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A NEW SPECIES OF *TELIPOGON* (ORCHIDACEAE: ONCIDIINAE) FOR NORTHERN PERU

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ABSTRACT. *Telipogon* is a highly diverse genus in the Andes, yet it remains incompletely documented in northern Peru. *Telipogon vasqueznunezii* is morphologically similar to *T. hystrix* but differs in the oblong-ligulate lip, the two small lobes at the lip base, the absence of a protrusion on the lip, and the tuft of acicular setae on the columnar appendix. A detailed description, illustrations, a distribution map, and a conservation assessment are provided here.

RESUMEN. *Telipogon* es un género altamente diverso en los Andes; sin embargo, está incompletamente documentado en el norte del Perú. *Telipogon vasqueznunezii* es morfológicamente similar a *T. hystrix*, pero se diferencia por el labio oblongo-lingulado, los dos pequeños lóbulos en la base del labio, la ausencia de una protuberancia en el labio y el mechón de setas aciculares en el apéndice columnar. Aquí se proporcionan una descripción detallada, ilustraciones, un mapa de distribución y una evaluación de su estado de conservación.

KEYWORDS / PALABRAS CLAVE: Andes, bosque montano relicto, miniature *Telipogon*, montane forest relic, *Telipogon* miniatura, *Telipogon embreei*, *Telipogon hystrix*

Introduction. *Telipogon* Kunth is a diverse neotropical orchid genus of Oncidiinae comprising more than 250 species (Martel *et al.*, 2020b). The genus is distributed from southern Mexico in the North to Bolivia in the South (Martel & Nauray, 2013). In South America, *Telipogon* species occur in the cloud Andean forests between 1500 and 3600 m elevation (Collantes & Martel, 2015), although occasional records outside this range have been reported (Martel, 2016). However, due to their specific niche ecological requirements, most *Telipogon* species have narrow distribution, oc-

curing in only a few localities or even a single valley. Thus, many *Telipogon* species are only known from one locality (e.g., *T. phuyupatamarcensis* W.Galiano, P.Núñez & Tupayachi; Collantes & Martel, 2016).

Based on the size of the plants and the flower characteristics, *Telipogon* species can be morphologically classified into two informal groups: (a) *Telipogon* species with large and showy flowers, and (b) *Telipogon* species with small and inconspicuous flowers. The latter informal group is known as miniature *Telipogon*, the former genus *Stellilabium* Schltr. which was syn-

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onymized within *Telipogon* (Williams *et al.*, 2005). The miniature *Telipogon* are characterized by their small plants (around 10 cm or less), flowers of around 1 cm or less in diameter, which present a pale or dark coloration (cream, greenish, reddish or purplish), and the morphology of the lip is highly distinct from that of the petals (Martel *et al.*, 2017). This informal group represents around 5% of the *Telipogon* richness and, due to their size and ephemeral lifespan, has fewer collections represented in herbaria and has been less studied than *Telipogon* species with showy flowers.

In Peru, twelve species of miniature *Telipogon* are currently recognized: *T. astroglossus* Rchb.f., *T. bennettii* (Dodson & R.Escobar) N.H.Williams & Dressler, *T. chachapoyensis* C.Martel & Collantes, *T. choquequiraoense* C.Martel & Collantes, *T. deuterocuscoensis* J.M.H.Shaw, *T. huancavelicanus* Collantes & C.Martel, *T. mariae-luisae* Gut.Peralta, Charcape & Nauray, *T. pogonostalis* Rchb.f., *T. pseudobulbosus* (D.E.Benn. & Christenson) N.H.Williams & Dressler, *T. selbyanus* N.H.Williams & Dressler, *T. villonacoensis* M.M.Jiménez, Iturralde & C.Martel, and *T. yanesha* L.Valenz. & Nauray (Gutiérrez *et al.*, 2023; Jiménez *et al.*, 2025; Martel *et al.*, 2017, 2020a, 2026; Valenzuela-Gamarra & Nauray-Huari, 2025). Interestingly, only three of these have an auriculate or alate column (i.e., *T. astroglossus*, *T. chachapoyensis*, *T. mariae-luisae*). However, field explorations are expected to reveal undescribed taxa in the coming years.

During explorations in the cloud forests of the northern Peruvian Andes, some miniature *Telipogon* were spotted in different forest patches, two of which were collected. After a careful morphological examination, we concluded that these *Telipogon* plants belonged to an undescribed species. Therefore, we propose a new miniature *Telipogon* species that is very distinctive from any other previously described *Telipogon*.

Materials and methods. More than ten specimens of the new species were found during botanical expeditions in La Palma, province of Chota, Cajamarca, Peru, in 2020 and 2022. In 2022, two plants were collected and cultivated *ex situ* independently by two of the authors (JACG and GIV), which flowered a few months later. Plant material was collected from these two specimens and preserved in spirit (the inflorescence) and dried (vegetative organs). Vegetative

and floral characters were analysed and measured using a stereomicroscope. Spirit-preserved material was used to prepare the line drawing. One of these plants was deposited as a herbarium specimen in the Universidad Nacional de Cajamarca (CPUN). After concluding the plants belonged to an undescribed species, another specimen was located at the herbarium of the Universidad Nacional Autónoma de Chota (UNACH), which was collected and photographed independently by two of the other authors (WTR and JDE) in 2020. In total, three specimens were examined; pictures of plant and floral material on graph paper were digitally processed to assess character measurements. *In situ* and *ex situ* photographs were taken with a Nikon COOLPIX P5 and a Nikon D850 equipped with Nikkor lenses at the UNACH. The photographs were used to prepare the figures and plates. Figures and a composite digital line drawing were prepared from the type specimen images in Adobe Photoshop® 2019. We calculated the extent of occurrence (EOO) and area of occupancy (AOO) of the new species using GeoCAT (Bachman *et al.*, 2011, <https://geocat.iucnredlist.org>), which were used to prepare a preliminary conservation assessment following the IUCN (2024) criteria. Terminology used follows Beentje (2012).

