–2.0 mm long, apex acute, sericeous outside, trichomes acute. **Cypselae** dark brown, obconical, 1.3–1.6 × 0.8–1.1 mm, strongly 10-ribbed, densely sericeous, with sessile glands near base; carpodium annular, cream-colored; pappus setae biseriate, whitish, serrulate, persistent, outer series paleaceous, 0.5 mm long, inner series setose, 4.2–4.6 mm long.

Distribution and habitat – *Lepidaploa campirupestris* is known from a few recent collections at Pico do Padre Ângelo in the municipality of Conselheiro Pena, eastern Minas Gerais (fig. 3). It grows at elevations between 1025 and 1530 m a.s.l. in campos rupestres vegetation (fig. 2G).

Phenology – The species was collected with flowers and fruits in June, August, and November, both in the dry and rainy seasons.

Etymology – The species epithet refers to the vegetation where the new species occurs.

Provisional IUCN conservation assessment – Critically Endangered: CR B2ab(ii,iii,v). The species is currently known from six collections from Pico do Padre Ângelo (also locally known as Pico da Bela Adormecida), which is the southern massif of the larger Serra do Padre Ângelo. Given the type of habitat and the elevational range occupied by the species, it might also occur in the lesser sampled northern massif, which includes two other mountains: Pico do Pinhão (ca 1530 m) and Pico do Sossego (1605 m). Neither of the massifs are protected. The northern and southern massifs are separated by a valley over 3 km wide, dominated by unsuitable habitats of cultivated land, which include pastures covered by introduced African grasses (*Urochloa* sp. and *Melinis* spp.) and eucalyptus and coffee farms (Gonella et al. 2015). Similar habitats and elevations are also found in other smaller campos rupestres islands in the area, all similarly fragmented and susceptible to invasion by alien grasses. They are further threatened by the altered fire regime due to anthropic fires and the presence of livestock (Porembski et al. 2016). Furthermore, studies have shown that campos rupestres areas will be severely affected in the next few decades by climate change (Barbosa & Fernandes 2016). In a recent, large-scale wildfire event in late September 2020 (late dry season in the region), most of the native vegetation of Pico do Padre Ângelo was destroyed, including vast areas of the upper plateau where most individuals of *L. campirupestris* were found (Paulo M. Gonella pers. obs.). Over 90% of the mature individuals of the species were affected, with very few individuals remaining in the undisturbed area. Resprouting could occur by individuals less affected by the fire, as well as recruitment from the soil seed bank in areas where the fire was less intense and did not

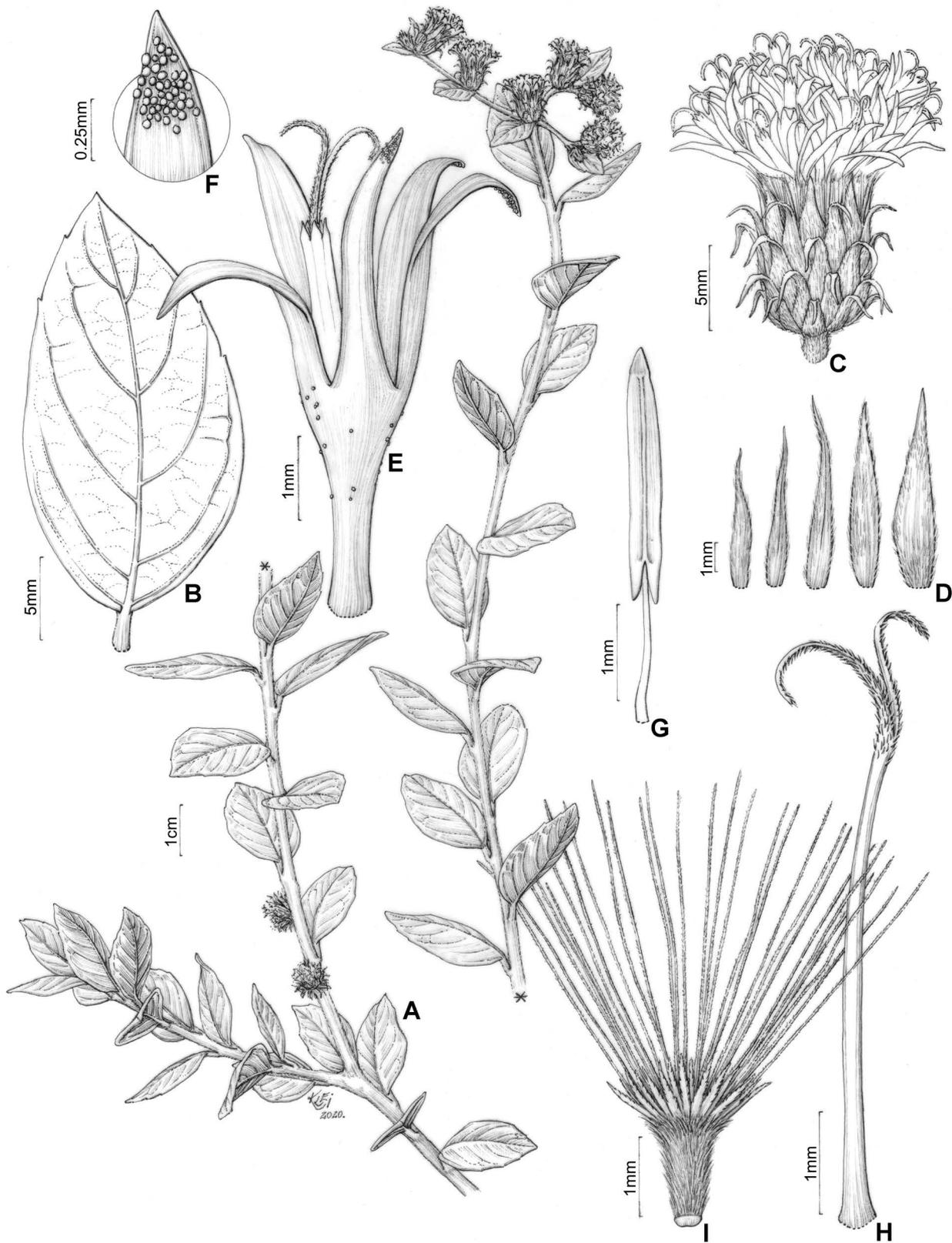


Figure 1 – *Lepidaploa campirupestris* Antar & Loeuille. **A**. Habit. **B**. Leaf, abaxial surface. **C**. Capitulum. **D**. Outer to inner involucre bracts. **E**. Corolla, stamens, and style. **F**. Corolla lobe apex. **G**. Stamen. **H**. Style. **I**. Cypselas with pappus. A–I from Loeuille *et al.* 891 (SPF). Illustration by Klei Sousa.

