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Expanding *Waltillia*: an addition to a previously monotypic genus of Bromeliaceae from the Espinhaço range, Brazil

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Abstract

We describe *Waltillia itambana*, a new species placed in the previously monotypic genus *Waltillia,* presenting as main differences from *Waltillia hatschbachii* features such as a water-impounding rosette, shorter and broader leaves, divergent non-secund flowers and the light-green petals. The species is, as far as known, restricted to Pico do Itambé State Park, in Minas Gerais, growing above 1500 m of elevation in the rupestrian grasslands, of the Diamantina Plateau, Espinhaço Range, Minas Gerais State. We compare *W. itambana* with other similar species that occur in the rupestrian grasslands and provide illustrations, information on geographic distribution, a map, and ecological and conservation observations on the new species.

Keywords: endemism, lithophyte, mountain, neotropical, pollen, Vrieseinae

Introduction

Waltillia Leme, Barfuss & Halbritter (Leme *et al.* 2017: 29) is a monotypic genus of the subfamily Tillandsioideae recently described. It accommodates a single species, *Waltillia hatschbachii* (Smith & Read 1975: 292) Leme, Barfuss & Halbritter (2017: 30), thought to be extinct and formerly placed in *Alcantarea* (E. Morren ex Mez 1894: 516) Harms (1929: 802) (Leme *et al.* 2017). A molecular phylogenetic analysis indicates that individuals of *W. hatschbachii* form a monophyletic, highly supported group in sister position to *Alcantarea* (Leme *et al.* 2017). However, a recently biogeographic analysis of subtribe Vrieseinae Barfuss & W. Till (in Barfuss *et al.* 2016: 55) indicated that *Waltillia* is more related to a clade consisting of *Vriesea* Lindley (1843:11) *s.str.* and *Stigmatodon* Leme, G.K. Brown & Barfuss (Barfuss *et al.* 2016: 56) than to *Alcantarea* (Kessous *et al.* 2019). In any case, *Waltillia* is morphologically and ecologically distinct from the remaining genera of subfamily Tillandsioideae. According to Leme *et al.* (2017), *Waltillia* can be differentiated from *Alcantarea*, *Stigmatodon* and *Vriesea* by the unappendaged petals that are 4 to 6 times longer than wide, pollen with a sulcus covered by a kind of operculum with smooth exine elements, stigma of convolute-blade II type, and seeds with basal appendages equalling to distinctly shorter than the apical appendage (*Alcantarea* type).

The genus is endemic to the state of Minas Gerais, in southeastern Brazil, occurring above 1500 m of elevation in the Espinhaço mountain range. *Waltillia* occurs as terrestrial plants in rupestrian grassland (*campos rupestres*) vegetation, always associated with water streams in narrow valleys (Leme *et al.* 2017). Due to a wide range of environmental conditions, rupestrian grasslands in Espinhaço mountain range harbour a high number of species and endemism, being important for biodiversity conservation (Conceição *et al.* 2016). This mountain range is also the main area of endemism for Bromeliaceae in Minas Gerais (Versieux *et al.* 2008). A clear example is *W. hatschbachii*, a microendemic species with only two known populations 40 km apart (Coffani-Nunes *et al.* 2010, Leme *et al.* 2017, Versieux & Wanderley 2021).

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In addition to sustaining a great biodiversity, the Espinhaço mountain range also has great economic importance. The growing interest in outdoor activities and adventure tourism in the mountains stimulate the local economy and leads to that many people visit areas along the Espinhaço (Fernandes 2016). This increase in the number of tourists with little understanding of the ecosystem can be linked to impacts such as the increase of garbage, contamination of aquifers, extraction of bromeliads and orchids in addition to the occurrence of accidental fires initiated by humans (Fernandes 2016). Another historical economic activity related to socioeconomic development in the region is the extraction of minerals such as gold, diamonds, iron and manganese (Fernandes 2016, Pena *et al.* 2017). There are many direct and indirect impacts, as consequence of mining activities (Daniel *et al.* 2015, Fernandes *et al.* 2014, Sonter *et al.* 2014a, 2014b), especially on endemic species of Espinhaço mountain range (Pena *et al.* 2017). One example is rupestrian grassland endemic bromeliads in which local habitat degradation is the main impact caused by mining due to the removal of native vegetation and soils (Versieux 2011). To cope with these impacts, Brazilian law requires a series of environmental studies (*e.g.* floristic surveys) before the implementation of any enterprise that can affect the environment and also the allocation of a compensation area equivalent to at least three times the size of the intervening area (Brasil 2006). Furthermore, some companies develop their own strategic studies to conserve species of interest, including documenting floristic and ecological diversity and development of seeds germination and plant propagation protocols (*e.g.* Santos 2018, Viana *et al.* 2016). In these studies, floristic surveys are carried out in public and private protected areas and the samples collected are supplying scientific collections. Such well-documented fieldworks are particularly important, under the current scenario of cuts on the budget allocated to science by the Brazilian government, limiting research on floristic documentation, and consequently hindering the increase in available data in biodiversity databases (Angelo 2016, Fernandes *et al.* 2017, Gibney 2015). Thus, the cooperation between private initiatives and scientists, notably taxonomists, can assist in the process of identifying the collected specimens, revealing new occurrences or even new species for science (Moura *et al.* 2018, Ribeiro *et al.* 2020, Versieux *et al.* 2017).

