

Increasing knowledge on the diversity of canelas-de-ema in the campo rupestre: two new species of *Vellozia* (Velloziaceae) from the southern Espinhaço Range, Brazil

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Abstract

Background and aims – Two new species of *Vellozia* (Velloziaceae) are here described and illustrated, *Vellozia albohexandra* and *V. mellosilvae*. These new species are morphologically similar to *Vellozia armata*, *V. luteola*, and *V. inselbergae*, probably belonging to the same informal group.

Material and methods – Morphological and anatomical descriptions were based on herbarium specimens and in situ observations. Standard taxonomy and plant anatomy practices and methods were applied.

Key results – *Vellozia albohexandra* can be easily distinguished from the other species of the group of *V. luteola* by its sessile flowers with white and smaller petals and sepals, six stamens, and smaller style and stigma. The species is endemic to the Cristália municipality, Minas Gerais state, and has been classified as Data Deficient according to IUCN criteria. *Vellozia mellosilvae* shares morphological affinities with *V. armata*, but it is distinguished by the leaves with serrate margin and abaxial furrows, longer and evident pedicel, and larger petals and sepals. This species is endemic to the Itacambira municipality, and should be considered Critically Endangered.

Keywords

endemism, leaf anatomy, Pandanales, rocky outcrops, taxonomy

INTRODUCTION

Velloziaceae (Pandanales; APG IV 2016) is an amphitropical family composed of five genera (i.e. *Acanthochlamys* P.C.Kao, *Barbacenia* Vand., *Barbaceniopsis* L.B.Sm., *Vellozia* Vand., and *Xerophyta* Juss.) and approximately 250 species (Mello-Silva et al. 2011). Most of its diversity is found in the Neotropical region, especially in the Brazilian campo rupestre, where Velloziaceae is one of the most abundant and species-rich group of vascular plants with about 200 species, of which 183 are endemic (e.g. Mello-Silva 1995; Conceição et al. 2007a, 2007b; Flora e Funga do Brasil 2021). Even with a high number of species recorded, its diversity is probably underestimated due to the difficulty of accessing

some occurrence areas (e.g. Brazilian campo rupestre and Atlantic Forest inselbergs) and to the micro-endemism of many species (Mello-Silva and Menezes 1999).

Campo rupestre is a Brazilian ecosystem associated with high altitude areas, between 1,000 and 2,000 meters above sea level (Saadi 1995; Vasconcelos et al. 2020). This ecosystem is mainly distributed in the Espinhaço Range and Chapada dos Veadeiros in Central/Eastern Brazil, and its vegetation is composed by shrubs and herbs associated to rock outcrops and sandy soils (Vasconcelos 2011; Alves et al. 2014). Campo rupestre is exceptional due to its rich and highly endemic flora (Colli-Silva et al. 2019), with 115 species of *Vellozia* (out of 121), of which 99 are endemic (Mello-Silva et al. 2011; Mello-Silva 2018; Flora e Funga do Brasil 2021).

Two new species of *Vellozia*, popularly known in Brazil as canela-de-ema, *V. albohexandra* Mello-Silva ex Andr. Cabral & Magri and *V. mellosilvae* Andr. Cabral, Magri & J.C. Lopes, endemic to the campo rupestre in the southern portion of the Espinhaço Range in Minas Gerais State are described here. These two new species, together with the recently described *Vellozia inselbergae* Mello-Silva ex Andr. Cabral (Cabral et al. 2021), are probably related to an informal group composed by *Vellozia armata* Mello-Silva and *V. luteola* Mello-Silva & N.L. Menezes, due to their morphological similarity (Renato Mello-Silva pers. comm.). This group was characterized by leaf blades persistent, involute, and amphystomatic, with smooth subsidiary cells, pedicel with nine fibro-vascular bundles and circular in cross section, outer integument of empty cells vanishing in the seeds in a previous cladistic analyses (Mello-Silva 2005).

The results of this article are part of a broad project on the systematics of *Vellozia luteola* group, led by Renato Mello-Silva, who suddenly passed away before he could finish it. The specific epithet of *Vellozia albohexandra* was chosen by Renato Mello-Silva and with *V. mellosilvae*, we formalized a tribute to his memory. Renato Mello-Silva (1961–2020) was an outstanding Brazilian botanist who dedicated decades to the study of the phylogeny and taxonomy of Annonaceae and Velloziaceae and made substantial contributions to the knowledge of the Brazilian biodiversity, especially of the campo rupestre.

