

Doomed to extinction by mining: a new species of *Hoplocrypтанthus* (Bromeliaceae: Bromelioideae) from Congonhas, Minas Gerais, Brazil

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Abstract

A new species of *Hoplocrypтанthus*, a member of the bromelioid “Cryptanthoid complex”, is described based on plants discovered in a ferruginous rupestrian grassland located in the southern Iron Quadrangle region, Minas Gerais state, Brazil. *Hoplocrypтанthus serrapirensis* is endemic to the Pires Range, a region under strong threat by mining exploitation. The morphological characters of *H. serrapirensis* are discussed in comparison with *H. knegtianus* and *H. tiradentesensis*. This microendemic species is assessed as Critically Endangered (CR), reinforcing the need for a strategy to protect the biodiversity of the region. Characters related to leaves proved useful in the taxonomic delimitation of this new species. Morphological analyses also validated and reinforced the diagnostic floral and inflorescence characters used in the circumscription of *Hoplocrypтанthus*.

Key words: bromeliads, conservation, Espinhaço Range, morphology

Introduction

Hoplocrypтанthus (Mez 1891: 202) Leme, S. Heller & Zizka (2017: 62) is a genus of the “Cryptanthoid complex” of Bromeliaceae (Bromelioideae), endemic to the central-southeast region of Minas Gerais state, growing exclusively in rupestrian grasslands vegetation, mostly in the Iron Quadrangle area, south of the Espinhaço Range, with some southwestern extensions towards the municipality of São Tomé das Letras (Leme *et al.* 2017, Leme *et al.* 2020). It comprises nine small-sized species (Gouda *et al.* cont. upd.), which grow as saxicolous or epilithic plants at elevations between 500 to 1834 m.

The genus is characterized by homogamous plants that propagate by short axillary shoots. The inflorescence is compound or rarely simple, sessile and corymbose, with sessile or short pedicellate fragrant flowers. The sepals and petals are connate at the base and the unappendaged petals form at the base a distinct common structure with filaments and style, while the corolla is of the open, fan-like type, distinctly exposing the stamens. The stigma is of the cylindric-distinct type and pollen grains are medium-sized, sulcus with small exine elements, and sulcus margins are indistinct. The ornamentation is reticulate, microreticulate or even perforate. The fruits are small with persistent sepals, usually slightly shorter than to equal in length to the fruit, or rarely up to 1.4 times the fruit length, producing many small-sized

seeds. In addition to morphology, the circumscription of the genus is also supported by molecular phylogenetic data (Leme *et al.* 2017).

The ferruginous geosystems of the Iron Quadrangle area are in the southern portion of the Espinhaço Range, a mountain comprised of rocks highly resistant to weathering, especially quartzites and iron formations (Saadi 1995). The vegetation of the Iron Quadrangle includes a complex of ferruginous rupestrian grassland environments also known as “cangas”, as well as other phytophysionomies associated with ferruginous substrates. With restricted distribution, they represent one of the least known vegetation complexes in Brazil (Jacobi & Carmo 2008). Studies on these environments show an extraordinary flora comprising thousands of species, many of them endemic and endangered (Carmo *et al.* 2018).

The Iron Quadrangle is also a region of major interest for the Brazilian mineral industry. The strong threat of mining exploitation in ferruginous grasslands led to a loss of half of their original area (Salles *et al.* 2019) and reveals how insufficient the protection of this environment is (Lobo & Cioni 2024).

After a thorough analysis of specimens collected in the Pires Range, located in the south of the Iron Quadrangle between the coordinates 20°26'40.71"S and 43°51'34.13"W, we propose a new species for the genus *Hoplocryptanthus*. The Pires Range belongs to the municipality of Congonhas, Minas Gerais state. At around 15 km from the central region of the municipality, the area comprises 243 hectares with elevations ranging from 1090 to 1300 m, and is inserted between two hotspots, namely the Atlantic Forest transitioning into Cerrado.

The Pires Range exhibits a unique complex of phytophysionomies on the ferruginous matrix, composed of forest (e.g. semi-deciduous forests), grassland formations and canga outcrops (Castro 2024). In this study, we provide a full description, photo images, and conservation assessment, as well as comments on the morphological relationship of the new *Hoplocryptanthus* species with similar taxa.