During the first author's study and identification of plant species collected by private initiative strategic studies, it was possible to recognize a species of *Waltillia* that could not be attributed to *W. hatschbachii*. Therefore, after a careful investigation, we describe it here as a new species.

Material & Methods

The specimen was obtained through the project "*Search for flora species of interest for conservation in protected areas of the Minas Gerais state*" promoted and financed by Vale S.A., performed mainly in its protected areas, but also in governmentally protected areas, with technical support from Bioma Meio Ambiente LTDA. The specimen were deposited in the herbarium BHCB [acronym following Thiers (cont. updated)]. The morphological description and illustration were based on the material deposited in the herbarium. The terminology used in the morphological description follows Smith & Downs (1977) and Scharf & Gouda (2008).

The pollen samples were removed from the herbarium specimen and rehydrated for a few seconds to obtain the turgescent pollen grain. For the investigation using scanning electron microscopy (SEM) the material was dehydrated using an increasing hydroalcoholic series using ethanol followed by acetone and then dried at critical point (Hesse *et al.* 2009). The samples were mounted on a stub and metallized with about 10 nm of gold and then examined at FEI Quanta 200 (FEI Company, Eindhoven, Netherlands) at 12–20 kV, with digital image capture at the Center for Electron Microscopy at the Universidade Federal de Minas Gerais (UFMG).

Results

Taxonomy

Waltillia itambana T. Machado & Versieux, *sp. nov.*

Waltillia itambana is distinguished from *W. hatschbachii* by forming a water-impounding rosette (*vs.* non-impounding rosette), shorter leaf blade (up to 30 cm long *vs.* longer than 55 cm), leaf blade not canaliculate (*vs.* strongly canaliculate); longer inflorescence peduncle (*ca.* 174 cm long *vs.* 75–110 cm long), upper peduncle bracts ovate with obtuse apex (*vs.* narrowly lanceolate to ovate with Long-attenuate-acute apex), floral bracts completely covering the sepals (*vs.*

equalling 3/5 to 5/6 of the length of the sepals), flowers suberect to divergent at anthesis, not secund (*vs.* distinctly downwardly secund at anthesis), and the internodes of the rachis shorter (1–1.2 cm long *vs.* 1–3.5 cm long).

Type:—BRAZIL. Minas Gerais: Santo Antônio do Itambé, Parque Estadual Pico do Itambé, 1588 m elev., 12 June 2018, *J.A.M. Souza 295*, *J.A.M. Paiva & S.H.A. Silva* (BHCB 192312).