MATERIAL AND METHODS

Morphological descriptions and measurements were based on field observation and herbarium specimens, the second one using a stereomicroscope Olympus SZ-STB. *Vellozia albohexandra* and *V. mellosilvae* specimens are deposited at NY, R, and SPF (herbaria acronyms according to Thiers continuously updated). The description of *Vellozia albohexandra* was based only on a herbarium specimen, while for the description of *V. mellosilvae*, fresh material preserved in alcohol was also used. Transverse sections of the median portion of leaves and pedicels were made with a hand-held razor blade, clarified with 20% Sodium Hypochlorite (Kraus and Arduin 1997), and stained with astra blue and basic fuchsin (Roeser 1972). Leaf epidermis was diaphanized and, subsequently, stained with alcoholic safranin (Franklin 1945). Anatomical and morphological descriptions followed the terminology used by Mello-Silva and Menezes (1988) and Mello-Silva et al. (2011). Species delimitation followed the taxonomic species concept (Rieppel 2007; Assis and Brigandt 2009). Conservation status of each species was calculated through GeoCAT (Bachman et al. 2011) using a default cell area of 2 km². The species were classified following the IUCN (2012) categories and criteria. The distribution map was produced using QGIS v.2.18.17 (QGIS Development Team 2022).

TAXONOMIC TREATMENT

Vellozia albohexandra Mello-Silva ex Andr. Cabral & Magri, **sp. nov.**

urn:lsid:ipni.org:names:77304615-1

Figs 1, 2A–D, 3; Table 1

Type. BRAZIL – Minas Gerais • Cristália, Jacuba, estrada Cristália-Botumirim, próximo ao córrego Jacuba; 700 m; 28 Sep. 1997; fl. and fr.; *Mello-Silva 1449*; holotype: SPF; isotypes RB, R, SP, BHCB.

Diagnosis. *Vellozia albohexandra* is similar to *V. armata* by the tristichous leaves roughly of the same dimensions. However, *V. albohexandra* has sessile flowers (vs pedicel approx. 1.5 cm long in *V. armata*), white sepals and petals (vs violet in *V. armata*), 6 stamens (vs 18 stamens in *V. armata*), and capsule 5.7–6.7 × 5.3–6.2 mm (vs 10 × 6–9 mm in *V. armata*).

Description. Stems 3.8–15 cm long. Leaves tristichous; leaf lamina 3.7–9.4 × 0.5–0.8 cm, linear-triangular, caudate, arcuate, involute, sparsely serrate on margins and midrib on abaxial side, abscission line absent, the old laminae marcescent and reflexed. Flowers solitary, sessile; hypanthium ca 0.5 × 0.2 cm, obtriangular, densely covered with subulate emergences, green. Perianth white; sepals 0.9–1.3 × ca 0.2 cm, oblanceolate, margin and midrib of apex and base sparsely covered with subulate emergences on abaxial side, adaxial smooth; petals 1.0–1.2 × 0.1–0.2 cm, narrowly-obovate, smooth or sparsely covered with subulate emergences on the base of abaxial side, adaxial smooth. Stamens 6, appendages absent; filaments separated, 2.5–4.0 mm long, colour not seen; anthers 3.6–4.5 mm long, basifixed, colour not seen. Style 9.1–10 mm long, white-yellowish; stigma 1.3–1.4 mm diam., trilobate-peltate, yellow. Capsule loculicidal, ellipsoid to broadly ellipsoid, 5.7–6.7 × 5.3–6.2 mm, ochre. Seeds not seen.

Leaf and pedicel anatomy. Blade dorsiventral (Fig. 2A). Abaxial furrows about one fifth thickness of blade (Fig. 2A). Cuticle slightly thickened on both surfaces (Fig. 2A). Adaxial epidermis 2–4-seriate (Fig. 2A–B), abaxial epidermis uniseriate (Fig. 2A). Stomata paracytic, confined to furrows (Fig. 2D). Cells elliptically clustered present on adaxial epidermis (Fig. 2C). Aquiferous uniseriate hypodermis present on adaxial surface, extending adaxially to the bundle sheaths as aquiferous parenchyma (Fig. 2A–B). Palisade mesophyll 3(–4) cell-layers thick (Fig. 2A–B). Fibro-vascular bundles surrounded by a unique bundle sheath, 1–3 large vessels present in each fibro-vascular bundle (Fig. 2A). Phloem strands 2, separated (Fig. 2A). Bundles of sclerified cells 2–7 cells thick present on the adaxial epidermis, spaced each 3–6 epidermal cells (Fig. 2A–B). Blade borders with large and rounded fibro-vascular bundles, conduction tissues present (Fig. 2A).