TAXONOMIC TREATMENT

Telipogon vasqueznunezii C.Martel, Chamaya & Iberico, *sp. nov.* (Fig. 1–3)

TYPE: Peru. Cajamarca: Prov. Chota, Dist. Chota, Comunidad La Palma, Bosque La Palma, 17M, 762792.33 E, 9281337 S, 2835 m, 28 Sept. 2022, J. Chamaya G. 106 (holotype: CPUN!).

DIAGNOSIS: *Telipogon vasqueznunezii* is most similar to *Telipogon hystrix* (Dodson) N.H.Williams & Dressler but is distinguished by the larger flowers (9–11 × 8–13 mm vs. 5 × 5 mm), the obovate to sub-oblong petals (vs. narrowly ovate), the oblong-ligulate lip (vs. elliptical to oblong), the sub-auriculate lip base with a pair of small lobes (vs. the sagittate base with two long lobes), the absence of a protrusion on the lip (vs. a hump-like protrusion on the lower half), and one tuft of acicular setae on the columnar appendix (vs. one tuft of setae with a stellate apex on the columnar appendix).

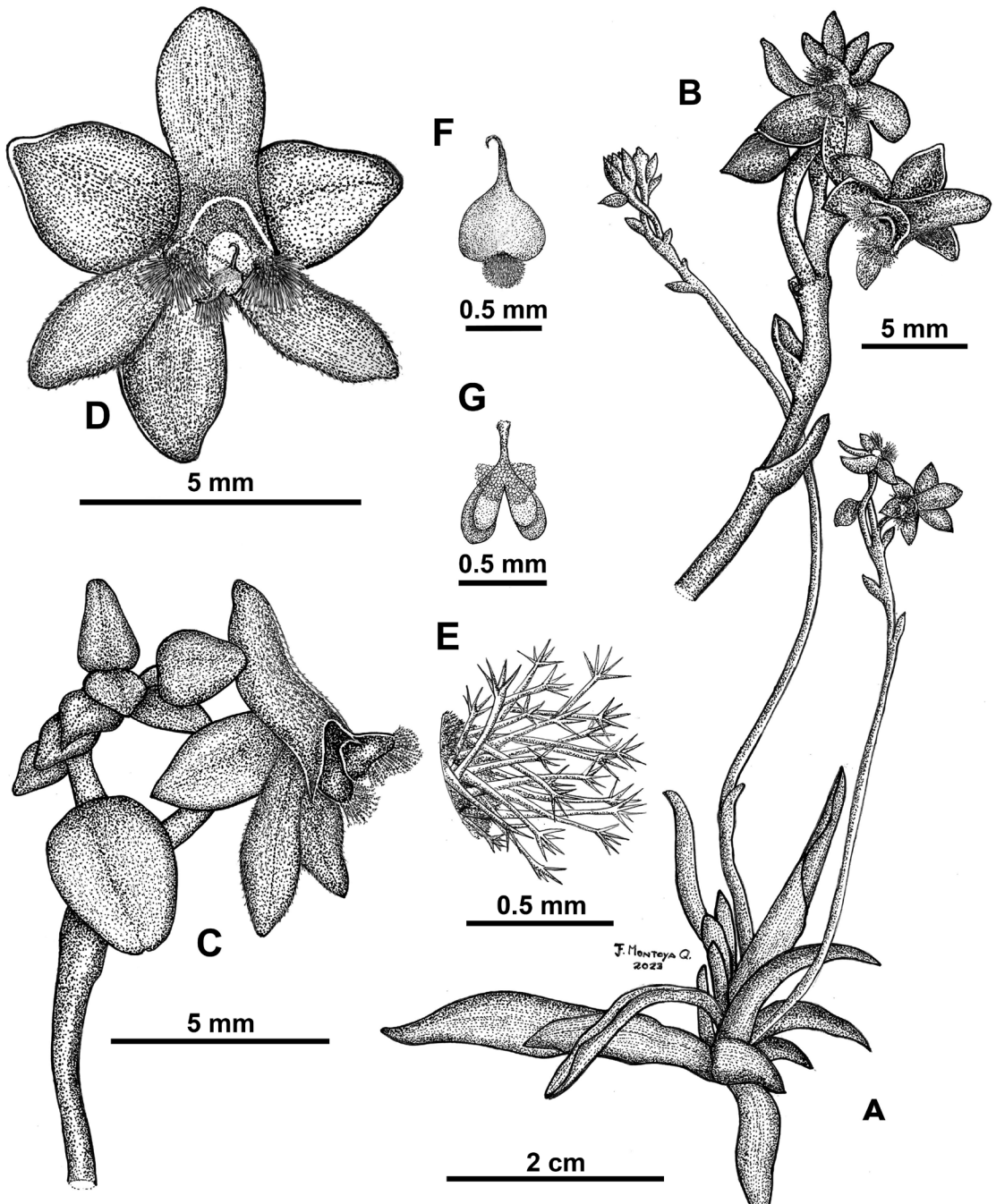


FIGURE 1. *Telipogon vasqueznunezii*. **A**. Habit. **B**. Portion of inflorescence with flowers. **C**. Flower, lateral view. **D**. Flower, $\frac{3}{4}$ view. **E**. Details of setae with stellate apices. **F**. Anther cap with pollinarium and tuft of setae on the columnar appendix, ventral view. **G**. Pollinarium, ventral view. Based on *J. Chamaya 106* (holotype CPUN). Drawn by Juan F. Montoya Quino.