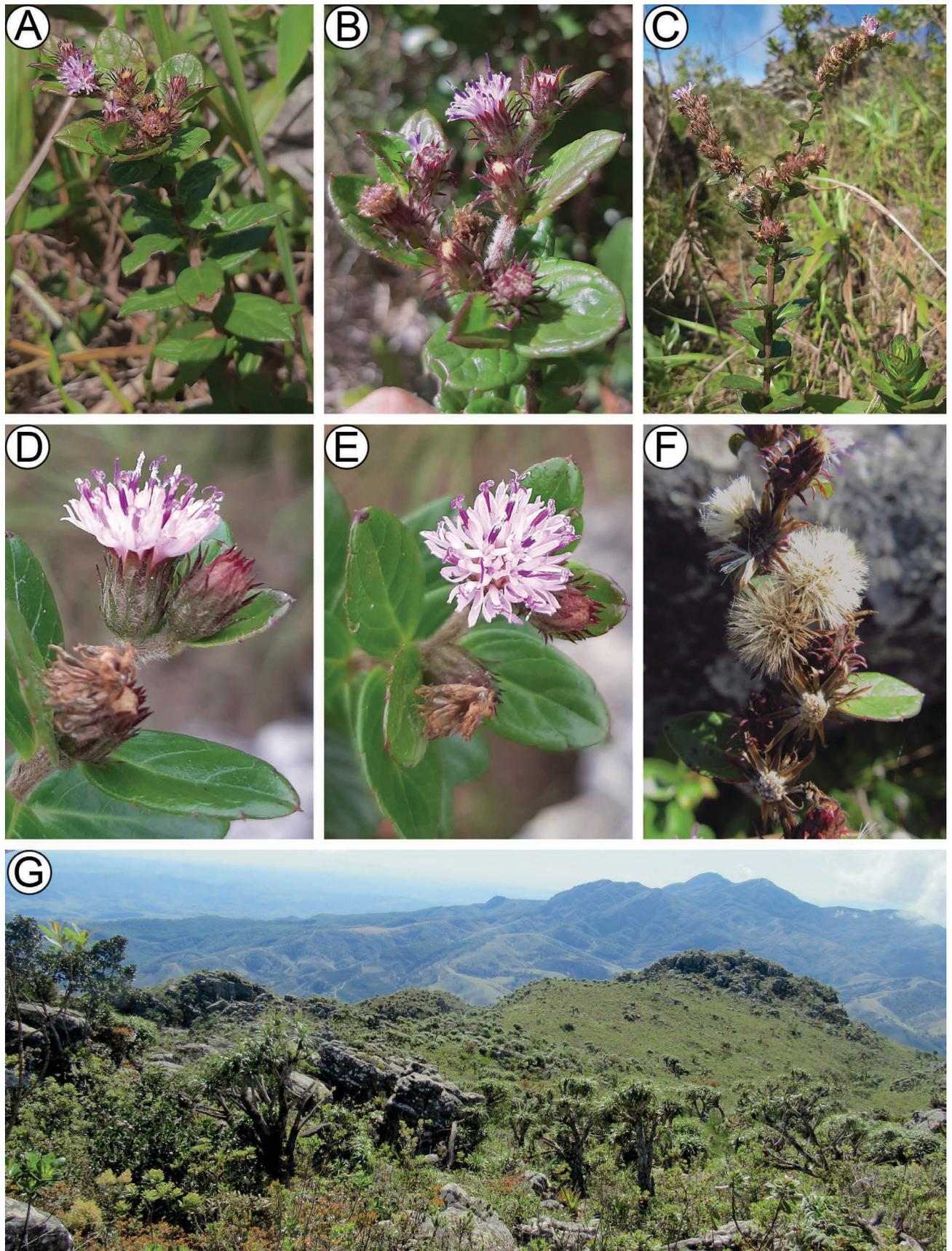


Figure 2 – *Lepidaploa campirupestris* Antar & Loeuille. **A.** Habit. **B–C.** Inflorescence. **D–E.** Capitula with florets at anthesis. **F.** Mature capitula. **G.** Habitat. All photographs by Paulo M. Gonella.

Table 1 – Diagnostic morphological characters of *Lepidaploa campirupestris* and related species.

Character	<i>Lepidaploa aurea</i>	<i>Lepidaploa campirupestris</i>	<i>Lepidaploa pseudaura</i>
Plant height (m)	0.4–2.0	ca 1	0.9–1.5
Petiole size (mm)	3.0–9.0	1.2–3.5	0–2
Leaf size (cm)	1.5–6.2 × 1.8–3.0	1.8–4.0 × 1.0–1.7	0.8–2.7(–3.5) × 0.5–1.5
Leaf adaxial surface indumentum	sericeous	glabrous	sericeous
Leaf blade shape	ovate	elliptic to wide elliptic, rarely oblanceolate	lanceolate, ovate or broadly ovate
Leaf blade base	truncate or subcordate	cuneate or rounded	cordate to rounded or obtuse
Peduncle size (mm)	sessile	0.5–3.0	sessile
Head size (mm)	6–10 × 7–8	8.5–10.1 × 6.5–8.5	7 × 6
Number of florets	33–45	18–24	20–30
Number of involucrel bract series	4–6	4–6	3

consume the soil peat layer (Fernandes et al. 2021). Fire can also be a facilitator for the expansion of alien grass species (D'Antonio & Vitousek 1992), such as *Melinis minutiflora* P.Beauv., which was previously identified as a threat to the native species of Serra do Padre Ângelo (Gonella et al. 2015). Currently, *Lepidaploa campirupestris* is known as a microendemic species from Pico do Padre Ângelo present in a single location with an AOO of 8 km². Because of the single location, the low AOO, and the observed and inferred reduction in the quality and extent of its habitat resulting from the above-mentioned threats, *L. campirupestris* is assessed as Critically Endangered (CR) based on criterion B2ab(ii,iii,v) of IUCN (2012).

Additional specimens examined – BRAZIL – Minas Gerais • Conselheiro Pena, Pico do Padre Ângelo, subindo pela crista sul da montanha, campo rupestre, afloramento de arenito entremeado por solo arenoso com grande quantidade de matéria orgânica, vegetação com *Vellozia* arborescentes; 19°19'46.14"S, 41°34'26.43"W; 1025 m; 27 Nov. 2013; *P.M. Gonella & F. Rivadavia 637*; SPF • Conselheiro Pena, Serra do Padre Ângelo, Pico do Padre Ângelo, no platô do topo do pico, campo rupestre, solo arenoso com matéria orgânica entre afloramentos rochosos; 19°19'14.2"S, 41°34'43.7"W; 1530 m; 11 Jun. 2017; *P.M. Gonella et al. 791*; SPF • Conselheiro Pena, Serra do Padre Ângelo, Pico do Padre Ângelo, no platô do topo do pico, campo rupestre, solo arenoso com matéria orgânica entre afloramentos rochosos; 19°19'14.2"S, 41°34'43.7"W; 1530 m; 4 Dec. 2018; *P.M. Gonella et al. 1031*; SPF • Conselheiro Pena, Serra do Padre Ângelo, Pico do Padre Ângelo, platô do topo do pico, campo rupestre, solo arenoso com afloramentos rochosos; 19°19'5.04"S 41°34'46.26"W; 1480 m; 8 Jun. 2020; *P.M. Gonella et al. 1236*; SPF • Conselheiro Pena, Serra do Padre Ângelo, Pico do Padre Ângelo, platô do topo do pico, campo rupestre, solo arenoso com afloramentos rochosos; 19°19'5.04"S 41°34'46.26"W; 1480 m; 11 Jun. 2020; *P.M. Gonella et al. 1427*; SPF.