Material and methods

Taxonomic sampling

The studied species were collected in their natural habitats during field activities with the specific purpose of biodiversity surveys and were taken into cultivation. The morphological descriptions and illustrations were based on living fertile material before pressing and drying. The descriptive terminology follows Smith & Downs (1974, 1977, 1979), with adaptations suggested by Scharf & Gouda (2008), and definitions used by Barfuss *et al.* (2016) and Leme *et al.* (2017). Voucher specimens were dried and pressed following Fidalgo & Bononi (1984) and deposited in the herbaria CESJ and RB (acronyms following Thiers [cont. updated]).

Geographic distribution maps and extinction risk assessment

We produced the distribution map of the species using ArcGIS Pro version 3.0.3 (Fig. 1) and assessed its extinction risk following the IUCN Red List Categories and Criteria, version 16 (IUCN 2024). We used the Geospatial Conservation Assessment (GeoCAT) tool (Bachman *et al.* 2011) and the default methods to estimate the spatial parameters, Area of Occupancy (AOO) and Extent of Occurrence (EOO), to infer the conservation status of the species.

Pollen analysis

Pollen samples from fresh flowers at the beginning of anthesis were taken and stored on filter paper in a dry place. For scanning electron microscopy investigation, pollen was rehydrated for a few minutes with water to obtain the turgescence pollen state. Then the material was dehydrated in 2,2-dimethoxypropane and critical-point dried (Halbritter 1998). The samples were mounted on stubs with double-sided sticky tape, sputter coated with gold and analyzed using a Zeiss Evo MA10 scanning electron microscope. Descriptive terminology follows Halbritter & Hesse (1993), Punt *et al.* (2007), and Halbritter *et al.* (2018).