Distribution and habitat. *Vellozia albohexandra* is endemic to the southern Espinhaço Range in Cristália

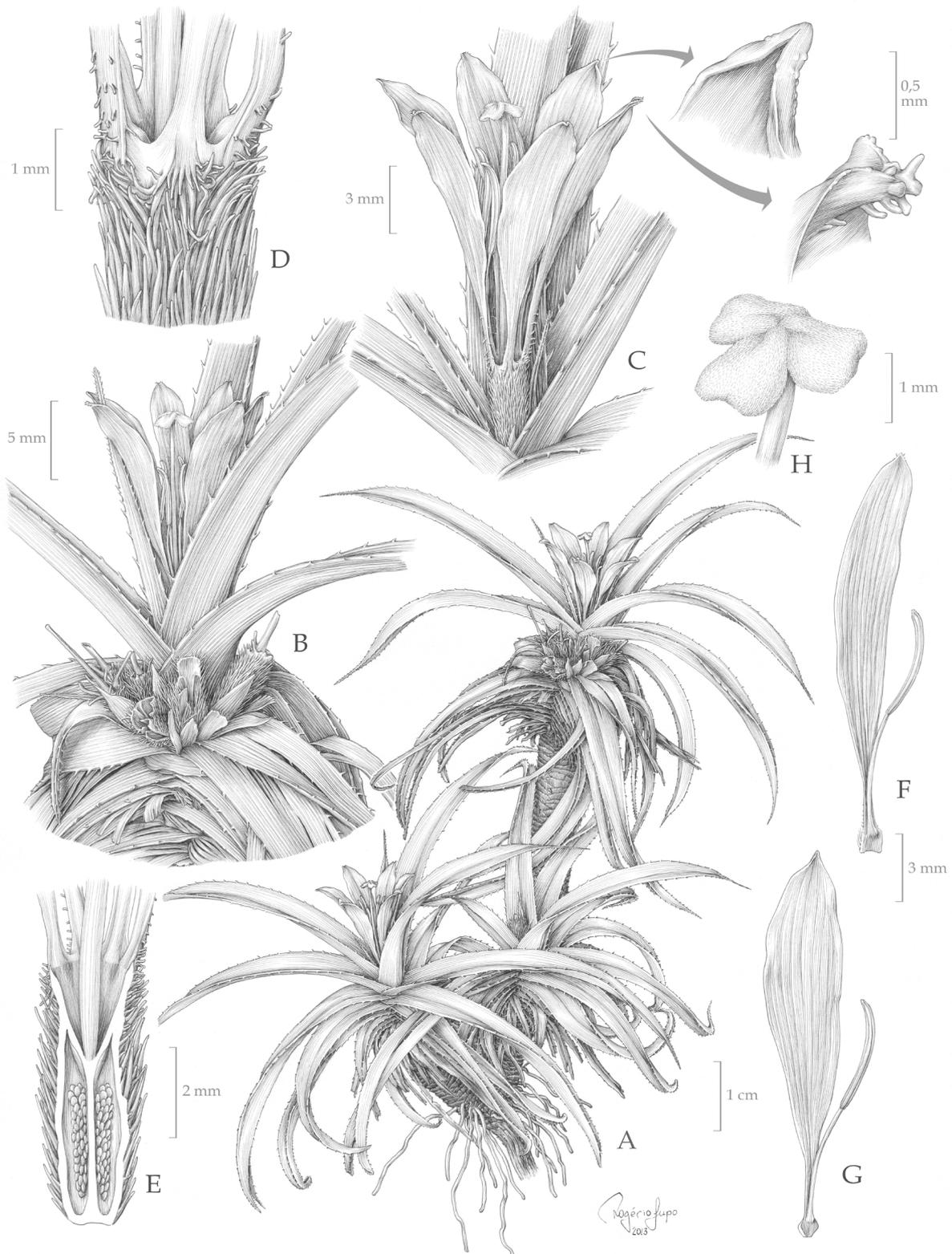


Figure 1. *Vellozia albohexandra*. A–B. Habit. C. External view of the flower with detail of the apex of the sepal and petal. D. Detail of hypanthium emergences. E. Longitudinal section of ovary. F. Sepal. G. Petal. H. Stigma. Drawn by Rogério Lupo based on Mello-Silva 1449.

Table 1. Morphological comparison among the species of the *Vellozia luteola* group.