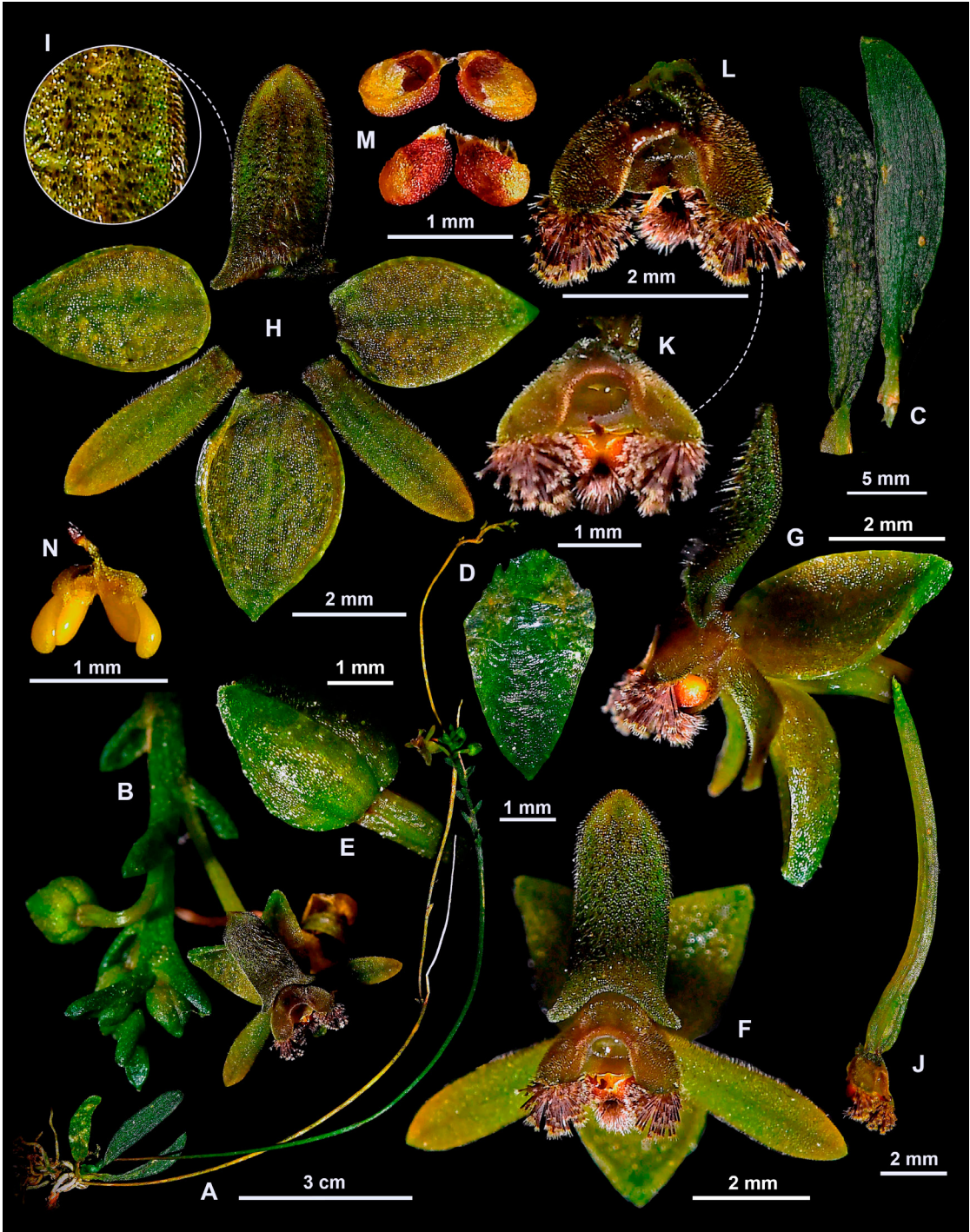


FIGURE 2. *Telipogon vasquezunuezii*. A. Habit. B. Portion of inflorescence with flowers. C. Leaves. D. Bract of the inflorescence. E. Flower bud. F. Flower, frontal view. G. Flower, lateral view. H. Dissected flower. I. Details of the lip trichomes. J. Ovary and column, lateral view. K. Column, frontal view. L. Column, ventral view. M. Anther cap, frontal and dorsal views. N. Pollinarium. Based on *W. Tafur 131* (UNACH). Plate prepared by Jose D. Edquén.