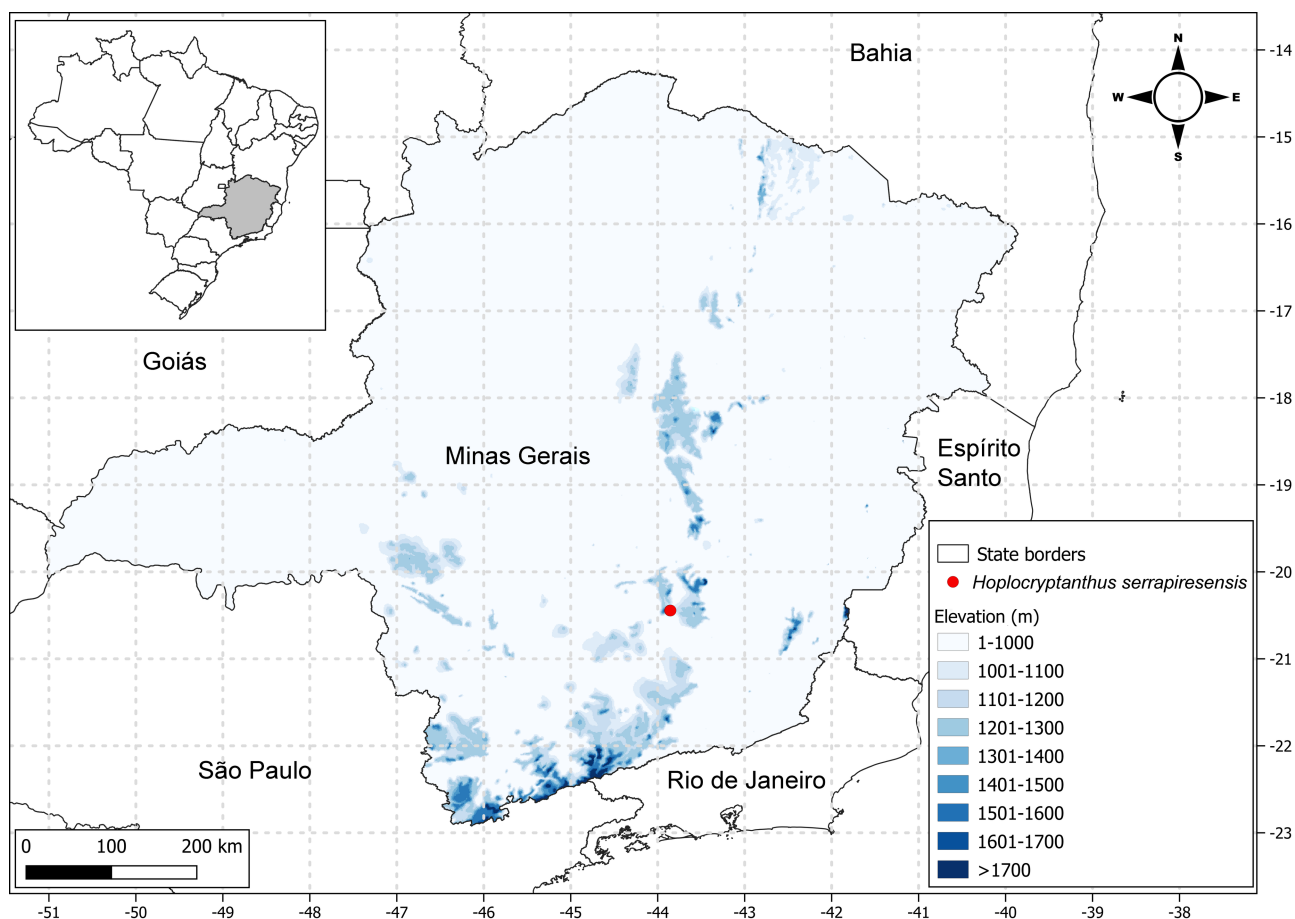


FIGURE 1. Map with the geographical distribution of *Hoplocryptanthus serrapiresensis*.

Taxonomy

Hoplocryptanthus serrapiresensis Leme, J.L.Lobo, O.B.C.Ribeiro & A.P.Gelli, *sp. nov.* (Figs. 2 A–L, 5 A–F).

Diagnosis:—*Hoplocryptanthus serrapiresensis* is morphologically closely related to *H. knegtianus* O.B.C. Ribeiro & Leme (Leme *et al.* 2020: 177), differing from it by the less numerous leaves (13–15 vs. 18–32 in number), leaf blades with longer spines (1–1.5 mm vs. 0.5–1 mm), which are reddish (vs. green to yellowish), inflorescence inconspicuously compound, appearing simple (vs. distinctly compound), with primary fascicles bearing 1 to 2 flowers (vs. 2-to 4-flowered), floral bracts smaller (7×3.5 –4 mm vs. ca. 13×7 mm), distinctly shorter than the sepals (vs. about equal to the sepals), and smaller sepals (6 – 6.5×1.5 mm vs. 9 – 9.5×3 mm).

Type:—BRAZIL. Minas Gerais: Congonhas, Serra do Pires, $20^{\circ}26'45.5''\text{S}$ $43^{\circ}51'32.4''\text{W}$, 29 April 2021, J.L. Lobo & L. Marques *s.n.*, fl., fr. cult. E. Leme 10355 (holotype: RB!).

Plants stemless, flowering ca. 2 cm tall, propagating by short basal shoots. *Leaves* 13–15 in number, subspreading, forming a subdense rosette 10–15 cm in diameter; *sheath* subtrapeziform to broadly elliptic, 0.9 – 1×1.2 cm, whitish toward the base on both sides, abaxially dark red to wine colored, densely and coarsely white lepidote toward the distal end, distinctly nerved, corrugate, adaxially glabrous, greenish except for the dark red distal margins, laxly spinulose; *blade* narrowly triangular-lanceolate, attenuate-caudate, 5–12 cm long, 3.5–5 mm wide near the proximal part, green except for the dark reddish margins, coriaceous mainly toward the base, canaliculate mainly under water stress, abaxially distinctly nerved, densely white lepidote, trichomes along the nerves not obscuring the leaf color, adaxially glabrous or glabrescent, margins subdensely spinose; *spines* 1–1.5 mm long, 2–6 mm apart, reddish, subspreading, straight to slightly antrorse. *Inflorescence* sessile, inconspicuously compound, subcorymbose, ca. 1.5 cm long, ca. 1 cm in diameter (not including the primary bracts); *primary bracts* resembling the leaves, subspreading, green; *primary fascicles* inconspicuous, positioned at the base of the inflorescence, with 1 to 2 flowers; *floral bracts* narrowly triangular, apex broadly acute and apiculate, 7×3.5 –4 mm, membranaceous, greenish toward the apex, hyaline toward the margins, carinate, irregularly spinulose near the apex, distinctly nerved, subdensely and coarsely white lepidote