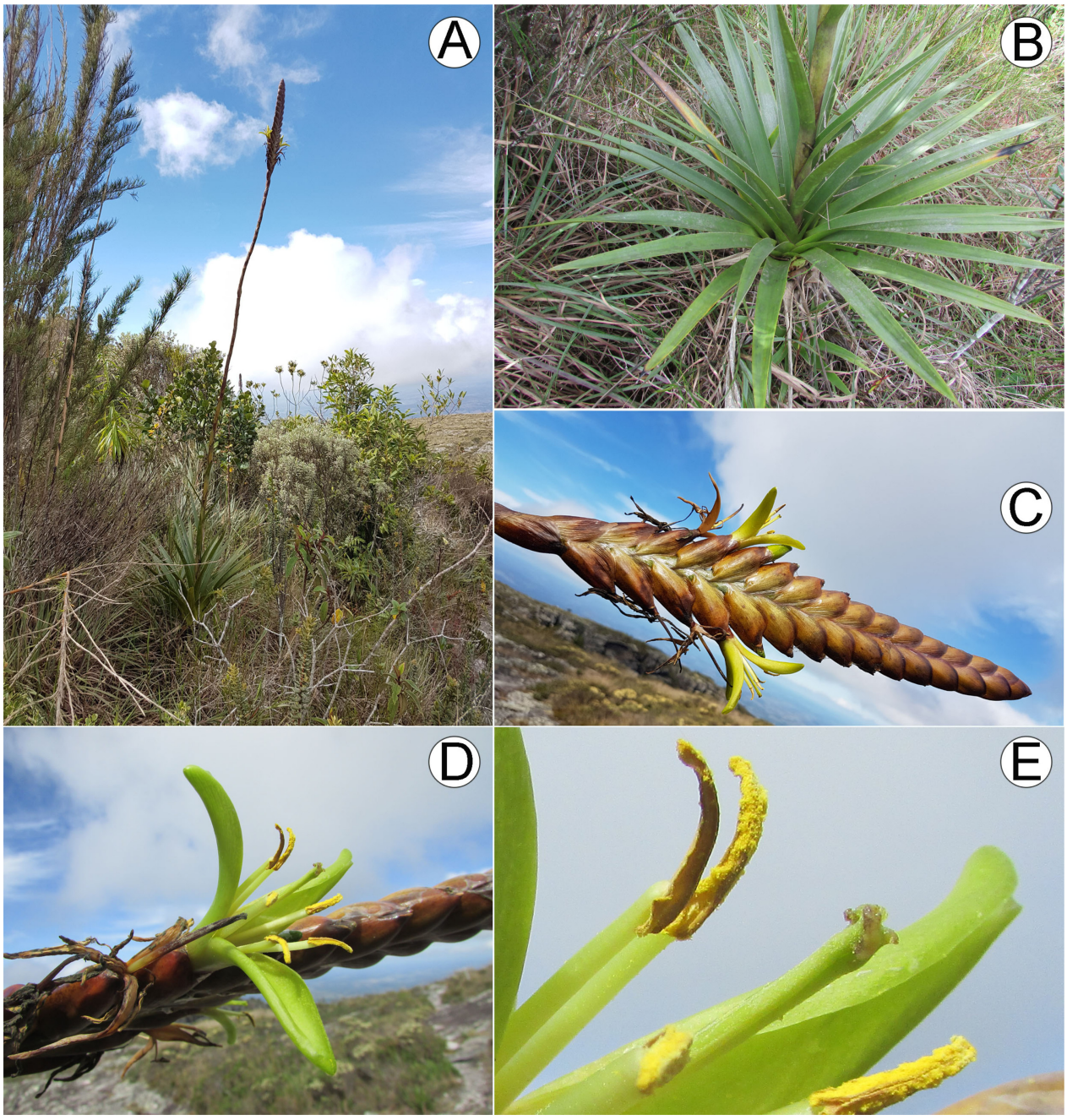

FIGURE 1. *Waltillia itambana*. **A**. Flowering individual in the rupestrian grassland habitat of Parque Estadual do Pico do Itambé. **B**. Water impounding leaf rosette. **C.** Detail of the simple inflorescence. **D**. suberect distichously arranged flowers. **E**. Flower detail showing the anther with introrse dehiscence and convolute-blade II stigma type. Photographs by Júlia A. M. Paiva.

Plants terrestrial or saxicolous, flowering *ca.* 2.20 m high with an extended inflorescence. ***Leaves*** 20 to 30 in number, spirally arranged, suberect, forming a water-impounding infundibuliform rosette; ***sheaths*** elliptic, *ca*. 12.5 cm long, *ca*. 5.5 cm wide, densely lepidote on both sides of appressed trichomes, green; ***blades*** lanceolate, 30–37 × 2–2.5 cm, coriaceous, green on both sides, densely white lepidote adaxially with strongly appressed trichomes forming a layer, densely brown lepidote abaxially, apex acuminate. ***Peduncle ca.*** 174 cm long, ***ca.*** 1 cm in diameter, erect, brown, covered with a white wax that is lost when dry; ***peduncle bracts*** the basal ones foliaceous and many times exceeding the

internodes, erect or nearly so, green, the upper ones ovate, obtuse, 5–5.5 × 4 cm, brownish, erect, equalling or slightly shorter than the internodes, its basal portion completely enfolding the peduncle, lepidote and covered by a white waxy substance (lost when dry), brown lepidote abaxially. ***Inflorescence*** (fertile part) simple, *ca*. 40 cm long, erect, *ca*. 27-flowered, rachis straight, internodes 1–1.2 × 0.8 cm. ***Floral bracts*** decurrent on the rachis, broadly elliptic, *ca*. 40 × 37 mm, apex rounded, brownish, lepidote on both surfaces and covered by a white waxy substance (lost when dry), convex, ecarinate to slightly carinate toward the apex, nerved when dry, completely covering the sepals, divergent with the flowers. ***Flowers*** suberect at anthesis, contiguous with each other, densely arranged and not secund at anthesis, 7–8 cm long (including the stamens), diurnal; receptacle *ca*. 8 mm long, glabrous; ***sepals*** elliptic, apex obtuse, *ca*. 32 × 14 mm, densely lepidote on both surfaces, free, slightly carinate in the proximal part, brown with light-brown margins, coriaceous; ***petals*** narrowly spathulate, apex narrowly obtuse to emarginate with the margins slightly incurved, *ca*. 63 × 13 mm, 4–5 mm connate at the base, light-green, blades spreading at anthesis with the tips slightly recurved, exposing the stamens, unappendaged. ***Stamens*** much shorter than the petals, nearly equalling the corolla; ***filament*** *ca*. 42 mm long, the antepetalous ones adnate to the petals for *ca*. 6 mm, the antesepalous ones adnate to the petals for 1–2 mm, slightly complanate, yellowish-green; ***anther*** linear, *ca*. 16 mm long, base bilobed, apex narrow obtuse, dorsifixed *ca*. 4 mm above the base, curved outward, introrse dehiscent; ***pollen*** oblate in shape, elliptic in outline, *ca*. 50 µm in diameter, exine reticulate, lumina *ca*. 2 µm wide with sparse granula, becoming smaller towards the sulcus, sulcate, the sulcus with margins moderate to weakly defined, covered by a kind of operculum formed by a thick exine layer that is not continuous; ***style*** equalling the corolla and stamens, light-green; ***ovary*** *ca*. 11 mm long, *ca*. 7 mm of it inferior; ***stigma*** of the convolute-blade II type, blades spreading-contorted, densely papillose, light-green, *ca*. 1.7 mm long. ***Fruits*** not seen.