Similar species and remarks – *Lepidaploa campirupestris* is classified in the genus *Lepidaploa* because it presents eglandular anther appendages and styles with a basal node. It is unique in the genus by the combination of leaf blade indumentum adaxially glabrous and abaxially densely punctate, petioles 1.2–3.5 mm long, inflorescences seriate-cymose with 6–15 pedunculate capitula, and squarrose involucrel bracts. *Lepidaploa aurea* (Mart. ex DC.) H.Rob. is morphologically close to the new taxon, sharing similar habit, seriate-cymose inflorescences, squarrose involucrel bracts and similar number of involucrel bract series. *L. campirupestris* presents capitula with fewer florets (18–24 vs 33–45), leaf blade indumentum adaxially densely punctate with scattered, simple, appressed trichomes, abaxially glabrous (vs sericeous on both surfaces with long, simple, eglandular trichomes and sessile glands) and pedunculate capitula (vs sessile). It also resembles *Lepidaploa pseudaura* (D.J.N.Hind) H.Rob., differing by the peduncle size (0.5–3.0 mm long in *L. campirupestris* vs sessile) and the number of involucrel bract series (4–6 in *L. campirupestris* vs 3). The main morphological differences among *Lepidaploa campirupestris* and related species are summarized in table 1.

Lessingianthus petraeus Ant. & Loeuille, **sp. nov.** (figs 4, 5A–B) – Type: BRAZIL • Minas Gerais, Alvarenga, Pico da Aliança, campo rupestre; 19°23'47.98"S, 41°40'19.65"W; 1300 m; 4 Aug. 2014; *B. Loeuille, C.M. Siniscalchi & C.T. Oliveira 901*; holotype: SPF[216065]; isotypes: RB, US.

Diagnosis – Species *Lessingianthus* adenophyllo capitulis campanulatis solitariis et foliis sessilibus similis, sed foliis congestis ramorum apicem versus (non congestis ramorum basin versus), foliis supra sericeis (non glabris), foliorum basi cuneata ad attenuata (non rotundata) et pedunculis 1.1–2.1 cm longis (non 8–10 cm longis) differt.

Description – **Shrub or subshrub**, up to 30 cm tall, erect, branched; younger stems angular, canaliculate, densely sericeous with greyish or brownish simple trichomes, older stems ± terete, irregularly ribbed, with prominent

lenticels, leaf scars conspicuous, 2–4 mm diameter at base. Leaves alternate to subopposite near tips, rarely opposite, restricted to distal part of branches, simple, sessile to subsessile, petiole up to 2 mm long; blade 1.1–2.5 × 0.1–0.4 cm, concolorous, chartaceous, very narrow-elliptic, linear, or narrow-oblongate, base cuneate or attenuate, apex obtuse, vinaceous in younger leaves, margins entire, slightly revolute or flat; abaxial surface densely sericeous, adaxial surface rugulose, sparsely sericeous or sericeous, with simple trichomes and rounded glandular trichomes sunken in small depressions, venation inconspicuous, midrib prominent abaxially, impressed adaxially. Capitula homogamous, discoid, solitary, terminal, pedunculate, peduncle 1.1–2.1 cm long, subinvolucral bracts 7.0–10.5 × 1.0–1.8 mm, leaf-like, usually scarcely exceeding involucre; involucre campanulate, 5.3–9.6 × 4.7–8.7 mm, 4–8 seriate, involucral bracts imbricate, brown, outer involucral bracts 1.1–1.7 × 0.6–1.0 mm, deltoid, sericeous, margins inconspicuously ciliate, upper part scarious, apex acute, dark brown, inner involucral bracts 5.2–6.6 × 0.8–1.4 mm, piriform, narrow oblong, oblongate, linear or very narrow elliptic, sericeous to glabrescent, margins ciliate near apex, apex acute, obtuse or slightly acuminate, sometimes darker;

receptacle areolate, glabrous. Florets 16–18, bisexual, fertile; corolla actinomorphic, deeply 5-lobed, lilac to purple, corolla tube 3.7–5.3 × 0.3–0.5 mm, with few minute hairs and sessile cylindrical glandular trichomes in middle of tube, eglandular trichomes glabrescent, corolla lobes 1.7–3.2 × 0.7–0.8 mm, apex acute, with sessile cylindrical glandular trichomes at apex; anthers calcarate 1.9–2.2 mm long, violet, apical anther appendages triangular, anther base short-sagittate, acute; style shaft 4.8–5.6 mm long, purple to lilac, glabrous throughout except for pubescence in upper 0.5 mm beneath style arms, style base lacking basal node, glabrous, nectariferous disk present, style arms 1.2–1.6 mm long, apex acute, pubescent outside, trichomes apex acute. Cypsela castaneous, cylindrical, 2.7–2.9 × 0.6–0.7 mm, 10-ribbed, sparsely hispid with long trichomes and short stipitate-glandular trichomes, sessile cylindrical glandular trichomes, mostly towards apex and base; carpodium inconspicuous; pappus setae biseriate, whitish, setose, persistent, outer series serrulate, 1.5–1.6 mm long, inner series barbellate, 4.2–5.2 mm long.

Distribution and habitat – *Lessingianthus petraeus* is known from two collections from Pico da Aliança in the