near the apex to glabrescent, distinctly shorter than the sepals. *Flowers* all perfect, 24–26 mm long (with the petals extended), fragrant, sessile to inconspicuously pedicellate, with pedicel *ca.* 1 mm long; *sepals* narrowly lanceolate, acute and apiculate, 6–6.5 × 1.5 mm, obtusely if at all carinate, shortly connate at the base for 2–3.5 mm, entire, white lepidote near the apex, white-hyaline near the base and along the margins, centrally green toward the apex; *petals* spatulate, 22–23 × 6–6.5 mm, shortly connate at the base for 1–1.5 mm into a common tube with the filaments and style, white, without distinct callosities, apex rounded, distinctly longer than the stamens but subspreading at anthesis and exposing them, forming an open, fan-like corolla; *filaments* *ca.* 13 mm long, adnate to the petals for 1–1.5 mm and forming an inconspicuous basal concrescence with the style; *anthers* *ca.* 2 mm long, dorsifixed near the base, base distinctly bilobed, apex apiculate; *pollen* microreticulate (lumina width <1 µm), medium-sized, about 45–55 µm in diameter (longest axis), oblate and amb elliptical (turgescer pollen), microreticulum heterobrochate with narrow muri, lumina small, width decreasing towards sulcus margins, sulcus wide, occupying the entire distal pole, ornamented with small isolate exine elements (insulae-type), sulcus margin with substantial exine deposition, ornamentation and germination area predominantly in the central region of the sulcus; *ovary* trigonous, 3–4 × 2–2.5 mm, white, glabrous; *epigynous* tube lacking; *ovules* obtuse; *placentation* apical; *stigma* cylindric-distent, white, blades *ca.* 2 mm long, cylindraceous toward the base, suberect to subspreading-recurved, the slightly expanded distal portion inconspicuously papillate. *Fruits* subglobose, *ca.* 5 × 4 mm, greenish-white, with persistent green sepals. Seeds subtriangular, 1–1.2 × 0.7–1 mm, castaneous, distinctly sulcate.

Distribution and habitat:—At present, *Hoplocryptanthus serrapiresensis* is only known from the type locality. The individuals grow as saxicolous or epilithic plants, exclusively on itabirite boulders (Fig. 3 C). The large banded itabirite blocks are randomly dispersed throughout the region and are home to many endemic species in the Pires Range (Fig. 3 A–D). The hematite present in this type of rock is an iron ore highly valued by the mining industry.

Etymology:—The specific epithet refers to the location where this new species was discovered, in the Serra Range, situated in Congonhas, Minas Gerais state, one of this municipality not entirely affected by mining activities.

Distinctive characters:—*Hoplocryptanthus serrapiresensis* is morphologically closely related to *H. knegtianus* due to their sharing small and delicate size, the very narrow leaf blades which are, at least toward the apex, glabrescent to glabrous adaxially (Fig. 4 A–G). However, this new species differs from it by the less numerous leaves (13–15 vs. 18–32), leaf blades with longer spines (1–1.5 mm vs. 0.5–1 mm), which are reddish (vs. green to yellowish), and slightly antrorse (vs. the basal ones slightly retrorse). The inflorescence of this new species is inconspicuously compound, appearing simple (vs. distinctly compound) with primary fascicles bearing 1 to 2 flowers (vs. 2–4-flowered). Floral bracts are smaller (7 × 3.5–4 mm vs. *ca.* 13 × 7 mm), distinctly shorter than the sepals (vs. about equalling the sepals). Additionally, the sepals of *H. serrapiresensis* are distinctly smaller (6–6.5 × 1.5 mm vs. 9–9.5 × 3 mm) and distinctly connate at the base for 2–2.5 mm (vs. shortly connate).

Hoplocryptanthus serrapiresensis also resembles *H. tiradentesensis* (Leme, 2007: 268) Leme, S. Heller & Zizka (2017: 65) by presenting a similar number of leaves per rosette, narrow leaf blades with pronounced red spines, and the floral bracts shorter than the sepals (Fig. 4 H). Nonetheless, this new species can be easily distinguished from *H. tiradentesensis* by the smaller leaf blades (5–12 cm × 3.5–5 mm vs. 9–15 cm × 9–11 mm), adaxially glabrous or glabrescent (vs. subdensely to densely white lepidote), inflorescence inconspicuously compound, appearing simple (vs. distinctly compound) with basal primary fascicles bearing 1 to 2 flowers (vs. 2 to 4-flowered), shorter sepals (6–6.5 mm vs. 8–10 mm), which are shortly connate at the base for 2–2.5 mm (vs. 3–4 mm).