Etymology:—The epithet "*itambana*" is a reference to the type locality, the Pico do Itambé region.

Phenology:—Flowering specimen were collected in June.

Distribution and ecology:—*Waltillia itambana* is restricted to Pico do Itambé State Park, in the state of Minas Gerais, Brazil. This state park encompasses one of the highest elevation areas in the Espinhaço mountain range and is situated at 61 km away from the type locality of *W. hatschbachii*, in the county of Gouveia, Diamantina plateau (Fig. 2). With this addition, the bromeliad flora of this State Park reaches now 12 genera and 17 species (Versieux 2008). The species described here is known from a single population with less than ten individuals observed, some occurring spatially aggregated, and exhibiting vegetative propagation with at least one axillary bud per rosette. *W. itambana* grows as a terrestrial on the thin layer of soil accumulated over the quartizite rock of the rupestrian grassland habitat. These plants occur at ca. 1590 m elevation, completely exposed to sunlight and close to small water streams.

Conservation status:—Although *Waltillia itambana* occurs within the Parque Estadual do Pico do Itambé, the proximity of the population to the edges of the conservation unit does not guarantee the quality of the habitat since anthropic interference and occurrence of fires caused by humans frequently reach the limits or areas within the park. The species has an Area of Occupancy (AOO) smaller than 10 km^2 (B2), with only one known population in an area with continuous decline in habitat quality [ab(iii)]. Thus, according to IUCN (2019) criteria B2ab(iii), *W. itambana* must be categorized as Critically Endangered (CR). Therefore, it is important to make efforts to discover new populations for a better understanding of the plant's biology and ecology. A recent analysis conducted by Machado & Versieux (2021) indicated that the other species of the genus, *W. hatschbachii* is severely threatened and its likely to go extinct in the near future due to habitat loss and climate change.

The Parque Estadual do Pico do Itambé region is considered an area of endemism in the center of Espinhaço mountain range (Echternacht *et al.* 2011). Many species described for the park were considered local endemics but after the increase in the collections efforts along other areas of rupestrian grasslands new areas of occurrence were found, indicating that the range of these species was wider than previously assumed. This is the case of *Vriesea medusa* Versieux (2008: 713) and *Lapanthus itambensis* (Versieux & Leme 2007: 130) Louzada & Versieux (2010: 500) described from the Parque Estadual do Pico do Itambé and later collected in the Parque Estadual do Rio Preto. Thus, it is possible that the distribution of *W. itambana* is wider than currently known to us.

Comments:—The genus *Waltillia* can be differentiated from *Vriesea* by the absence of petal appendages (*vs.* petals bearing appendages at the base), and petals almost five times longer than wide (*vs.* usually three times) and pollen showing a sulcus covered by a type of operculum (*vs. insulae* type) as well as its seeds with apical and basal appendages developed (*Alcantarea* type).

The specimen described here (Souza 295) was previously identified in the herbarium as *Vriesea clausseniana* (Baker) Mez (1894: 545) (Fig. 4A–B). Probably, characteristics such as simple inflorescence, with decurrent dark-brown floral bracts and large flowers caused this incorrect identification. *Waltillia itambana* can be differentiated from *Vriesea clausseniana* by the rosettes with lanceolate leaves ≤ 2.5 cm with acuminate apex (*vs.* broad leaves > 4 cm

with a rounded apex), flower not secund at anthesis (*vs.* unilaterally secund flowers), longer than wide petals in an open fan like corolla (*vs*. short and wide petals in a campanulate corolla) (Fig. 4B). Rosettes with lanceolate leaves such as those of *W. itambana*, are not common in bromeliads with distribution in rupestrian grasslands, which tend to have sub-upright broader leaves or tubular shape rosettes, improving the capacity to hold water. Among the *Vriesea* species that occur in the rupestrian grassland, those with narrow-triangular leaves more like *W. itambana* are *Vriesea longistaminea* C.C. Paula & Leme (in Leme & Paula 2004: 27) (Fig. 4C–D) and *Vriesea atroporpurea* Silveira (1931: 3). However, both species have a compound and lax inflorescence, with campanulate flowers that have shorter and wider petals than those of *W. itambana*.