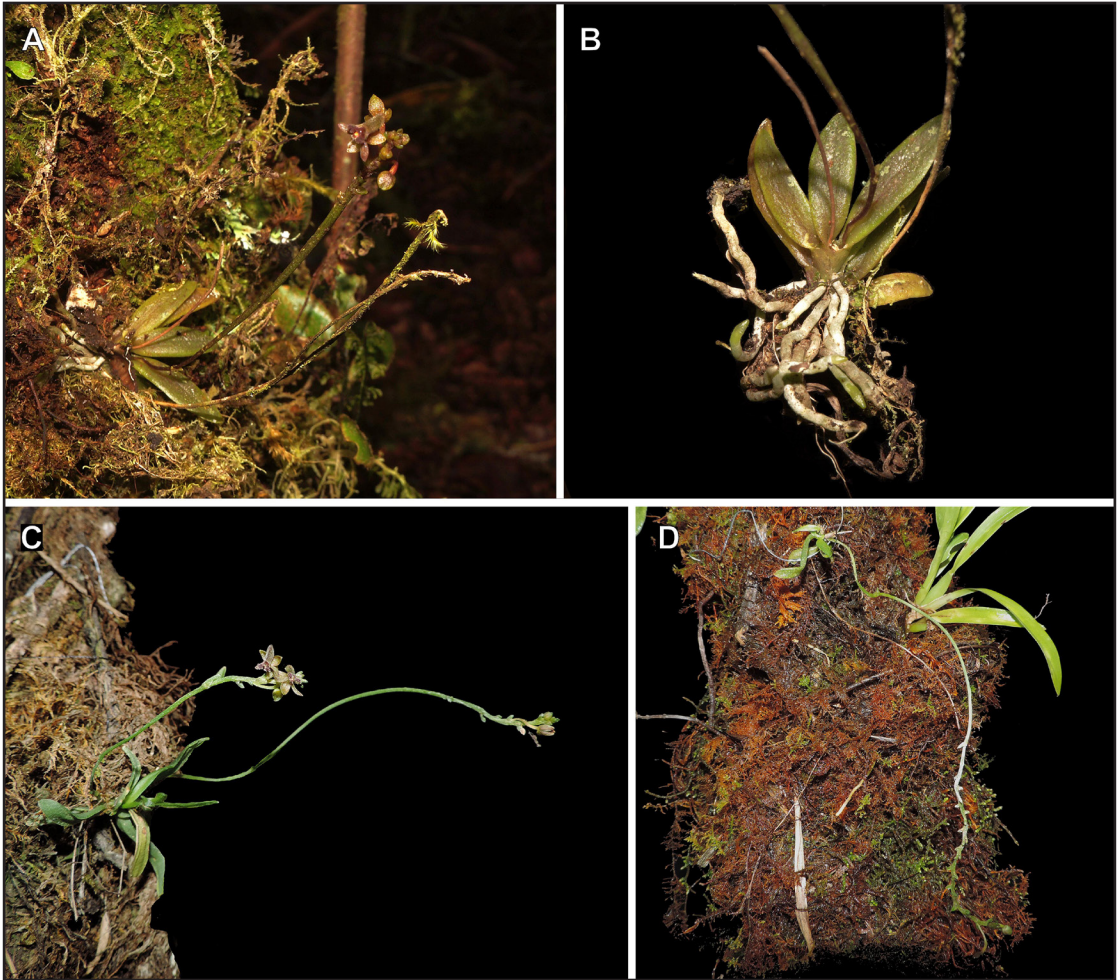


FIGURE 3. *Telipogon vasqueznunezii*. **A.** Plant *in situ*. **B.** Vegetative plant. **C.** Two plants with sub-erect inflorescences. **D.** The same individual shown in the background in **C**, with the inflorescence becoming pendant during further development. Photos by James A. Chamaya G.

Plant epiphytic, up to 25 cm tall, including the inflorescence. *Roots* 0.3–0.5 mm in diameter, fleshy, cylindrical, basal. *Leaves* 2.0–3.4 × 0.5–0.8 mm, 3–5, sub-coriaceous, distichous, obovate-oblong, slightly falcate, acute, articulated to a short decurrent, conduplicate leaf sheath. *Inflorescence* apical and lateral, erect or pendant, sub-terete, racemose, branched, green, up to 23 cm long, 5–10 flowered produced in succession, spirally arranged, one or two flowers open at a time; *peduncle* up to 10 cm, complanate, with 1 amplexicaul triangular bract apically; *rachis* up to 12 cm, slightly subterete, sub-verrucose; *floral bracts* 3.9 × 2.3 mm, conduplicate, triangular-ovate, acute. *Ovary* up to

13 mm long, sub-terete, green, pedicellate; *pedicel* sub-terete, arching. *Flowers* 9–11 × 8–13 mm, non-resupinate. *Sepals* free, 1-veined, ovate, acute, adaxially papillose, entire, membranous, mustard yellow to pale green; *dorsal sepal* 4.1–4.4 × 2.1–2.3 mm, slightly concave basally; *lateral sepals* 4.6–4.8 × 2.3–2.5 mm, slightly concave, oblique. *Petals* 3.9–4.1 × 0.9–1.1 mm, narrowly obovate to sub-oblong, light green to pale red, pilose, ciliate, truncate base, acute apex, 1-veined. *Lip* 3.8–4.1 × 1.6–1.8 mm, oblong-ligulate, green to pale red, sessile, with a pair of small lobes at the base, ecallose, densely pilose, ciliate, 3-veined. *Column* 2.2–2.4 × 2.4–2.6 mm, biauriculate, sessile, light