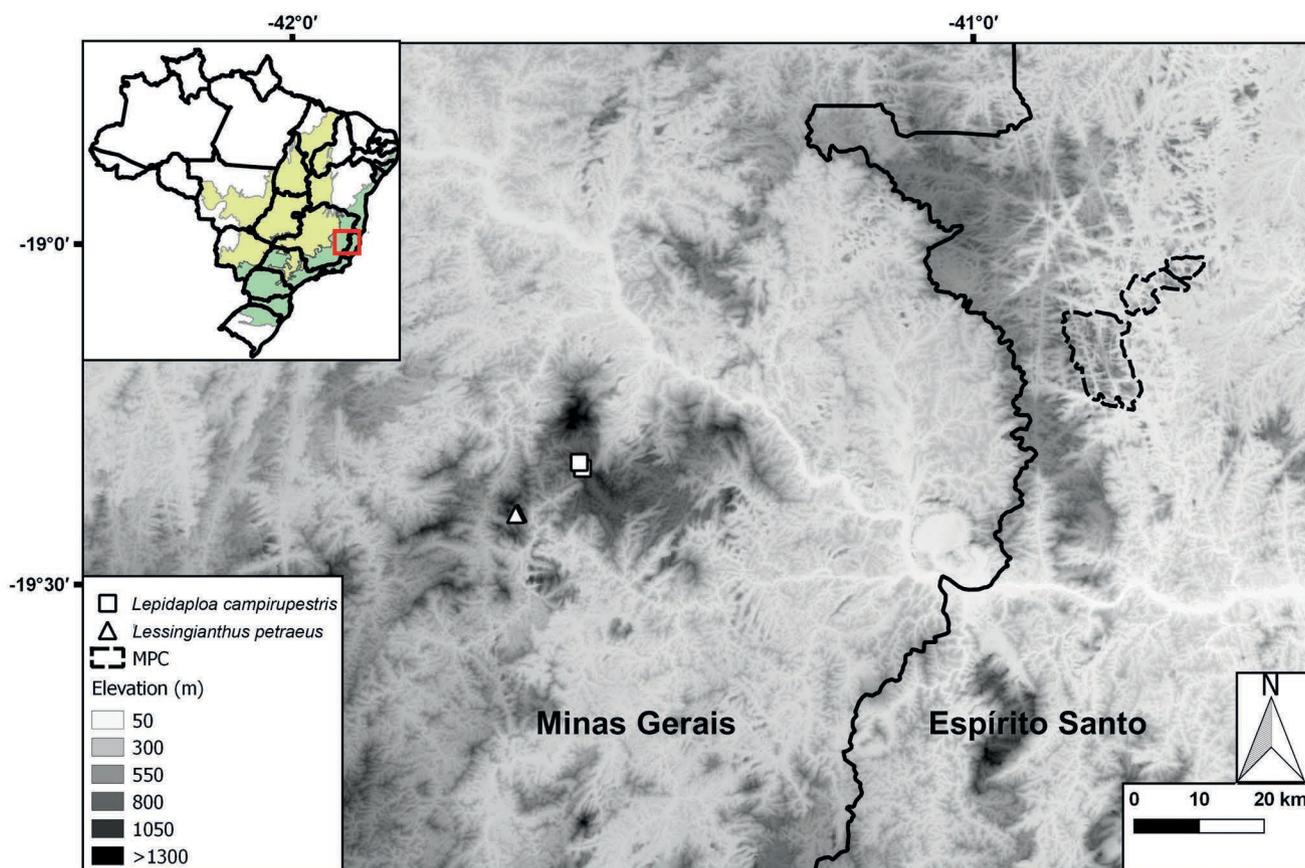


Figure 3 – Distribution of *Lessingianthus petraeus* Antar & Loeuille and *Lepidaploa campirupestris* Antar & Loeuille. MPC: Monumento Natural dos Pontões Capixabas, a Federal Protected Area. In the inset map, the yellow area shows the extension of the Cerrado domain and the green area shows the extension of the Atlantic Forest domain. Map created with QGIS v.3.0.1 (QGIS Development Team 2018).

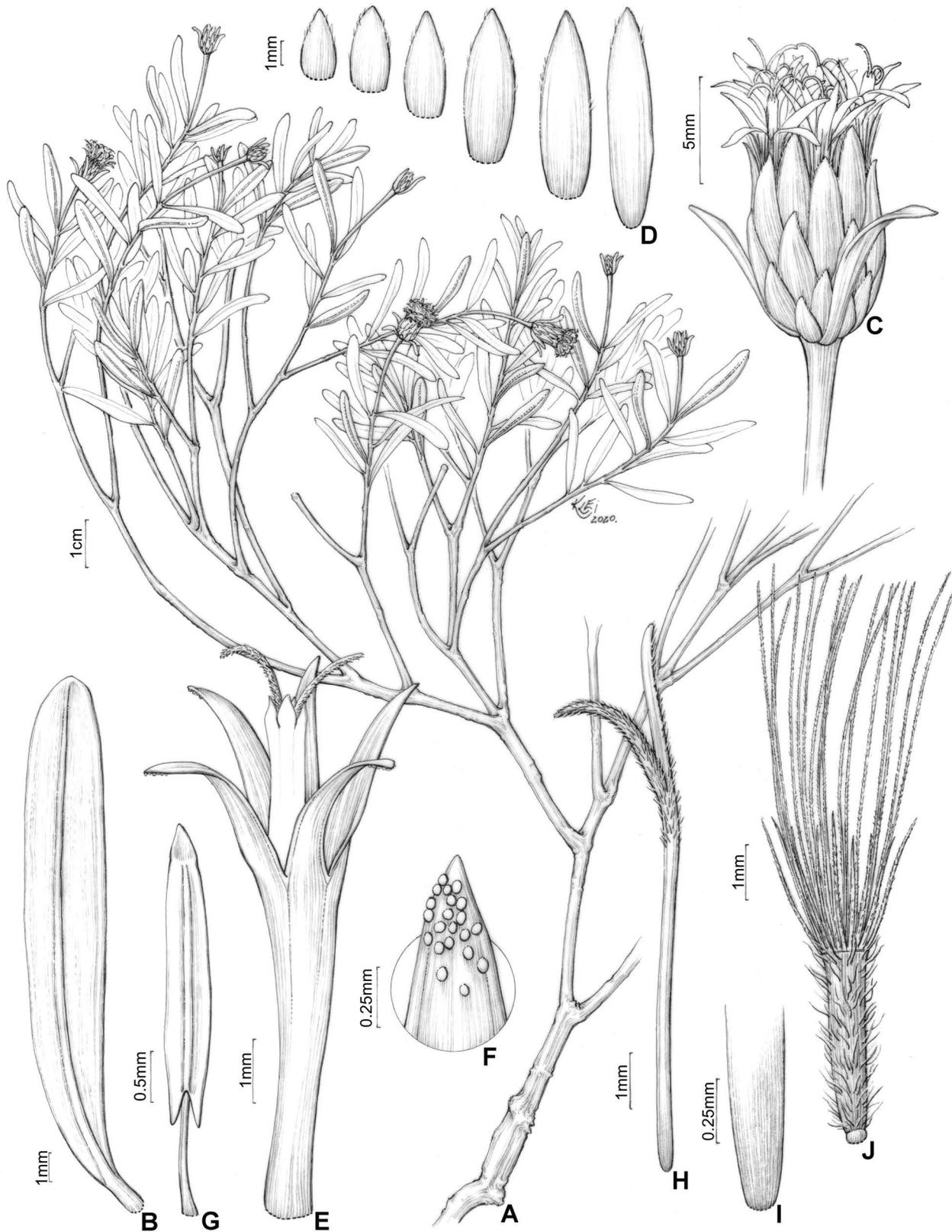


Figure 4 – *Lessingianthus petraeus* Antar & Loeuille. **A**. Habit. **B**. Leaf, abaxial surface. **C**. Capitulum. **D**. Outer to inner involucral bracts. **E**. Corolla, stamens, and style. **F**. Corolla lobe apex. **G**. Stamen. **H**. Style. **I**. Style base. **J**. Cypsela with pappus. A–J from Loeuille *et al.* 901 (SPF). Illustration by Klei Sousa.