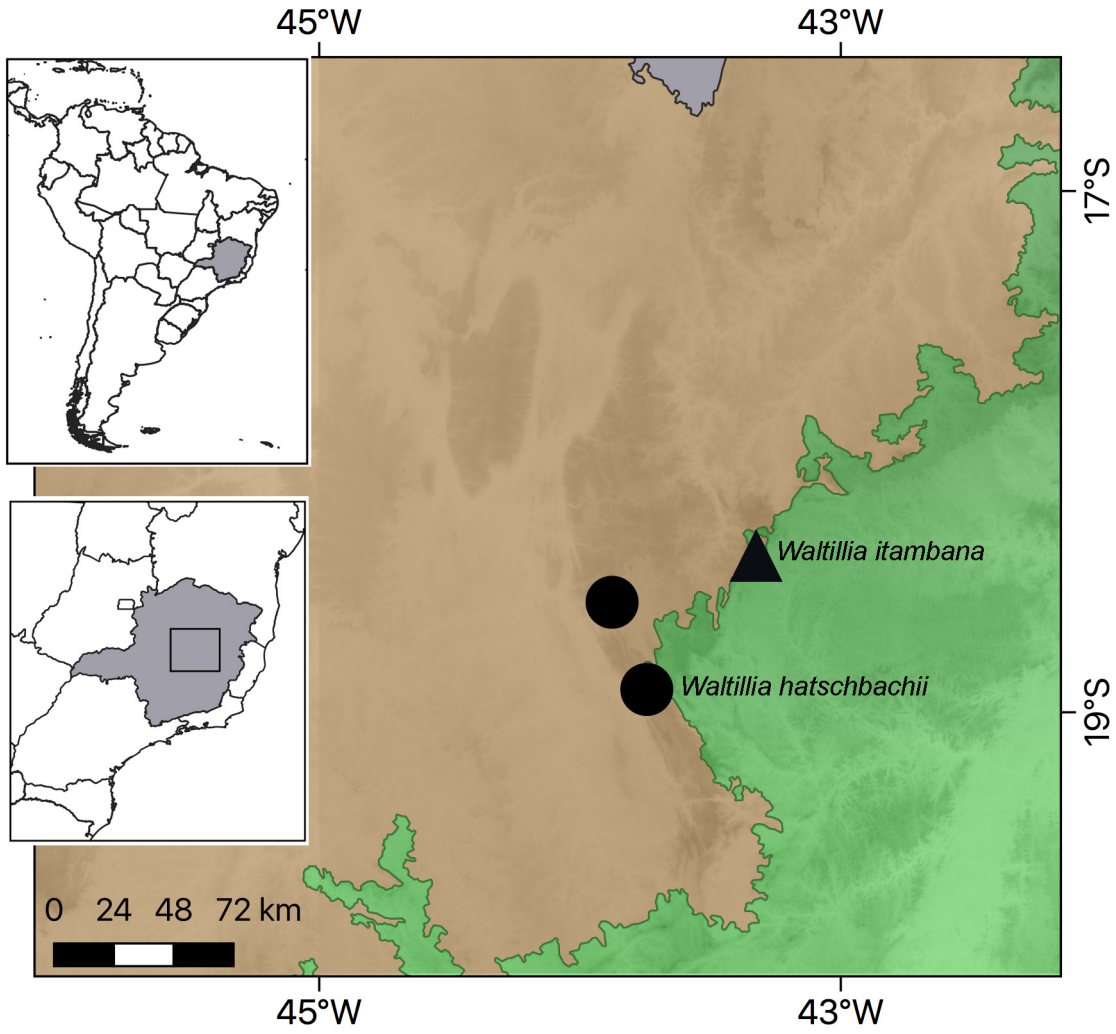

FIGURE 2. Map indicating the population of *Waltillia itambana* (described here, black triangle) 61 km apart from the closest population of *W. hatschbachii* (black circle), both in the state of Minas Gerais, Brazil. Brown areas indicates Cerrado savanna domain and the green portion indicates the Atlantic Forest domain. The shaded parts indicate elevations above 900 m covered by rupestrian grasslands.

In relation to *Alcantarea* species, the genus *Waltillia* can be differentiated by its simple and congested inflorescence (*vs.* inflorescence generally compound or lax when simple), floral bracts decurrent on the rachis (*vs.* not decurrent), petals with tips slightly recurved at anthesis (*vs.* strongly recurved at anthesis), which are unappendaged (*vs*. bearing large appendages at the base), anther with introrse dehiscence (*vs.* anthers with extrorse dehiscence), pollen showing a sulcus covered by a type of operculum (Fig. 5A, B, E, F) [*vs.* pollen showing a sulcus without indumenta covering (Santos *et al.* 2018)], stigma convolute-blade II (Fig. 1E; Fig. 3G) (*vs.* conduplicate-erect or conduplicate-patent) (Leme *et al.* 2017, Versieux & Wanderley 2021). Among the *Alcantarea* species with distribution in rupestrian grassland such as *A. compacta* Leme & O.B.C. Ribeiro (2010: 257), *A. duarteana* (L.B. Sm.) J.R. Grant (1995: 13) and *A. nanhoumii* (Leme) J. R. Grant (1995: 13), and *A. recurvifolia* Leme (2014: 75) none has an inflorescence structure similar to *W. itambana*, which makes the species described here quite unique (Versieux & Wanderley 2021). Regarding the rosette shape alone, the new species is most similar to *A. duarteana*.