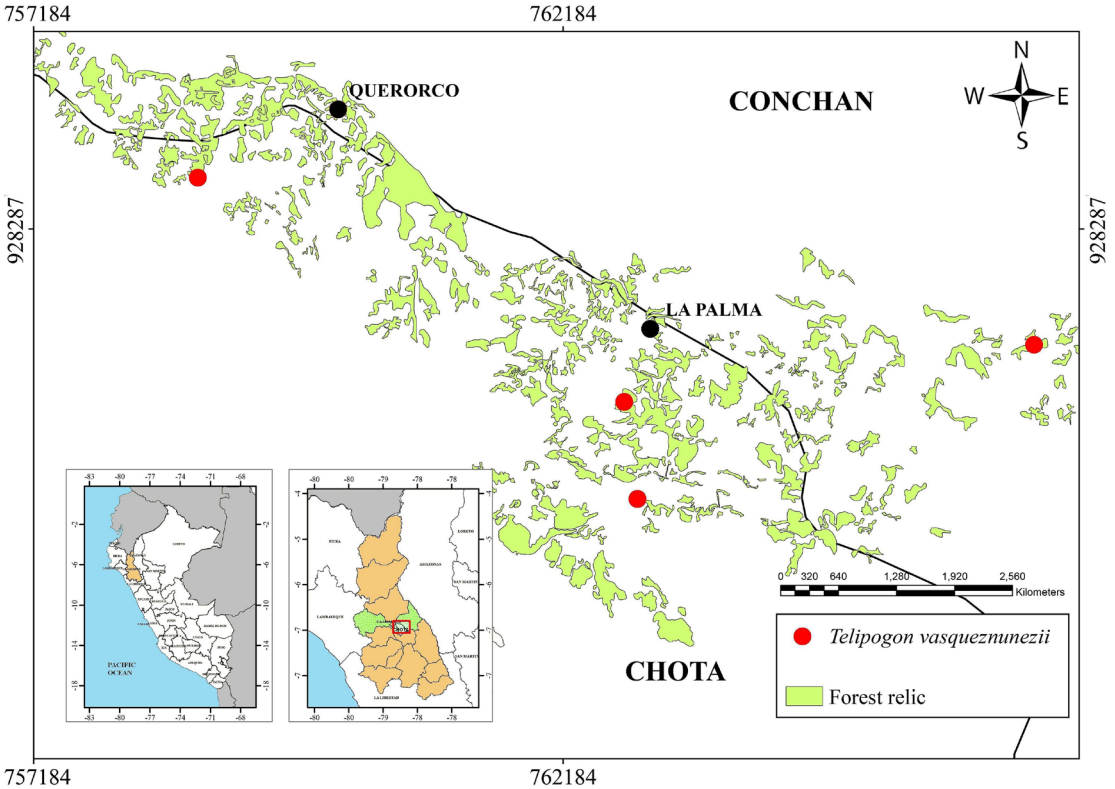


FIGURE 4. Distribution map of *Telipogon vasqueznuñezii* in northern Peru. Prepared by James A. Chamaya G.

green to wine red, densely shortly hirsute, with a dorsal appendix whose superior margin is rounded and lip-like; *columnar auricle* elliptic, laminar, apex rounded, densely setose, 1 tuft of setae on each auricle towards the apex, setae purplish and stellate; *columnar appendix* densely setose towards the apical half, setae acicular and purple to white, acicular. *Stigma* apical, elliptic; *rostellum* erect; *anther* dorsal. *Anther cap* oblong, 0.7×1.25 mm, bilocular, purple suffused with yellow. *Pollinarium* 1.1 mm long, with two unequal pairs, narrowly ovoid *pollinia*, *stipe* 0.3 mm long, *viscidium* uncinat. *Fruit capsule*, 7.5×5.0 mm.

EPONYMY: The species is named after Dr Leopoldo Pompeyo Vásquez Núñez, a Peruvian botanist and professor at Universidad Nacional Pedro Ruiz Gallo. Professor Vásquez has dedicated his life to better understanding the plant diversity of northern Peru with a focus on potentially useful plants.

DISTRIBUTION: *Telipogon vasqueznuñezii* is found in the montane forests of Querorco montane range, in northern Peru, on the western Andean slopes (Fig. 4). Plants of this species naturally grow as epiphytes on shrub branches and tree trunks in areas not fully exposed to sunlight (Johansson's Zone II). The collected and recorded specimens came from La Palma forest (Fig. 4), a set of fragmented forest patches with small remnants of pristine vegetation in which *Clusia* sp. *Weinmannia* sp., *Myrcianthes* sp., and *Clethra* sp. are the dominant tree species. The ecosystem of this area is classified by the Peruvian state as relic forests of the Western slopes (in Spanish: Bosque relicto montano de vertiente occidental; Ministerio del Ambiente, 2019), which is characterized by dense, fragmented cloud forest with trees up to 20 m, with abundant epiphytes. This ecosystem is found on the western slopes of the Andes in northern Peru. Including the type locality, four patches of the new species are currently known (Fig. 4).

PHENOLOGY: *Telipogon vasquezunnezii* plants were recorded in flower between July and September, so they will flower during the southern hemisphere's dry season.

CONSERVATION STATUS: *Telipogon vasquezunnezii* is only known from four nearby locations in the relic forests of northern Peru (Fig. 4). These forests are disturbed and fragmented, and their extent has mainly decreased in the last 40 years. The main threats to the species are habitat loss and degradation due to land conversion. Its estimated EOO is 9.33 km² and its AOO is estimated at 16 km². Therefore, following the IUCN (2024) criteria, *T. vasquezunnezii* is assessed as Critically Endangered based on criteria B1 and B2 (CR, B1ab(i,iii), B2ab(ii,iii)).

ADDITIONAL SPECIMENS EXAMINED: Peru. Cajamarca: Prov. Chota, Dist. Conchán, Bosque La Palma, 6°29'32.2" S 78°35'40.5" W, 2950 m. 8 Sept. 2020, *W. Tafur, M. Enco & J. Edquén 131* (UNACH!).

TAXONOMIC DISCUSSION: *Telipogon vasquezunnezii* is most similar to *T. hystrix* (Table 1) by the inflorescence with a slightly sub-terete rachis, the greenish flowers, the ovate lateral sepals, the ciliate petal margins, the pubescent lip with ciliate margins, the occurrence of two columnar auricles and a columnar appendix, and the setae on the columnar auricles having stellate apices (Fig. 5). Nevertheless, the new species is distinguished by its larger flowers (*T. vasquezunnezii*: 9–11 × 8–13 mm vs. *T. hystrix*: 5 × 5 mm), the obovate to sub-oblong petals (vs. narrowly ovate), the oblong-ligulate lip with auriculate base presenting two small lateral lobes (vs. elliptical to oblong lip with sagittate base presenting long lobes), the absence of a protrusion on the lip (vs. a hump-like protrusion on the lower half), and a tuft of acicular setae on the columnar appendix (vs. a tuft of setae with stellate apices on the columnar appendix). Furthermore, *T. vasquezunnezii* is known so far only from the western Andean slopes in northern Peru, whereas *T. hystrix* is known from the eastern Andean slopes of central Ecuador, 550 km away in a straight line. *Telipogon vasquezunnezii* is also morphologically similar to *T. reventadorensis* N.H. Williams & Dressler (ex *Stellilabium vulcanicum* Dodson & Hirtz), but morpholog-

ical and genetic evidence support the inclusion of *T. reventadorensis* as a synonym of *T. hystrix* (Jiménez *et al.*, in prep.).