Conservation status:—Plotting the known occurrence of *Hoplocryptanthus serrapiresensis* in Geocat software (Bachman *et al.* 2011), the obtained estimated extent of occurrence (EOO) is 0.002 km², and the area of occupancy (AOO) is 8 km². The presence of mining is striking, with visible signs of activity extending to the limits of the study area (Fig. 3 D), which places the species in the IUCN concept of Critically Endangered (CR) B1 [ab (i, ii, iii)]. We also estimate that the population of *H. serrapiresensis* has less than 50 mature individuals. When its very small and restricted population and small area of occurrence are associated with the highly negative human pressure mentioned above, the criteria D (IUCN 2024) reiterates its CR status. Since the Pires Range is not protected by Conservation Units, the *in-situ* survival of this species is uncertain, recommending extra conservation efforts to keep it alive at least *ex-situ*.

Additional specimens examined (paratypes):—BRAZIL. Minas Gerais: Congonhas, Serra do Pires, 20°26′43.3″S 43°51′09.5″W, 1196 m, 26 January 2023, *fl.*, J.L. Lobo 020 (CESJ!); Congonhas, Serra do Pires, 20°26′42.3″S 43°51′33.3″W, 1280 m, 16 December 2023, *fl.*, J.L. Lobo 939 (CESJ!).

General remarks:—*Hoplocryptanthus serrapiresensis* presents a specialized ecological niche usually growing in organic material accumulated in crevices in itabirite rocks associated with the Velloziaceae species *Barbacenia tomentosa* Martius (1824: 18). As observed in other Bromeliaceae species of the Cryptanthoid complex with similar

habitat preferences and small seeds, including its close morphological relatives, its dispersal may be associated with termite foraging activity.