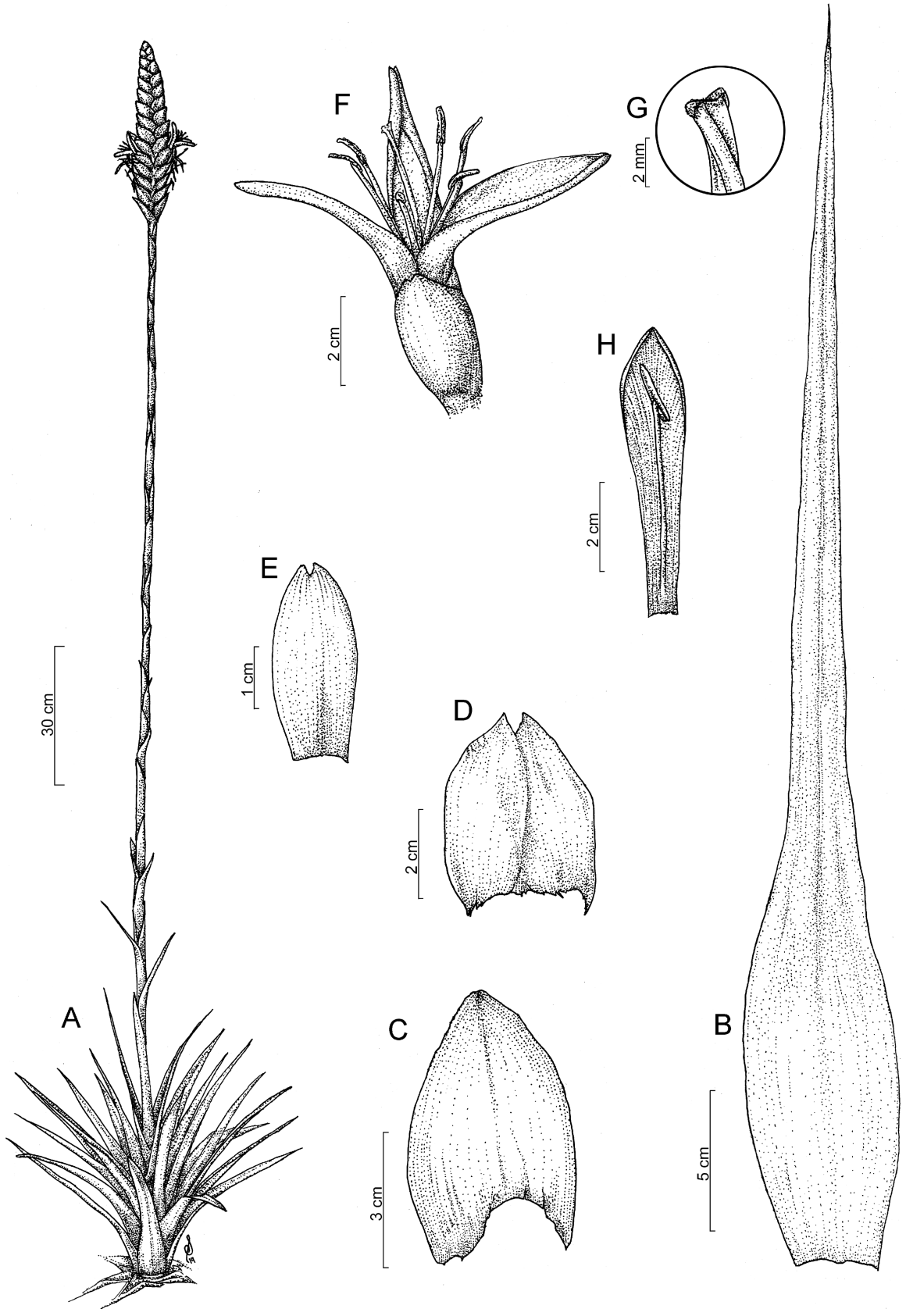

FIGURE 3. *Waltillia itambana***. A**. Plant habit. **B**. Leaf. **C**. Upper peduncle bract. **D**. Floral bract. **E**. Sepal. **F**. Flower. **G**. stigma detail. **H**. Petal and antepetalous stamen. Illustrator: Samyra Furtado.