	<i>V. albohexandra</i>	<i>V. armata</i>	<i>V. inselbergae</i>	<i>V. luteola</i>	<i>V. mellosilvae</i>
Leaf length (cm)	3.7–9.4	2.5–11	15.9–21.3	4–20	11.9–29
Leaf width (mm)	4.7–7.7	4–8	7–13.9	6–14	5.6–13.2
Leaf furrows	present	absent/reduced	present	absent	present
Pedicel length (cm)	flowers sessile	ca 1.5	12.3–18.5	ca 2.5	1.6–4.3
Perianth colour	white	violet	predominantly white	yellow	violet
Sepal and petal length (cm)	0.9–1.3	1.5–2.3	6.9–10.5	1.5–2.5	2.5–4.2
Sepal and petal width (mm)	1–2	5	19.7–33.7	4–7	9–12.7
Number of stamens	6	18	24	15	18–20
Anthers length (mm)	3.6–4.5	ca 7	16.5–22.7	4–7	6–11
Style length (mm)	9.1–10	ca 15	40.7–61	10–25	14.6–23
Stigma diameter (mm)	1.3–1.4	2–3	7–10	ca 6	2.4–4.0
Capsule dimensions (mm)	5.7–6.7 × 5.3–6.2	ca 10 × 6–9	20.3–28 × 15.3–17.7	7–11 × 4–10	8–18 × 6–10

municipality, Minas Gerais state, Brazil (Fig. 3). The species occurs in rock cracks of campo rupestre areas, at elevations around 700 m.

Phenology. Collected with flowers and fruits in September.

Etymology. The epithet refers to the flowers with white perianth and six stamens.

Preliminary IUCN conservation assessment. To date, *Vellozia albohexandra* is known only from the type locality and is therefore classified as Data Deficient (DD).

Notes. *Vellozia albohexandra* can be easily distinguished from the other species of the *V. luteola* group by its sessile flowers, with white and smaller petals and sepals, six stamens, and smaller style and stigma (Table 1). The combination of sessile white flowers with six stamens is rare among the species of *Vellozia*. *Vellozia sessilis* L.B.Sm. ex Mello-Silva has a white perianth and six stamens, but despite its specific epithet, this species has pedicels with ca 1 cm long that is hidden among the old persistent laminae (Mello-Silva 1997). *Vellozia sessilis* is distinguished from *V. albohexandra* mainly by its long hypanthium tube and general plant size and habit (Mello-Silva 1997).

Vellozia mellosilvae Andr.Cabral, Magri & J.C.Lopes, **sp. nov.**

urn:lsid:ipni.org:names:77304616-1

Figs 2E–I, 3, 4, 5; Table 1

Type. BRAZIL – Minas Gerais • Itacambira, Serra de Itacambira. Estrada Juramento Itacambira, 46 km do balneário de Juramento, 250 m a oeste da estrada; 17°00'36.8"S, 43°20'28.5"W; 1280 m; 24 Dec. 2017; fl.; R. Mello-Silva 4347, A. Cabral, F.K. Kiataqui & D.Y.M. Nakamura; holotype: SPF; isotypes RB, R, SP, BHCB.

Paratype. BRAZIL – Minas Gerais • Itacambira, Estrada para Montes Claros; 9 Jan. 1986; fr.; Mello-Silva CFCR 9093;

R [R000163051, R000163051a], SPF • Itacambira, Serra de Itacambira, a 45 km de Juramento; 17°04'S, 43°20'W; 1200 m; 14 Feb. 1988; fr.; Pirani 2259; NY [NY00898964], SPF • Itacambira, no alto da serra; 17°04'S, 43°18'W; 1200 m; 14 Feb. 1988; fr.; Pirani 2275; NY [NY00898963], SPF.

Diagnosis. *Vellozia mellosilvae* resembles *V. armata* by their tristichous phyllotaxis, violet perianth, and overlapping number of stamens, and dimensions of anther, style, and stigma. However, *V. mellosilvae* differs by the longer (1.6–4.2 cm vs 1.5 cm in *V. armata*) and evident pedicel (vs completely hidden by the leaves in *V. armata*), larger petals and sepals (2.5–4.2 × 0.9–1.2 cm vs 1.5–2.3 × 0.5 cm in *V. armata*), leaf furrows (present vs absent/reduced in *V. armata*), and margin (serrate vs spinescent in *V. armata*).

Description. Caespitose herb. **Stems** 2.1–11.2 cm long. **Leaves** tristichous; leaf lamina 11.9–29 × 0.6–1.3 cm, linear-triangular, caudate, arcuate, involute at the base, sparsely serrate on margins and midrib of the abaxial side, abscission line absent, the old laminae marcescent and reflexed. **Flowers** 1–4; pedicel 1.6–4.3 cm long, sparsely covered with subulate emergences, light green to yellowish-green; hypanthium 5–6 × 3–4 mm, obovoid, densely covered with subulate emergences, light green to yellowish-green. **Perianth** violet on the adaxial side and light violet on the abaxial side; sepals 2.8–3.7 × 0.9–1.3 cm, widely-oblongate, abaxial face and margin sparsely covered with subulate emergences, adaxial smooth; petals 2.5–4.2 × 1–1.2 cm, obovate, midrib of the abaxial side sparsely covered with subulate emergences on apical and proximal region, adaxial smooth. **Stamens** 18–20, 3–5 grouped, appendages absent; filaments irregularly united at the bottom, light-violet; anthers 6–11 mm long, basifixed, yellow. **Style** 14.6–23 mm long, white; stigma 2.4–4 mm diam., trilobate-peltate, yellow. **Capsule**