Telipogon vasquezunnezii is also similar to *T. embreei* N.H. Williams & Dressler (ex *Stellilabium frymirei* Dodson). They both share the inflorescence with similar-sized flowers (*T. vasquezunnezii*: 9–11 × 8–13 mm vs. *T. embreei*: 10 × 11 mm; Table 1), a subterete peduncle, the ciliate petal margins, the pilose lip with ciliate margins, the occurrence of two columnar auricles and a columnar appendix, the tufts of setae with stellate apex on the columnar auricles, and the tuft of acicular setae on the columnar appendix. Nevertheless, *T. vasquezunnezii* is distinguished by the light green to pale red flowers (vs. brown flowers), the narrowly obovate to sub-oblong petals (vs. elliptical petals), the oblong-ligulate lip (vs. ovate lip), the small pair of lobes at the lip base (vs. longer and falcate lobes), and the stiff trichomes throughout the lip (vs. 5 veins with stellate trichomes). *Telipogon embreei* occurs on the eastern slopes of the Ecuadorian Andes, approximately 250 km in a straight line north of the recorded localities of *T. vasquezunnezii*.

In Peru, *T. vasquezunnezii* is morphologically more similar to *T. astroglossus* (Table 1). However, it is easily discriminated by the oblong-ligulate lip with two small basal lobes (vs. triangular lip with hastate base), the absence of a protrusion on the lip (vs. a hump-like protrusion on the lower half), and the setae with stellate apex on the columnar auricles (vs. acicular setae on the columnar auricles).

Telipogon vasquezunnezii belongs to what we propose here as the “*T. astroglossus* group”, an informal group restricted to South America and characterised by having small plants with small flowers (around 1 cm or less), terete to sub-terete rachis, and a column bearing a pair of non-alate setose columnar auricles and a setose columnar appendix. This group includes six species *T. astroglossus*, *T. calveri* N.H. Williams & Dressler, *T. embreei*, *T. hystrix*, *T. roberti* N.H. Williams & Dressler, and *T. vasquezunnezii*. Garay & Romero (1998) and Dressler (1999) previously grouped most of these species within *Dipterostele* Schltr. and *Stellilabium* section *Dipterostele* Dressler, respectively, based on the presence of lobes in the column. Interestingly, they did not include *T. astroglossus*; instead, they grouped it with *T. pogonos-*

TABLE 1. Comparison of characters between *T. vasqueznunezii* and morphologically similar species. Flower characteristics extracted from: ¹Dodson and Dodson (1980), ²Dodson and Dodson (1982).

Flower character	<i>Telipogon vasqueznunezii</i>	<i>Telipogon astroglossus</i> ¹	<i>Telipogon embreei</i> ²	<i>Telipogon hystrix</i> ²
Flower diameter (mm)	9–11 × 8–13	6.2 × 5.9	10 × 11	5 × 5
Dorsal sepal dimensions (mm) and shape	4.1–4.4 × 2.1–2.3, ovate	3 × 3, broadly ovate	6 × 3, ovate	3.0 × 1.2, narrowly elliptical
Petals dimensions (mm) and shape	3.9–4.1 × 0.9–1.1, obovate to sub-oblong	4.0 × 2.2, obovate	6.0 × 3.5, elliptical	3.0 × 1.5, narrowly ovate
Lip dimensions (mm) and shape	3.8–4.1 × 1.6–1.8, oblong-ligulate, auriculate base with two small lateral lobes	5 × 3, ovate, sagittate base	4.2 × 2.1, ovate, sub-auriculate base with falcate appendages	4.2 × 2.1, elliptical to oblong, sagittate base with long lobes
Adaxial lip surface	densely pilose	disc with a rounded pubescent pad	5 parallel, stellate-pubescent veins	puberulent with a hump-like protrusion on the lower half
Seta shape on the columnar auricle	setae with stellate apices	acicular setae	setae with stellate apices	setae with stellate apices
Seta shape on the columnar apex	acicular setae	acicular setae	acicular setae	setae with stellate apices