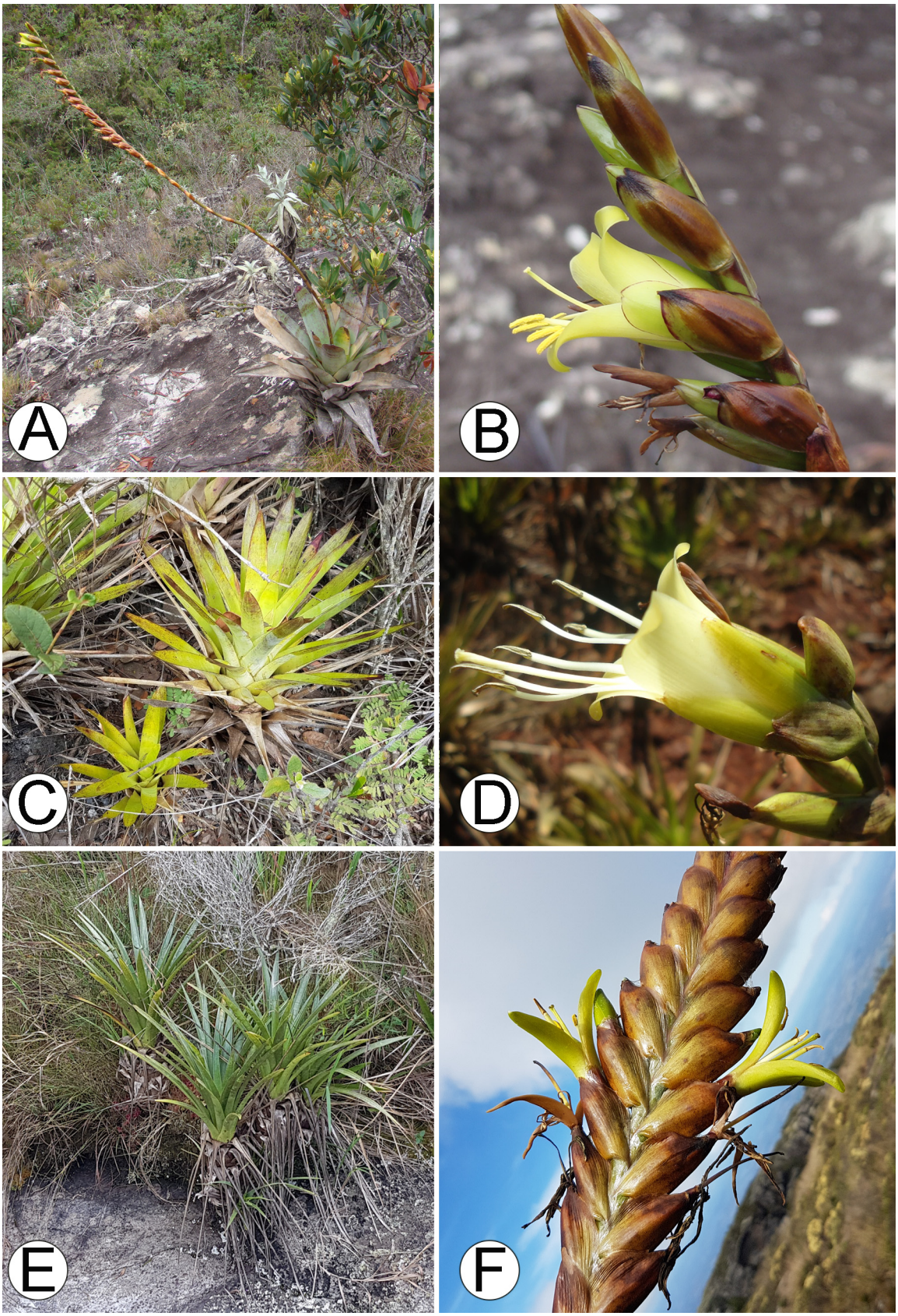

FIGURE 4. A–B. *Vriesea clausseniana*: **A**. Habit. **B**. Flower. **C–D**. *Vriesea longistaminea*: **C**. Rosette. **D**. Flower. **E–F**. *Waltillia itambana*: **E**. Rosette. **F**. Flower. Photographs: A–B by Talita M. Machado, C–F by Júlia A. M. Paiva.