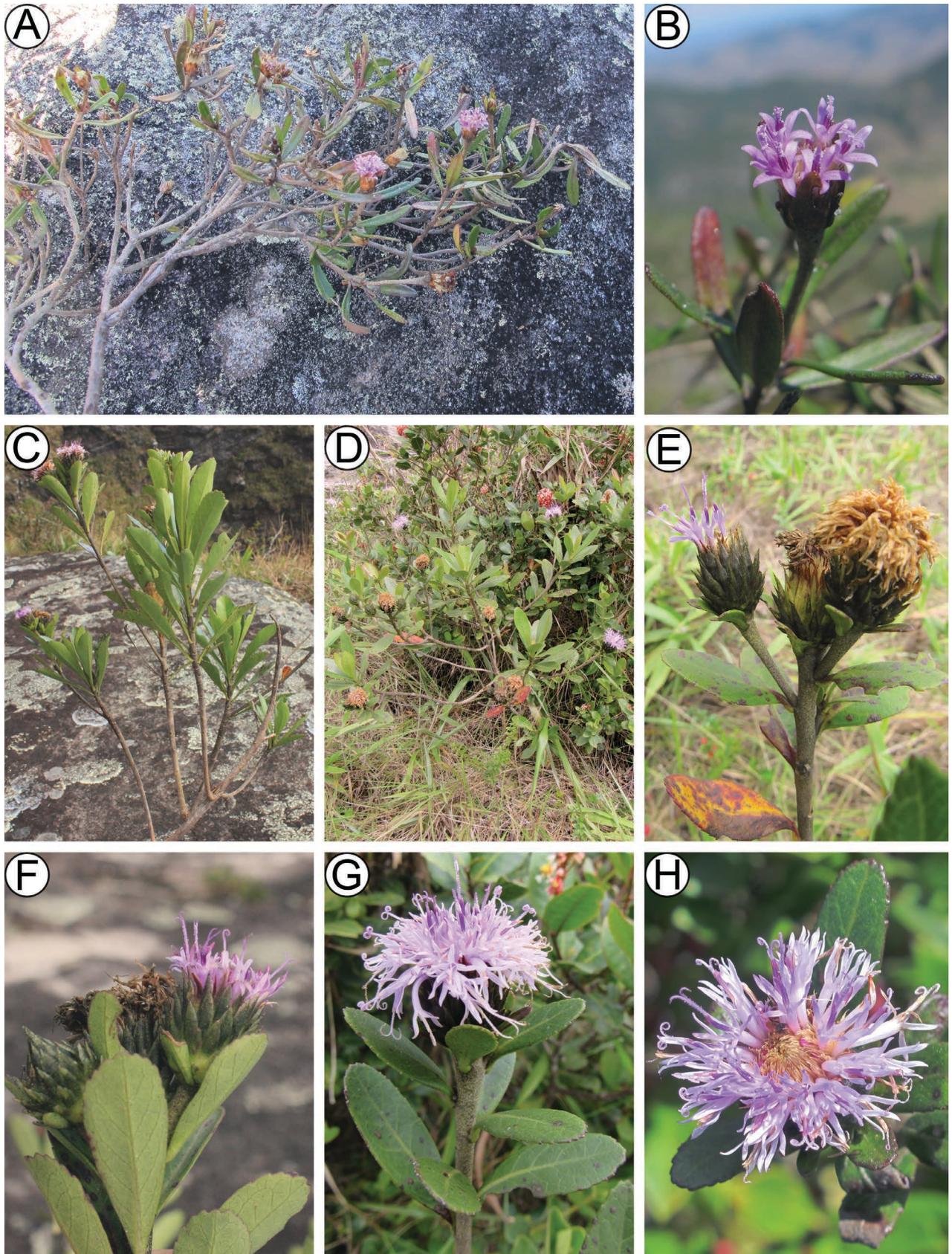


Figure 5 – A–B. *Lessingianthus petraeus* Antar & Loeuille, A. Habit. B. Detail of capitulum. C–H. *Lessingianthus squamosus* M.Monge & Semir C–D. Habit. E–F. Inflorescence. G. Capitula with florets at anthesis, side view. H. Capitula with florets at anthesis, viewed from above. Photographs: A–B by Benoit Loeuille, C–F by Carolina M. Siniscalchi, G–H by Paulo M. Gonella.

Table 2 – Diagnostic morphological characters of *Lessingianthus petraeus* and related species.

Character	<i>Lessingianthus adenophyllus</i>	<i>Lessingianthus linearis</i>	<i>Lessingianthus petraeus</i>	<i>Lessingianthus psilophyllus</i>
Leaf position	clustered at the base	distributed along the stem	clustered at the apex	distributed along the stem
Leaf size (cm)	3.1–4 × 0.4–0.8	1.2–9.3 × 0.1–0.3	1.1–2.5 × 0.1–0.4	6.5–8.5 × 0.2–0.3
Leaf adaxial surface indumentum	glabrous	glabrous to glabrescent	sericeous	glabrous
Leaf abaxial surface indumentum	punctate	lanate	sericeous	punctate
Leaf blade shape	obovate-lanceolate, oblong or obovate	linear	very narrow-elliptic, linear, or narrow-oblongate	linear-lanceolate, lanceolate oblong-elliptic
Leaf blade base	rounded	cuneate to attenuate	cuneate to attenuate	cuneate to attenuate
Leaf margin	not revolute	revolute	slightly revolute	slightly revolute
Number of capitula	1(–2)	1–3	1	1–3
Peduncle size (cm)	8–10	sessile to 0.1(–0.6)	1.1–2.1	0.5–4.3
Capitulum diameter (mm)	9–11	7–9	4.7–8.7	10–14
Number of florets	25–35	20–35	16–18	30–40
Number of involucre bract series	3–4	5–7	4–8	5–6

municipality of Alvarenga, eastern Minas Gerais state (fig. 3). It grows near the summit, from 1300 to 1430 m a.s.l., in campos rupestres vegetation among quartzite rocks, in sandy soils with organic matter. The area presents marked seasonality, with rainy summers and dry winters, but water condensation in the form of fog is present year-round at higher elevations.

Phenology – The species was collected with flowers and fruits in July and August, in the dry season.

Etymology – The epithet highlights the habitat of the new species, which grows among rocks in campos rupestres vegetation.

Provisional IUCN conservation assessment – Critically Endangered: CR B2ab(iii). The species is currently known from two recent collections from the summit of Pico da Aliança. It occurs in a single location and has an AOO of 4 km². Despite the fact that both the species and the area are under-sampled, the specific habitat of *L. petraeus*, in campos rupestres vegetation at higher elevations, limits its distribution. The species could be a narrow endemic or, at best, could also occur in Serra do Padre Ângelo and Sete Salões State Park, both containing areas of similar elevation, soil, and vegetation. As explained above for *Lepidaploa campirupestrus*, the surroundings of Pico da Aliança have been converted into farmlands, and are prone to altered fire regime, invasion by alien grasses, and the effects of climate change. Pico da Aliança, the only confirmed area of occurrence of *L. petraeus*, is not protected, despite harbouring a unique plant community that includes several recently described, narrow endemic and threatened species

(Leme & Kollmann 2013; Campacci 2014; Leme et al. 2014; Loeuille & Pirani 2016; Loeuille et al. 2019; Mello-Silva 2018; Kollmann 2020). Because of its single location, low AOO, and because we infer a reduction in the quality and extent of the habitat as a result of the above-mentioned threats, we assess *L. petraeus* as Critically Endangered, based on criterion B2ab(iii) of IUCN (2012).

Additional specimen examined – BRAZIL – Minas Gerais • Alvarenga, Pico da Aliança, topo do pico, campo rupestre, afloramento de arenito, solo arenoso; 19°23'43.22"S, 41°40'08.93"W; 1430 m; 9 Jul. 2014; P.M. Gonella et al. 699; SPF.