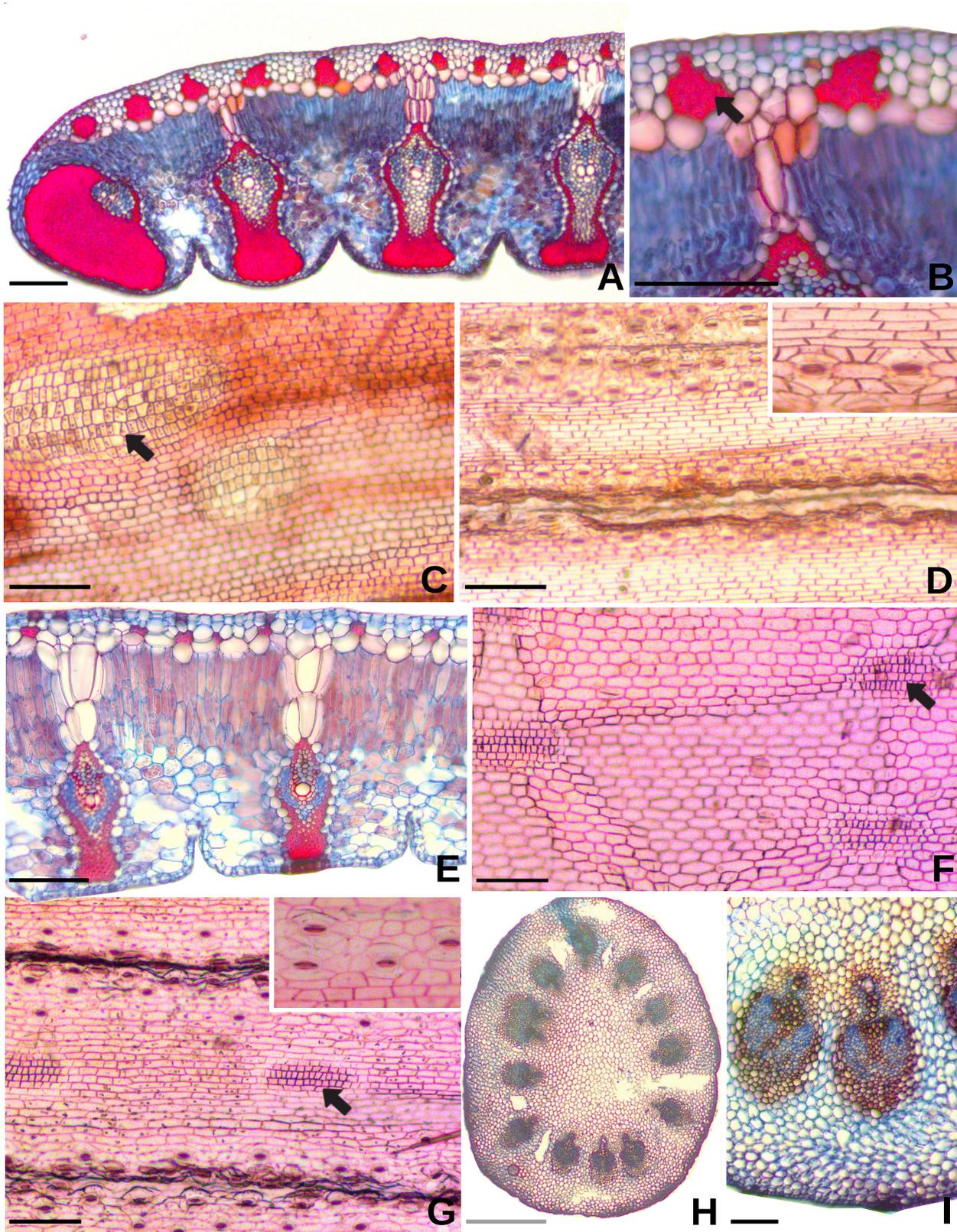


Figure 2. A–D is *Vellozia albohexasandra* (Mello-Silva 1449) and E–I is *Vellozia mellosilvae* (Mello-Silva 4347). A–B. Cross section of the middle region of leaf. B. Detail of sclerified cell bundles in adaxial epidermis (arrow). C. Leaf adaxial epidermis, arrow showing the cells elliptically clustered. D. Leaf abaxial epidermis, detail in the top right showing the paracytic stomata. E. Cross section of the middle region of leaf. F. Leaf adaxial epidermis, arrow highlighting the cells elliptically clustered. G. Leaf abaxial epidermis, arrow highlighting the cells elliptically clustered, detail in the top right showing the paracytic stomata. H–I. Pedicle cross-section. Black scale bars in A–G, I = 100 µm; grey scale bar in H = 250 µm.

loculicidal, ellipsoid to broadly ellipsoid, $8\text{--}18 \times 6\text{--}10$ mm, ochre. *Seeds* not seen.