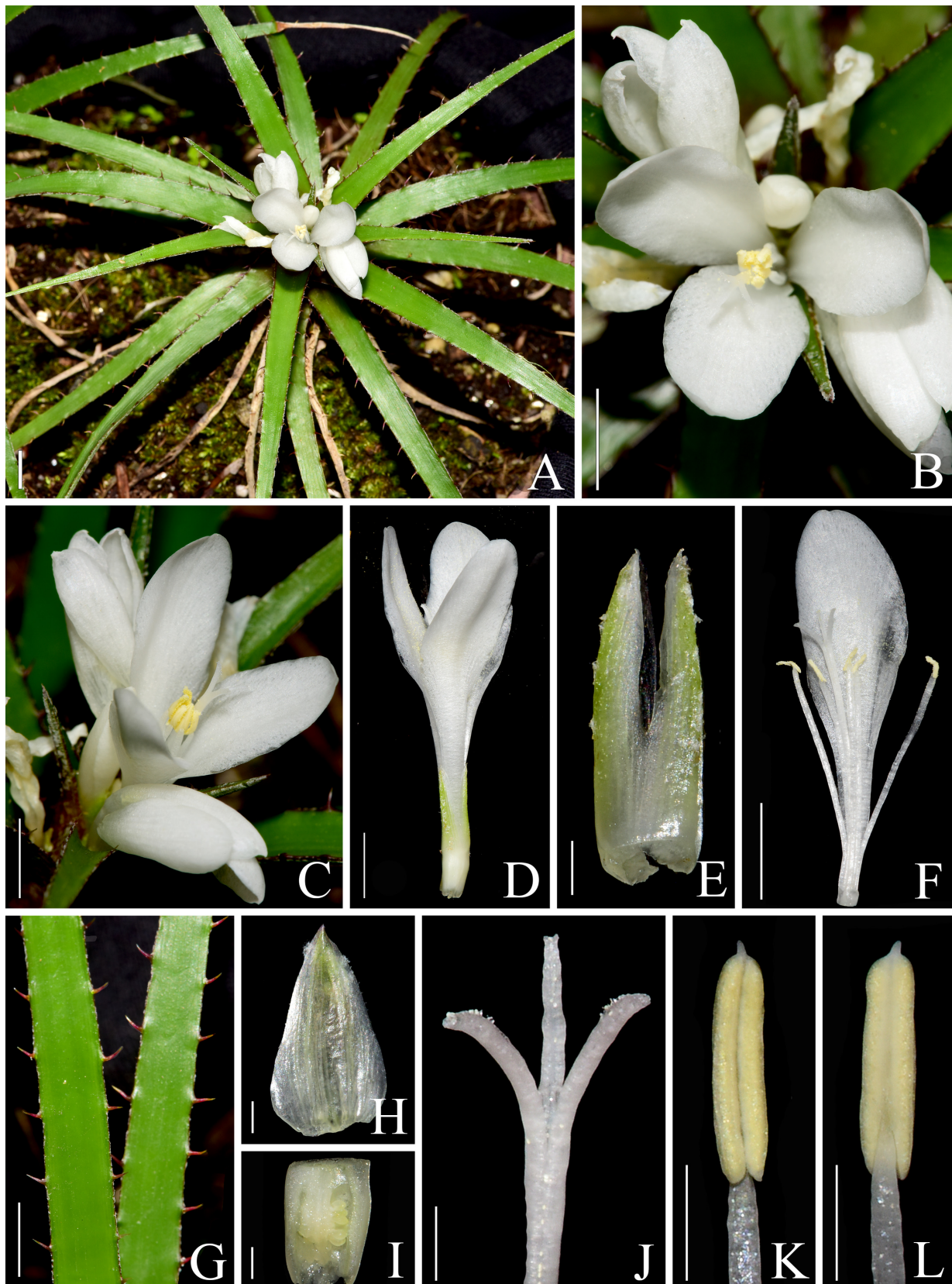


FIGURE 2. A–L. *Hoplocryptanthus serrapiresensis* (Leme 10355). A. Habit. B. Frontal view of the corolla. C. Lateral view of the corolla. D. Flower. E. Abaxial view of sepals connate at the base. F. Petal, filaments, and style forming a common basal tube which is typical for *Hoplocryptanthus*. G. Details of the basal portion of the leaf blades with pronounced marginal spines. H. Floral bract. I. Longitudinal section of the ovary. J. Stigma. K. Frontal view of the anther. L. Dorsal view of the anther. Photographs by E. Leme. Bars = 5 mm (A–D, F–G). Bars = 1 mm (E, H–L).



FIGURE 3. **A.** General view of the ferruginous rupestrian fields of Pires Range, situated in the Congonhas municipality, at the southern end of the Espinhaço Range, Minas Gerais state, Brazil. **B.** Details of large banded itabirite blocks which occur randomly dispersed throughout the area. **C.** The saxicolous habit of *Hoplocryptanthus serrapiresensis* at type locality. **D.** Presence of intense mining activity extending to the limits of the Pires Range. Photographs by P. H. Nobre.