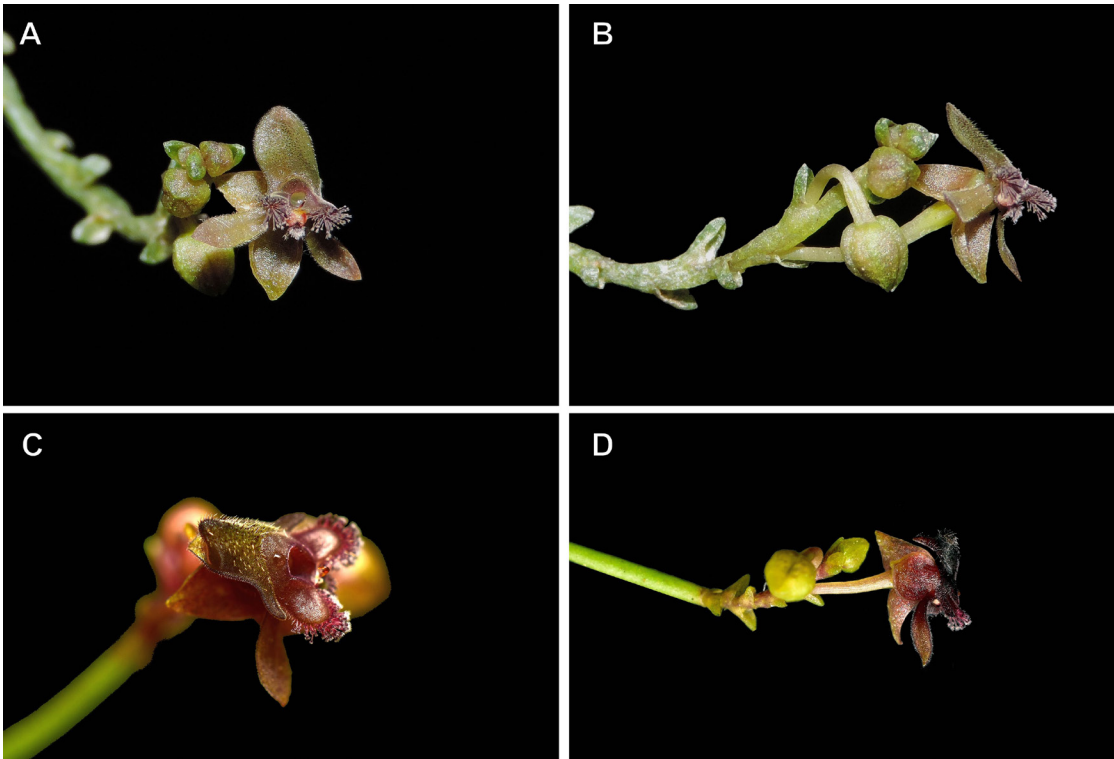


FIGURE 5. Comparison of flowers of *Telipogon vasqueznunezii* and *T. hystrix*. **A.** Flower of *T. vasqueznunezii*, ¾ view. **B.** Flower of *T. vasqueznunezii*, lateral view. **C.** Flower of *T. hystrix*, ¾ view. **D.** Flower of *T. hystrix*, lateral view. Photos by James A. Chamaya G. (A–B) and Gabriel Iturralde (C–D).

talix Rchb.f. in the *Stellilabium* section *Stellilabium*, which differs markedly in floral morphology. Moreover, *Dipterosteale* (sensu Garay & Romero, 1998). and *Stellilabium* section *Dipterosteale* (sensu Dressler, 1999) included *T. microglossus* (Schltr.) N.H. Williams & Dressler and *T. morganiae* (Dodson)

N.H. Williams & Dressler, species currently considered within the *Telipogon microglossus* group, which are characterized by presenting two columnar alate appendices (Martel *et al.*, 2020a). The species of this informal group are distributed in the Tropical Andes of Ecuador, Peru and Bolivia.

KEY FOR SPECIES OF THE *TELIPOGON ASTROGLOSSUS* GROUP

1. Lip with an acute or acuminate apex..... 2
- 1b. Lip with an auriculate apex..... *T. roberti*
2. Lip without a protrusion on the lower half, apex of the column without stellate setae..... 3
- 2b. Lip with a hump-like protrusion on the lower half, apex of the column with stellate setae..... *T. hystrix*
3. Auricles of the column with acicular or subulate setae..... 4
- 3b. Auricles of the column with stellate setae..... 5
4. Lip ovate with a rounded pubescent pad, auricles of the column with acicular setae..... *T. astroglossus*
- 4b. Lip transversely cordate and basally strongly falcate with scattered setae, auricles of the column with subulate setae..... *T. calueri*
5. Lip oblong-ligulate with an auriculate base and two small lateral lobes, densely pilose..... *T. vasqueznunezii*
- 5b. Lip ovate with a subauriculate base and falcate appendages, 5 parallel, stellate-pubescent veins..... *T. embreei*

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CONFLICT OF INTEREST. The authors declare that they have no known competing financial interests or relationships that could be construed to influence this work.

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A REGIONAL IUCN-BASED ASSESSMENT OF ORCHID SPECIES IN THE TROPICAL DRY FOREST OF VALLE DEL CAUCA, COLOMBIA

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ABSTRACT. This study presents a regional conservation assessment of orchid species in the Tropical Dry Forest (TDF) of Valle del Cauca, Colombia. We compiled a curated dataset of 391 georeferenced occurrence records representing 50 species across 34 genera, integrating vouchered herbarium specimens, published literature, and observational records from biodiversity databases, subjected to record-by-record quality control. Extent of Occurrence (EOO) and Area of Occupancy (AOO) were estimated following IUCN Red List Criterion B. To evaluate subcriteria B(a) (severe fragmentation) and B(b)(iii) (continuing decline in habitat area and quality), we applied an improved version of the EECORisk pipeline. This pipeline integrates Hansen Global Forest Change (GFC) data to assess habitat patch configuration and detect ongoing forest loss (2001–2023) around species occurrences. Of the 50 assessed species, seven were categorized as Critically Endangered (CR), 23 as Endangered (EN), 14 as Vulnerable (VU), and six as Least Concern/Near Threatened (LC/NT) at the departmental scale, underscoring the severity of habitat loss and fragmentation in TDF remnants. Orchid richness peaked between 900 and 1300 m a.s.l., and localities such as Hacienda El Medio (Zarzal) emerged as key areas concentrating records and richness. Overall, these results demonstrate the utility of the EECORisk pipeline for transparent, reproducible regional conservation assessments and underscore the need to prioritize habitat protection, connectivity restoration, and targeted monitoring in fragmented TDF ecosystems.