Leaf and pedicel anatomy. Blade dorsiventral (Fig. 2E). Abaxial furrows about one fifth thickness of blade (Fig. 2E). Cuticle slightly thickened on both surfaces (Fig. 2E). Adaxial epidermis 2–3-seriate, abaxial epidermis uniseriate (Fig. 2E). Stomata paracytic, confined to furrows (Fig. 2G). Cells elliptically clustered present on both surfaces (Fig. 2F–G). Aquiferous 1(–2)-seriate hypodermis present on adaxial surface, extending adaxially to the bundle sheaths as aquiferous parenchyma (Fig. 2E). Palisade mesophyll 2–3 cell-layers thick (Fig. 2E). Fibro-vascular bundles surrounded by a unique bundle sheath, 1–3(–4) large vessels present in each fibro-vascular bundle (Fig. 2E). Phloem strands 2, V-shaped (Fig. 2E). Bundles of sclerified cells 2–8 cells thick present on the adaxial epidermis, spaced each 1–7 epidermal cells (Fig. 2E). Blade borders with large and rounded fibro-vascular bundles, conduction tissues present. Pedicel rounded in transverse section, fibro-vascular bundles 13, belt of sclerified cells absent (Fig. 2H–I).

Distribution and habitat. *Vellozia mellosilvae* occurs in the campo rupestre of Itacambira municipality, southern

Espinhaço Range, Minas Gerais state, Brazil (Fig. 3). This species is found in rocky outcrops among shrubs in sandy soil and rock crevices at elevations from 1,200 to 1,280 m.

Phenology. Flowering in December and fruiting from January to February.

Etymology. The epithet is named after Renato Mello-Silva (1961–2020), the greatest authority in the systematics of Brazilian Velloziaceae and who also collected the holotype of *Vellozia mellosilvae*.

Preliminary IUCN Conservation assessment. *Vellozia mellosilvae* is endemic to the municipality of Itacambira and has an area of occupancy of 12 km² and extent of occurrence of approximately 11 km². Although it occurs in large populations, *V. mellosilvae* is not protected by conservation units. Besides that, the campo rupestre is a sensitive ecosystem to threats such as mining and livestock farming (Ribeiro and Freitas 2010). Therefore, *V. mellosilvae* is considered Critically Endangered: CR B1abiii.

Notes. *Vellozia mellosilvae* morphotype was already described under *Vellozia luteola* in Mello-Silva and Menezes (1988) based on vegetative characters and fruit morphology. However, the author observed conspicuous