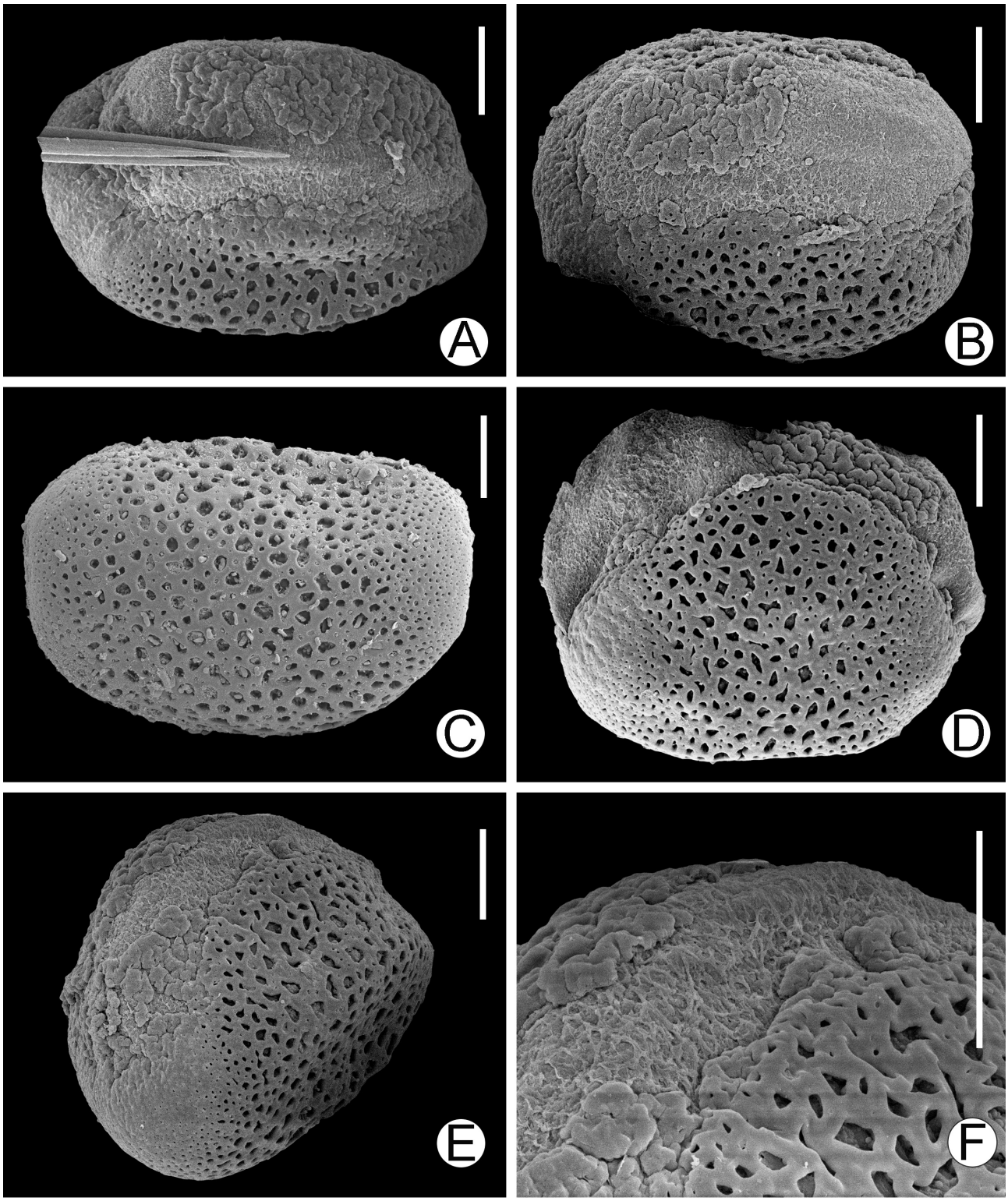

FIGURE 5. Scanning electron microscopy (SEM) images of pollen grains of *Waltillia itambana* (*Souza 295*). **A–B**. Polar distal view. **C**. Polar proximal view. **D**. Equatorial view (long axis). **E**. Equatorial view (short axis). **F**. Sulcus margin with reticulate ornamentation on the right, detail of the sulcus ornamentation like operculum on the left. Bars = 10μm.

The species here described can be included in *Waltillia* due to a combination of floral characters such as unappendaged petals (Fig. 3H), which are five times longer than wide, forming an open fan like corolla with curved tips (Fig. 1D); anthers presenting pollen sacs with introrse dehiscence (Fig. 1D–E) and pollen with the sulcus covered by a type of operculum (Fig. 5). In addition, the new species proposed here is ecologically similar to *Waltillia hatschbachii*, also growing in rock outcrops above 1500 m of elevation, close to water streams.

Conversely, *W. itambana* can be easily distinguished from the other species of *Waltillia* by the size of the plant, that has a longer inflorescence peduncle (*ca*. 174 cm) (Fig.1A). Unlike the grass-like rosette of *W. hatschbachii*, the new species has an infundibuliform rosette with suberect leaves (Fig. 1B, Fig. 4E). The leaves have narrower blades (*ca*. 2.5 cm wide), but the sheaths are wider (*ca*. 5.5 cm) and overlapping, featuring the accumulation of water. In addition, the inflorescence of *W. itambana* is densely flowered with dark-brown floral bracts that are decurrent on the rachis (Fig. 1C) and can be easily differentiated from the lax inflorescence with green bracts of *W. hatschbachii*. The flowers of *W. itambana* are not secund at anthesis opposing the unilaterally secund flowers of *W. hatschbachii*. The pollen can also be used to differentiate the two species in *Waltillia*. In *W. hatschbachii* the major part of the sulcus surface is covered by a type of operculum (Leme *et al.* 2017, Santos *et al.* 2018), whereas in *W. itambana* this operculum occupies a smaller part of the sulcus and can be segmented (Fig. 5). This segmentation of the sulcus ornamentation can be divided into three parts like in Figure 5A, in two parts (Fig. 5E) or forming a single plate covering half of the sulcus surface (Fig. 5B).

Key to *Waltillia* species

1. **Leaf blades** sublinear; **floral bracts** broadly ovate, apex acute to broadly rounded and apiculate, green to yellowish-green, not completely covering the sepals, slightly secund with the flowers at anthesis; **flower** divergent to distinctly secund at anthesis..... ..... *W. hatschbachii*

- **Leaf blades** lanceolate; **floral bracts** broadly elliptic, apex rounded not apiculate, brownish, completely covering the sepals, not secund at anthesis; **flowers** divergent, not secund at anthesis.....*W. itambana*

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Authors contributions

TMM identified the species with the support of LMV. TMM and LMV prepared the description, made comparison with other species and taxonomic comments. MODP conducted electron microscopy analyses and provided data and photographs. All authors contributed to the writing of the manuscript.

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