Similar species and remarks – *Lessingianthus petraeus* is classified in *Lessingianthus* as it presents pedunculate capitula, cypsela with short, stipitate, glandular trichomes, and style lacking basal node. It is unique in the genus by the combination of solitary campanulate capitula borne on peduncles 1.1–2.1 cm long, leaves restricted to the distal part of branches, sessile to subsessile, very narrow-elliptic, linear, or narrow-oblongate, sericeous on both surfaces, and with cuneate or rounded base. It morphologically resembles *L. adenophyllus* (Mart. ex DC.) H. Rob. by the solitary campanulate capitula and sessile leaves, but it is easily distinguished from the latter by leaves that are sericeous on both surfaces (vs leaves adaxially glabrous, abaxially densely punctate), peduncle 1.1–2.1 cm long (vs 8–10 cm long), and leaves restricted to the distal part of branches (vs leaves restricted to the proximal part). The new species is also similar to *L. psilophyllus* (DC.) H. Rob. as both species share sessile leaves, cuneate to attenuate leaf base, and slightly revolute leaf margins, but they differ as *L. petraeus*

presents smaller capitula, 4.7–8.7 mm diameter (vs 10–14 mm diameter), smaller leaves, 1.1–2.5 × 0.1–0.4 cm (vs 6.5–8.5 × 0.2–0.3 cm), and leaf indumentum sericeous on both surfaces (vs adaxially glabrous, abaxially densely punctate). Additionally, *L. petraeus* resembles *L. linearis* (Spreng.) H. Rob. due to the sessile linear leaves with cuneate leaf base but can be distinguished as the first presents leaves restricted to the distal part of branches (vs leaves distributed throughout the stem), sericeous on both surfaces (vs leaves adaxially glabrous or glabrescent, abaxially lanate) and peduncles 1.1–2.1 cm long (vs sessile or 0.1–0.6 cm long). The main differences among *L. petraeus* and morphologically related species are summarized in table 2.

Lessingianthus squamosus M. Monge & Semir (Monge et al. 2018: 599) (figs 5C–H, 6) – Type: BRAZIL • Espírito Santo, Santa Leopoldina, Bragança, prop. Assunta Salvador; 400–600 m; 20°7'23"S, 40°32'47"W; 17 Dec. 2006; fl., fr.; *L.S.F. Magnano et al.* 995; holotype: MBML[00030677]; isotype: SPF.

Description – **Shrub** 0.85–1.5 m tall, erect, moderately branched; younger stems angulose and canaliculate, greyish sericeous or glabrescent, older stems slightly terete, irregularly ribbed, leaf scars conspicuous, (3–)4–6 mm diameter at base. **Leaves** alternate, deciduous, restricted to distal part of branches, simple, petiolate, petiole 2–7.5(–9.5) mm long; blade (2–)3.4–6.5 × 0.9–2.6 cm, discolorous, chartaceous, oblanceolate, increasing in size towards branch apex, base attenuate, apex obtuse, sometimes mucronate, margins slightly revolute, rarely flat, crenate in upper half, teeth 6–14, abaxial and adaxial surfaces punctate with dense sessile glands, midvein somewhat sericeous, sometimes expanding to secondary veins, venation semicraspedodromous, adaxially mostly inconspicuous with midrib slightly prominent, abaxially reticulate with midrib and secondary veins prominent. **Inflorescence** corymbiform. **Capitula** 1–5, homogamous, discoid, pedunculate, peduncle (0.5–)1.2–4.9(–5.5) cm long, subinvolucral bracts leaf-like, 0.7–2.1 × 0.2–0.6 cm margins inconspicuously crenulate, not exceeding capitulum; involucre broadly campanulate, 1.4–1.7 × 1.4–2.4 cm, 8–12-seriate, involucral bracts imbricate, margins ciliate, outer involucral bracts 2.0–2.6 × 1.3–2.1 mm, deltoid, brown, upper part scarious, dark brown, apex acute with a tiny mucro, glabrescent, dark brown, inner involucral bracts, 12–16 × 0.9–1.3 mm, linear, piriform (sometimes slightly expanded at base and near apex), stramineous, internally glabrous, externally arachnoid, apex long apiculate, apiculum 1–2 mm long, brown to dark brown; receptacle flat, fimbriate, fimbriae 1.4–1.7 mm long. **Florets** 72–79, bisexual, fertile; corolla actinomorphic, deeply 5-lobed, lilac to purple, corolla tube 10–13 × 0.3–0.5 mm, glabrous, corolla lobes 3.7–6 × 0.6–0.8 mm, apex acute, with sessile glands at apex; anthers calcarate, 5.0–5.2 mm long, violet, apical anther appendage triangular, anther base sagittate, acute; style shaft 1.5–1.9 cm long, purple to lilac, glabrous throughout except for pubescent upper 1.5 mm beneath style arms, style with basal node, glabrous, nectariferous disk present, style arms 2.7–3.4 mm long, apex acute, pubescent outside, trichomes acute. **Cypselae** cylindrical, 1.7–2.9 × 0.9–1.3 mm, 10-ribbed, glabrous; carpodium inconspicuous; pappus setae biseriate,

stramineous, setose, serrulate, persistent, outer series 4.0–4.2 mm long, free or fused at base, inner series 10–12 mm long.

Distribution and habitat – *Lessingianthus squamosus* was described based on collections from the central region of the state of Espírito Santo, in the municipalities of Santa Leopoldina and Santa Teresa, where it occurs on granitic inselbergs, scrub and forest margins at elevations between 400 and 1000 m. It is reported here for the first time for the municipalities of Conselheiro Pena (Serra do Padre Ângelo) and Alvarenga (Pico da Aliança), in eastern Minas Gerais, being found in campos rupestres vegetation, growing in sandy soils over quartzitic bedrock at elevations from 1167 to 1500 m. At Serra do Padre Ângelo, the species was found on both Pico do Padre Ângelo (southern massif) and on the hills of Pico do Sossego, in the northern massif (based on photographic record: <https://www.inaturalist.org/observations/26314701>). All records in both states are within the Atlantic Forest phytogeographic domain.

Phenology – In campos rupestres areas, the species was recorded with flowers and fruits from June to August, complementing the range cited by Monge et al. (2018), who found specimens with flowers and fruits from December to May. This is probably due to subsampling, indicating that *Lessingianthus squamosus* might be fertile throughout the year.

Provisional IUCN conservation assessment – Endangered: EN B2ab(iii,v). With the addition of the new collections, the estimated AOO is 24 km² and the EOO equals 3868 km², but both values include large areas of unsuitable habitats (forests, pastures, monoculture farmlands, etc.), therefore being an overestimation. The herbarium specimens known for this species represent five unique occurrences and five locations. The locations are on inselbergs or in campos rupestres, but none are protected. This is a matter of concern as both inselbergs and campos rupestres harbour endemic and endangered species and are susceptible to biological invasions, livestock grazing, altered fire regime, and climate change (Porembski et al. 2016; Silveira et al. 2016). The species has also suffered a dramatic reduction (Paulo M. Gonella pers. obs.) in the number of mature individuals at Serra do Padre Ângelo, as the entire area where this species was collected and observed was affected by the September 2020 fire. Monge et al. (2018) assessed this species as Data Deficient, due to the few samples collected at the time of description. The new records reported here allow us to update this assessment. The potential area of occurrence of the species may include suitable areas in the 200-km gap between the known records. However, areas with suitable habitat would be severely fragmented. A survey in the region would certainly be useful. With the current knowledge of the species, based on the low number of locations, the low EOO and AOO, and the observed and inferred reduction in the quality and extent of the habitat as a result of the above-mentioned threats, we assess *Lessingianthus squamosus* as Endangered, according to the criterion B2ab(iii,v) of IUCN (2012).