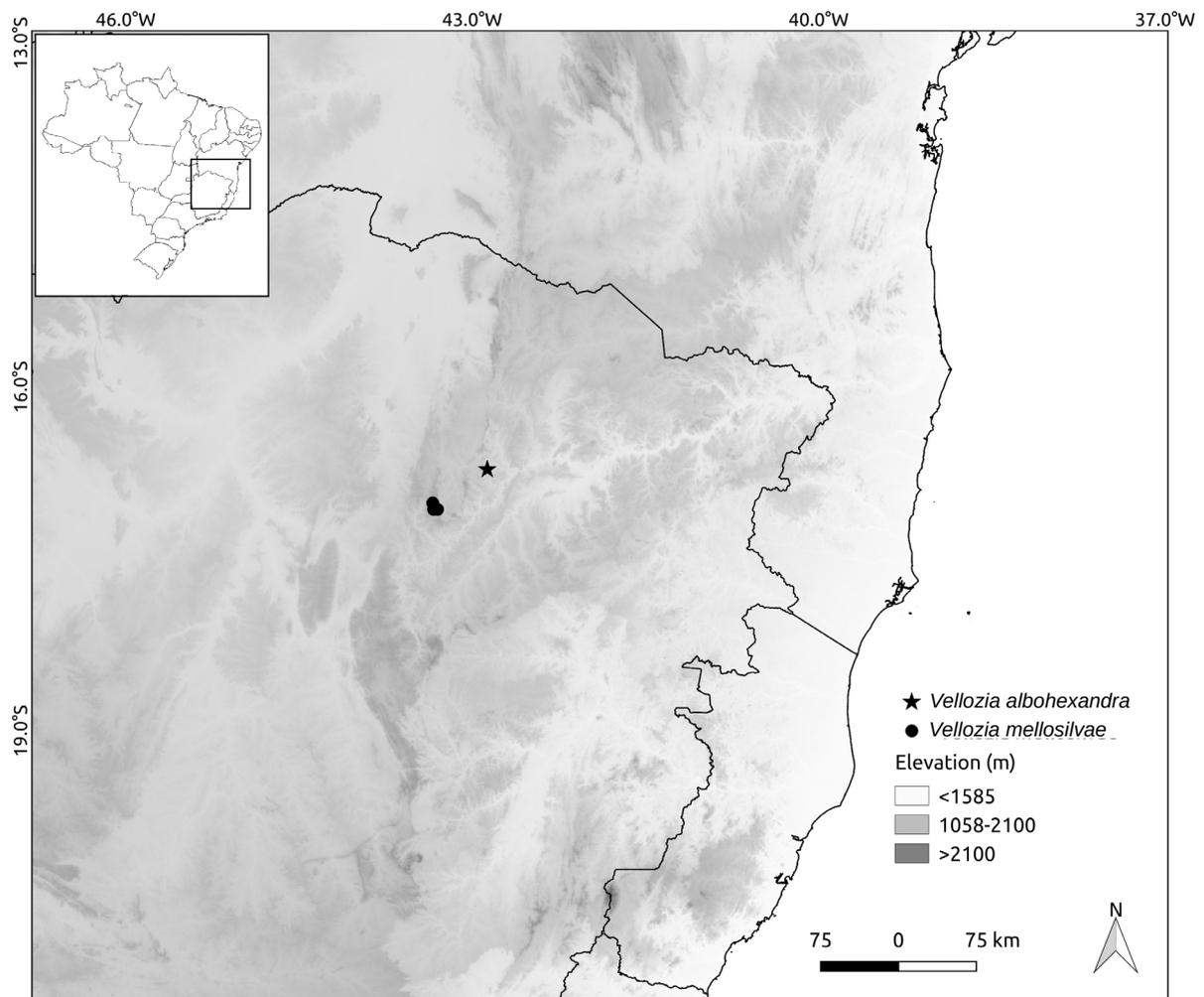


Figure 3. Distribution of *Vellozia albohexandra* (star) and *V. mellosilvae* (dots) in the Espinhaço Range, Minas Gerais state, Brazil.