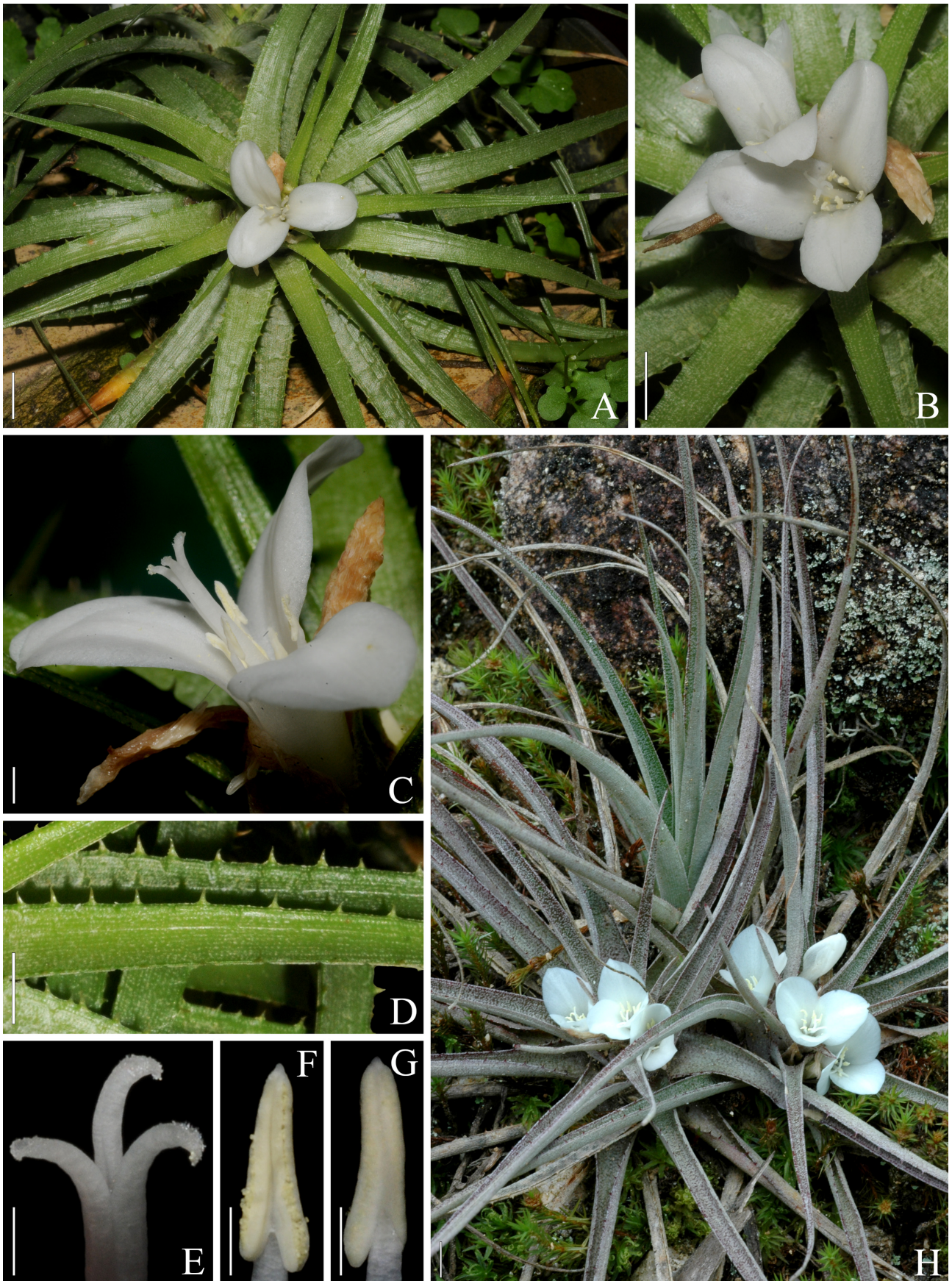


FIGURE 4. A–L. *Hoplocryptanthus knegtianus* (Leme 9322). **A.** Habit. **B.** Frontal view of the corolla. **C.** Lateral view of the corolla. **D.** Details of the basal portion of the leaf blades and the marginal spines. **E.** Stigma. **F.** Frontal view of the anther. **G.** Dorsal view of the anther. **H.** Habit of *Hoplocryptanthus tiradentesensis* (Leme 5819). Photographs by E. Leme. **Bars** = 5 mm (**A–B, D, H**). **Bars** = 2 mm (**C**), **Bars** = 1 mm (**E–G**).