Specimens examined (new records) – BRAZIL – Minas Gerais • Alvarenga, Pico da Aliança, no topo do pico, campo rupestre, afloramentos de arenito, solo arenoso;

19°23'43.22"S, 41°40'08.93"W; 1430 m; 9 Jul. 2014; *P.M. Gonella et al. 701*; SPF • Conselheiro Pena, Pico do Padre Ângelo, no topo do pico, campo rupestre, afloramentos de arenito, solo arenoso com muita matéria orgânica (serrapilheira); 19°19'14.2"S, 41°34'43.7"W; 1530 m; 8 Jul. 2014; *P.M. Gonella et al. 688*; SPF • Conselheiro Pena, Pico do Padre Ângelo, campo rupestre; 19°18'37.7"S, 41°34'32.71"W; 1167 m; 3 Aug. 2014; *B. Loeuille et al. 889*; SPF • Conselheiro Pena, Serra do Padre Ângelo, Pico do Padre Ângelo, no platô do topo do pico, campo rupestre, solo arenoso com matéria orgânica entre afloramentos rochosos; 19°19'14.2"S, 41°34'43.7"W; 1530 m; 11 Jun. 2017; *P.M. Gonella et al. 799*; SPF.

Similar species and remarks – *Lessigianthus squamosus* was described based on three collections from the municipalities of Santa Leopoldina and Santa Teresa, in the central region of the state of Espírito Santo (Monge et al. 2018), where it grows on granitic/gneissic inselbergs. Here, we report new records that are ca 200 km distant from the original distribution. These were collected in quartzitic campos rupestres, in different soil composition and vegetation, and in higher elevation than the original collections, making the new records and the type specimens

both geographically and ecologically isolated. Both populations have some differences in petiole length (2–4.6 mm long in Minas Gerais populations vs (3–)5–7.5(–9.5) mm in Espírito Santo populations) and leaf size (3.4–5.7 × 0.9–1.7 cm in the Minas Gerais populations vs (2–)3.5–6.5 × (1–)2.0–2.6 cm in the Espírito Santo populations) but they share the same overall morphological features. The basal node of the style is hereby firstly described for this species. Although uncommon, the structure has been observed in other *Lessigianthus* species, such as *L. brevifolius* (Less.) H. Rob., *L. carvalhoi* (H. Rob.) H. Rob., and *L. durus* (Mart. ex DC.) H. Rob. (Angulo & Dematteis 2014). We also note that the base of the outer pappus series bears only free setose bristles, while the protologue describes them as annular. Future population genetics and phylogeographic studies could clarify if these populations clusters are genetically isolated and which microevolutionary factors are acting in the maintenance of this taxon.

DISCUSSION

The two new species described here raise the number of endemic angiosperm species of the easternmost campos rupestres of Minas Gerais to 19 (Leme & Kollmann 2013;

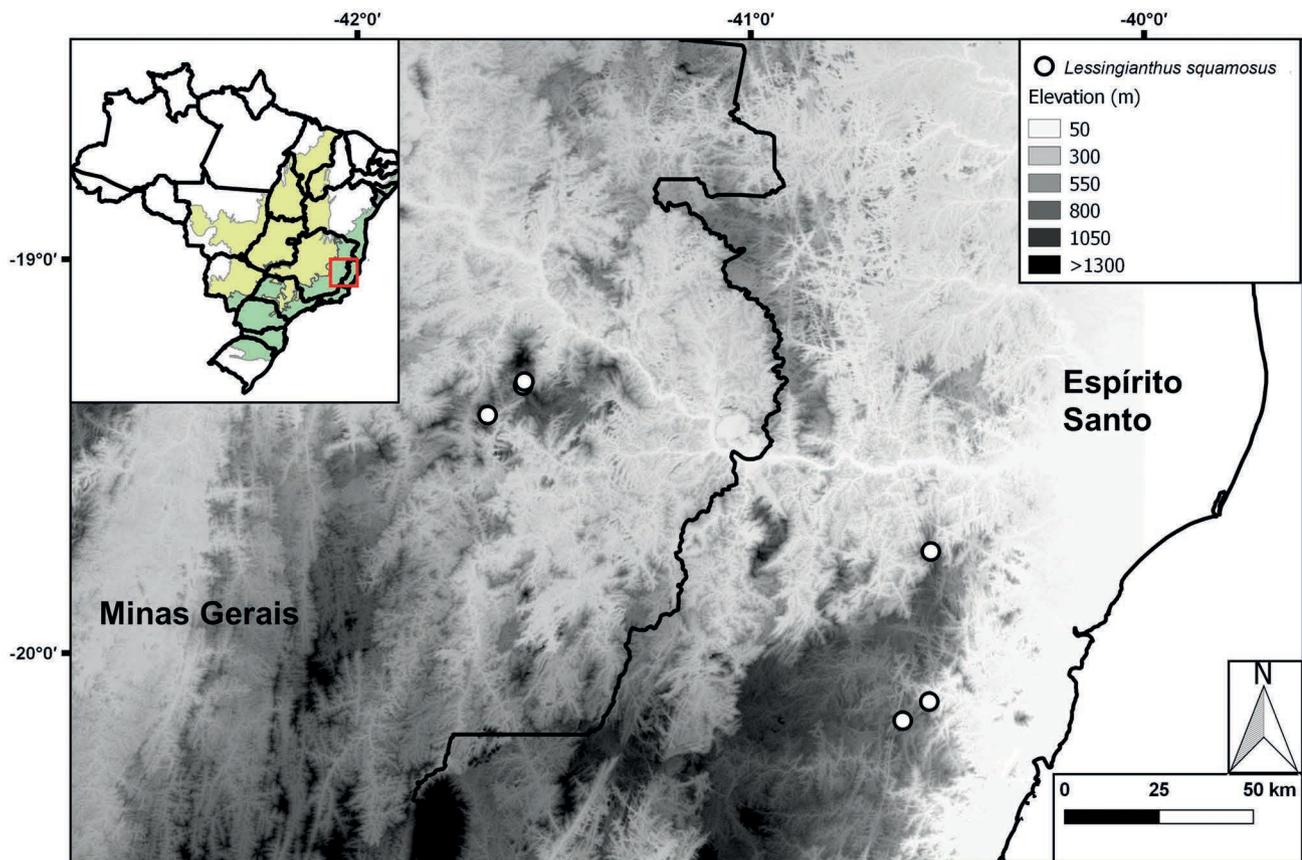


Figure 6 – Distribution of *Lessigianthus squamosus* M.Monge & Semir. In the inset map, the yellow area shows the extension of the Cerrado domain and the green area show the extension of the Atlantic Forest domain. Map created with QGIS v.3.0.1 (QGIS Development Team 2018).