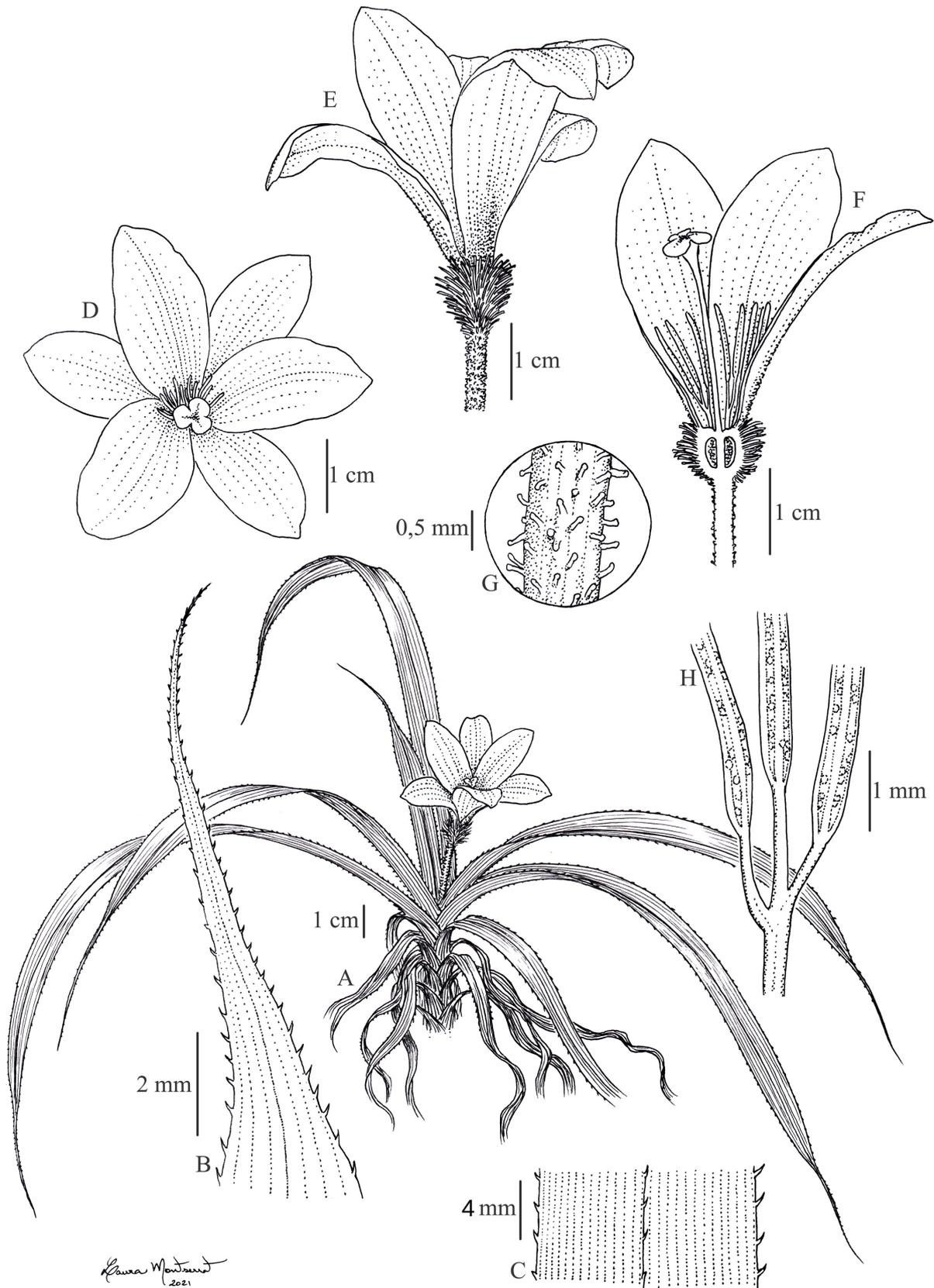


Figure 4. *Vellozia mellosilvae*. A. Habit. B. Leaf apex. C. Detail of the leaf abaxial surface. D. Flower in apical view. E. Flower in lateral view. F. Longitudinal section of the flower. G. Detail of pedicel emergences. H. Detail of the transition portion between filaments and anthers. Drawn by Laura Montserrat based on *Mello-Silva* 4347.

differences in the leaf anatomy between populations from the type-location of *V. luteola* and from Itacambira (i.e. presence/absence of bulliform cells and abaxial furrows). After analysing a recent collection of a flowering individual, we recognized the population of Itacambira as a distinct species. In addition to the characters highlighted by Mello-Silva (1988), *V. mellosilvae* can be differentiated

from *V. luteola* by the violet perianth (vs yellow in *V. luteola*), sepal and petal dimensions ($2.5\text{--}4.2\text{ cm} \times 9\text{--}12.7\text{ mm}$ vs $1.5\text{--}2.5\text{ cm} \times 4\text{--}7\text{ mm}$ in *V. luteola*) and presence and distribution of emergences on their abaxial surface, 18–20 stamens (vs 15 in *V. luteola*), anthers length (6–11 mm vs 4–7 mm in *V. luteola*), and stigma diameter (2.4–4 mm vs ca 6 mm in *V. luteola*) (Table 1).



Figure 5. *Vellozia mellosilvae*. A. Habitat of the species. B. Habit of the species. C. Frontal view of a flower. D. Lateral view of a flower and an immature fruit. E. Longitudinal section of a flower. F. Floral bud. G. Immature fruit. Photos by Renato Mello-Silva (A–E) and Andressa Cabral (F–G).

DISCUSSION

Besides the broad studies on the systematics of Velloziaceae (e.g. Smith 1962; Smith and Ayensu 1976), knowledge on the diversity of the family has gradually increased thanks to the taxonomic efforts focused on small clades or informal groups (e.g. Mello-Silva and Sasaki 2016; Mello-Silva and Cabral 2022), populations (e.g. Mello-Silva 2010), or a given area (e.g. Montserrat and Mello-Silva 2013). In this way, several new taxa have been described in Velloziaceae nowadays (e.g. Cabral et al. 2021; Mello-Silva and Cabral 2022; present study), although its diversity may be still underestimated (see Introduction).

The *Vellozia luteola* group is one of the several informal groups in Velloziaceae recognized in the first complete cladistic analyses of the family (Mello-Silva 2005). Although the species belonging to this group share morphological and anatomical characters (see Introduction), a phylogenetic inference including macromolecular evidence and a complete species sampling has not been performed so far. All these species, except by *V. inselbergae*, occur in the campo rupestre, southern Espinhaço Range, Cerrado domain. *Vellozia inselbergae* is the only species of the *V. luteola* group occurring in the inselbergs of the Atlantic Forest domain (Cabral et al. 2021).

Both campo rupestre and Atlantic Forest inselbergs have been under numerous threats, such as mining, livestock farming, tourism, road construction, and urbanisation (Porembski et al. 2016; Fernandes et al. 2020), and there is a risk that these environments will suffer great loss in their biodiversity and ecosystem services before we can fully understand them. For this reason, describing the diversity and investigating the systematics of an important element of these environments, such as Velloziaceae (Conceição et al. 2007a, 2007b), is an important step towards their conservation.

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