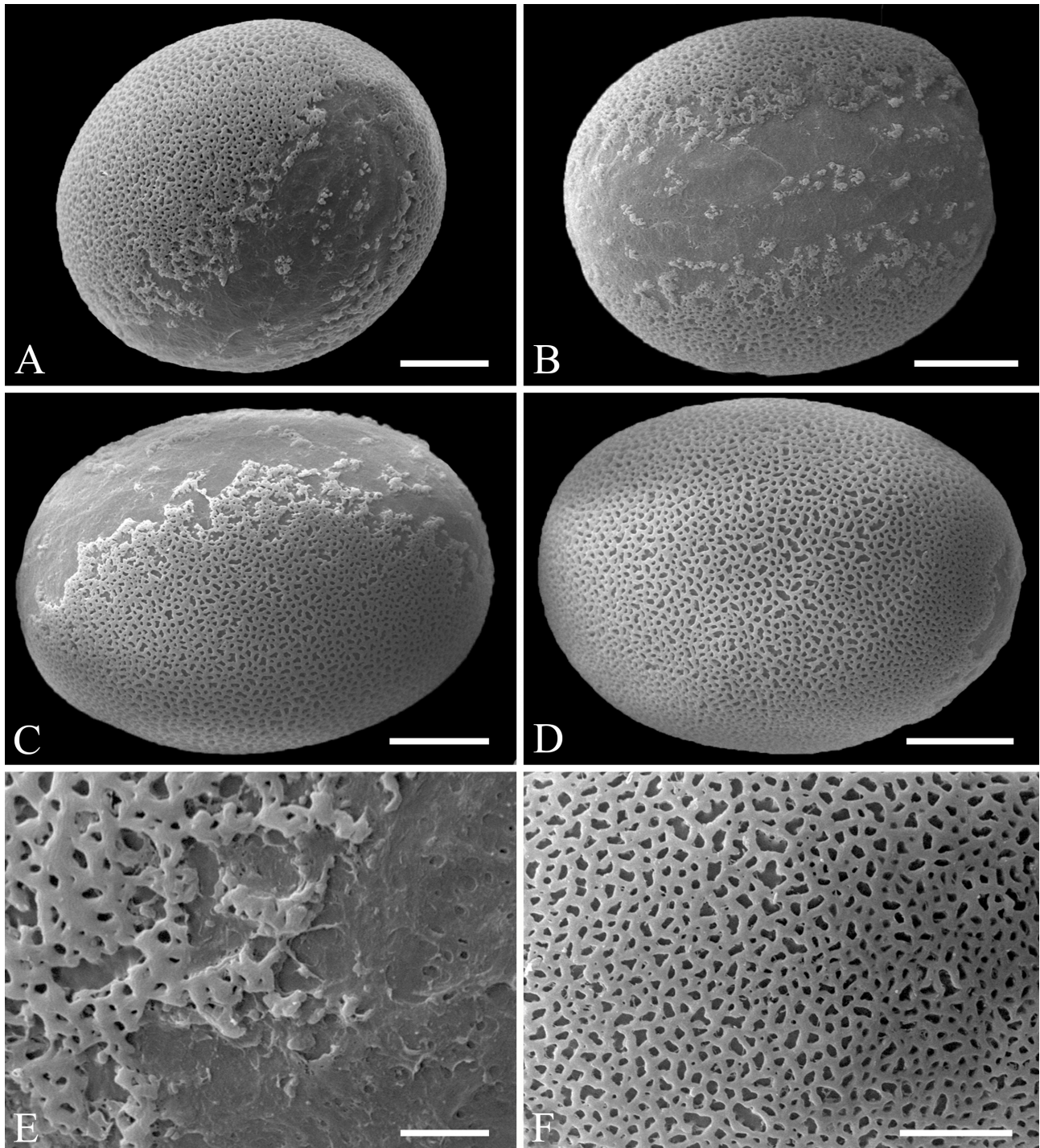


FIGURE 5. Pollen. **A–F.** *Hoplocryptanthus serrapiresensis* (Leme 10355). **A.** Equatorial view. Partial view of the microreticulum and the sulcus covered with small isolated exine elements. **B.** Distal polar view. View of the sulcus covered with small isolate exine elements. **C.** Equatorial view. Partial view of the microreticulum and the wide, ornamented sulcus margin with substantial exine deposition. **D.** Proximal polar view. View of the microreticulum. **E.** Details of the exine elements at the sulcus margin. **F.** Details of the microreticulum with narrow muri. Photographs by Pedro S. de Almeida. **Bars** = 10 μm (**A–D**). **Bars** = 5 μm (**F**). **Bars** = 2 μm (**E**).

Pollen in *Hoplocryptanthus serrapiresensis* has the characteristics described for the genus by Leme *et al.* (2017), especially its size (*ca.* 50 μm), ornamentation with small lumina (here, microreticulate ornamentation), and the insulae sulcus type (Fig. 5 A–F). It is important to mention that Leme *et al.* (2017) described the aperture margin in *Hoplocryptanthus* as indistinct. However, a better definition of the typologies of pollen grain aperture margins in Bromeliaceae is necessary. Certainly, the aperture margin of *H. serrapiresensis* and many species belonging to the Cryptanthoid complex do not fit into any of the typologies proposed by Halbritter (1992). Here, we observed a

distinct margin, described as broad and ornamented. The aperture margin is considered the region of the apertural area where exine deposition decreases and the microreticulum mesh is interrupted, with its boundary defined by the more centralized germination area at the distal pole.

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