Leme et al. 2014; Leme 2015; Campacci 2014, 2015; Gonella et al. 2015; Harding & Bohnke 2015; Siniscalchi et al. 2016; Loeuille & Pirani 2016; Loeuille et al. 2019; Leme et al. 2020; Kollmann 2020; Antar et al. 2021; Andriano & Gonella 2021). The high number of taxonomic novelties in a still poorly collected area highlights the elevated species diversity and endemism of the campos rupestres vegetation (Colli-Silva et al. 2019) and the urgent need of biodiversity inventory studies in the area.

The presence of iconic and endangered plant species can impact on the popular and political perception of these areas as priorities for proactive conservation measures. The presence of species such as the giant carnivorous plant *Drosera magnifica* Gonella & Rivadavia (Droseraceae) and the dracenoid *Vellozia gigantea* N.L.Menezes & Mello-Silva (Velloziaceae) in the area can be used to promote the conservation of the unique biodiversity of Serra do Padre Ângelo and Pico da Aliança. Such a 'charismatic flora' can aid in decreasing plant awareness disparity and combatting the failure to perceive plants in the environment and recognize them as significant elements of the biosphere (Wandersee & Schussler 2002; Parsley 2020), which can have severe implications for plant conservation. Overcoming these obstacles is especially urgent in Brazil, with the rise of anti-environmental actions by the current federal administration (Escobar 2019).

As discussed by Siniscalchi et al. (2016), Mello-Silva (2018), and Andriano & Gonella (2021), the floras of Serra do Padre Ângelo, Pico da Aliança, and Sete Salões State Park present a very interesting biogeographic pattern with floristic elements related to the core campos rupestres area inserted in the Cerrado domain, but immersed in the Atlantic Forest domain. We hereby report two new species that present the same pattern and also a range expansion from a species previously known only from granitic inselbergs, in different elevation range and soil composition. The novel taxa increase the understanding of the local biogeography but further studies are still needed to shed light on the processes that led to the development of this interesting flora (Gonella et al. in prep).

The interconnection of vegetation types across phytogeographical domains through small fragments restricted to specific topographic features is well-documented in the Brazilian flora. Some examples are the brejos de altitude (fragments of Atlantic Forest vegetation interspersed in higher-elevation areas in the Caatinga), the semi-deciduous forests associated to sandstone outcrops across the Cerrado and Caatinga, the ironstone fields (cangas) found in the Cerrado and Amazon Forest (Bitencourt et al. 2020), and the connection between the Atlantic and Amazon forests through riparian forests in the Cerrado and Caatinga. Therefore, it is not unexpected to find campos rupestres vegetation in disjunct areas from the core ER, as documented by other authors (e.g. Neves et al. 2018).

The rock-dwelling vegetation most commonly found in the Atlantic Forest domain is that associated with granitic-gneissic isolated outcrops (lowland inselbergs) and mountain ranges (campos de altitude) (Porembski et al. 1998; Porembski & Barthlott 2000; Martinelli 2007; Vasconcelos 2011; de

Paula et al. 2020). Although these formations usually share a number of families with the campos rupestres, assemblages of species found in each one are different (Vasconcelos 2011), likely related to edaphic factors. The range expansion hereby described for *Lessingianthus squamosus* may indicate that these easternmost fragments of campos rupestres also serve as a connection with other rock outcrop vegetation types, due to the influence of the surrounding Atlantic Forest. This connection is further supported by recent collections in Pico do Padre Ângelo of two other Asteraceae previously known only for granitic inselbergs: *Cololobus rupestris* (Gardner) H.Rob. [new collections: Loeuille et al. 886 (SPF216078); Gonella et al. 1203, 1335, 1349 (SPF)] and *Lepidaploa opposita* A.Teles, Sobral & J.N.Nakaj. [new collections: Loeuille et al. 890 (SPF216080); Siniscalchi et al. 508 (SPF224470)] (Telles et al. 2010). Ongoing floristic surveys in the area might highlight additional taxa shared with other phytogeographical domains and vegetation types (Gonella et al. in prep.).

Campos rupestres are fragmentary in nature, as their occurrence is limited by high elevation areas with specific soil requirements (Silveira et al. 2016). The presence of a mosaic of micro-climates created by the interplay among topography, declivity, and substrate is thought to be one of the major drivers of diversification in this phytophysiognomy, creating shared patterns of microendemic species, sometimes restricted to single mountain tops (Giulietti & Pirani 1988; Rapini et al. 2008). In the Asteraceae, one of the most representative groups in the campos rupestres is subtribe Lychnophorinae, with a large portion of its ca 120 species distributed across different areas of this vegetation type (Loeuille et al. 2015b). The location of the core campos rupestres area in the ecotone among three domains, the Atlantic Forest to the east, Cerrado to the west, and Caatinga in the northeast, is also thought to contribute to its high diversity, increasing the number of lineages possibly colonizing and establishing in the higher elevation areas (Neves et al. 2018). A recent multi-taxa diversification study focusing on this vegetation type showed a complex interaction between old lineages and emergence of new species in the campos rupestres flora that is still incipiently understood (Vasconcelos et al. 2020).

Small isolated populations of plants with very specific environmental requirements, such as those found in rock outcrops and other island-like environments, pose a challenge for conservation. The reduced gene flow among populations caused by the patchy distribution can lead to genetically differentiated populations and marked genetic structure due to the effects of genetic drift and inbreeding (Gevaert et al. 2013). This pattern of strong genetic structure requires the inclusion of several populations into conservation areas to preserve the whole genetic diversity of a taxon. This is unfeasible in most cases, especially in countries such as Brazil, with economies largely dependent on agricultural production for international trade, due to low investment in the creation and maintenance of protected areas, the increasing pressure of the agricultural business for expansion into forested land, and the political interactions at the federal, state, and municipal levels (Tabarelli et al. 2005; Arima et al. 2014). Mountaintop endemic species are also especially

susceptible to the effects of climate change, given that they may be eliminated if plant communities are pushed upwards due to rising temperatures (Grabherr & Paull 1994). This scenario is especially concerning for the campos rupestres flora, with dire projections of climatic suitability for this vegetation in the next decades (Bitencourt et al. 2016; Fernandes et al. 2018).

These factors represent a poor prospect for the campos rupestres areas in eastern Minas Gerais, as they are sparse and isolated from each other by agricultural land. Hopper (2009) argued that in cases of naturally fragmented vegetation types, preserving smaller fragments usually overlooked by conservation plans could be beneficial, provided that edge effects are minimal. Designing a conservation plan around the mountaintops containing campos rupestres and surrounding buffer zones could be effective, creating minimal disruption to the agricultural tradition of the lands in the general area. Given the large number of new taxa described for the region in the last decade and the current efforts to expand botanical sampling across the several mountains, it is very likely that the number of new species recognized will continue to grow, highlighting even more the need for conservation of these unique fragments and hopefully stimulating efforts to create protected areas in the region.

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