RESUMEN. Este estudio presenta una evaluación regional del riesgo de extinción de las orquídeas en los remanentes del Bosque Seco Tropical (Bs-T) del Valle del Cauca, Colombia. Compilamos un conjunto de datos curado de 391 registros georreferenciados de ocurrencia que representan 50 especies en 34 géneros, integrando especímenes de herbario, literatura publicada y registros observacionales de bases de datos de biodiversidad, sometidos a control de calidad registro por registro. La Extensión de Ocurrencia (EOO) y el Área de Ocupación (AOO) se estimaron según el Criterio B de la Lista Roja de la UICN. Para evaluar los subcriterios B(a) (fragmentación severa) y B(b)(iii) (disminución continua del área y calidad del hábitat), aplicamos una versión mejorada del pipeline EECORisk. Este pipeline integra datos de Hansen Global Forest Change (GFC) para evaluar la configuración de parches de hábitat y detectar la pérdida continua de bosque (2001–2023) alrededor de las ocurrencias de las especies. De las 50 especies evaluadas, siete fueron categorizadas como En Peligro Crítico (CR), 23 como En Peligro (EN), 14 como Vulnerable (VU) y seis como Preocupación Menor/Casi Amenazado (LC/NT) a escala departamental. La riqueza de orquídeas alcanzó su máximo entre 900 y 1300 m s.n.m. y localidades como Hacienda El Medio (Zarzal) emergieron como áreas clave que concentran registros y riqueza. Estos resultados demuestran la utilidad del pipeline EECORisk para evaluaciones regionales transparentes y reproducibles del riesgo de extinción de orquídeas y resaltan la necesidad de priorizar la protección de hábitats, la restauración de la conectividad y los monitoreos localizados en ecosistemas fragmentados del Bs-T.

KEYWORDS / PALABRAS CLAVE: análisis espacial, conservación de orquídeas, Criterio B UICN, disminución de hábitat, EECORisk, extinction risk, habitat decline, Hansen Global Forest Change, IUCN Criterion B, orchid conservation, riesgo de extinción, spatial analysis

Introduction. Tropical Dry Forests (TDFs) are among the most critically endangered ecosystems both in Colombia and globally. They are characterized by annual precipitation ranging from 250 to 2000 mm, with pronounced seasonality leading to extended dry periods (Espinal & Montenegro, 1963; Linares & Fandiño, 2009), and by one or two dry seasons where potential evapotranspiration exceeds precipitation (DryFlor, 2016). TDFs hold significant ecological value due to their high levels of biodiversity and the essential ecosystem services they provide, such as carbon sequestration, soil stabilization, and habitat for unique flora and fauna; recent evidence has also shown that these forests support socio-ecological resilience by underpinning rural livelihoods and regulating watershed dynamics in regions facing increasing aridity (Norden *et al.*, 2021). Historically, TDFs in Colombia covered approximately 9 million hectares; however, less than 8% of their original extent remains today, representing about 720,000 hectares (Etter *et al.*, 2008; Pizano & García, 2014). Current assessments indicate that only 5% of the remaining TDF fragments are under any legal protection, and mature forest is nearly absent, with most fragments being in early or intermediate successional stages (González-M. *et al.*, 2018).

The Valle del Cauca, a department notably rich in biodiversity, has undergone particularly intense transformation of its dry forests, primarily driven by the expansion of industrial crops, such as sugarcane, extensive cattle ranching, and urbanization (Montano Fuentes *et al.*, 2022; Uribe-Castro, 2015). These transformations have led to significant habitat loss and degradation, resulting in reduced biodiversity and fragmented ecosystems (Fig. 1). By 1957, dry forests covered approximately 6% of their original extent in the Geographical Valley of the Cauca River; however, by 1986, this coverage had declined to just 2% (CVC, 2000). Currently, less than 1% of these forests remain in scattered fragments, underscoring the urgent need for conservation measures (Vargas, 2012). Despite the fertility of its alluvial soils, which has driven intensive agriculture, small fragments of native vegetation persist, covering less than 500 hectares and scattered across an agriculturally dominated landscape. These remnant patches are often isolated and irregularly shaped, further limiting their ecological functionality (González-M. *et al.*, 2018). Such fragmentation in the

TDF creates “islands” of habitat surrounded by anthropogenic matrices, a scenario that calls for spatial analyses to identify priority conservation areas (Galindo *et al.*, 2005) and aligns with the island biogeography framework for understanding species richness in these forests relicts (Soto-Medina *et al.*, 2023). In 2018, Ramos and Silverstone conducted a comprehensive study in the Geographical Valley of the Cauca River, documenting plant collections from these fragments between 1986 and 2009. The study recorded 950 vascular plant species across 38 sites, of which 60.8% were identified as forest species, thereby highlighting the significant biodiversity still present in these remnants. These findings suggest that the total flora of the geographical valley may include approximately 2000 species (Ramos & Silverstone, 2018; Vargas, 2012).

Within this context, the Orchidaceae family, one of the most emblematic and diverse plant families in the TDF, faces severe threats. Colombia and Ecuador are the countries with the highest diversity of orchid species, with over 4000 registered species (Pérez-Escobar *et al.*, 2024). In the Valle del Cauca, around 71 orchid species have been documented within TDF fragments, of which 10 are endemic, underscoring the critical role of this region in biodiversity conservation (Ramos & Silverstone, 2018; Reina-Rodríguez *et al.*, 2016). However, the uniqueness of orchid diversity in each region is further accentuated by the high beta diversity and floristic turnover reported for the TDF across Colombia, where species assemblages differ markedly between regions, reinforcing the need for region-specific conservation actions (DryFlor, 2016; Kattan *et al.*, 2019). At the national scale, orchids comprise a significant portion of the Red List assessments, with approximately 52% of evaluated species identified as threatened (López-Gallego *et al.*, 2024).

Climate change represents an emerging threat that may further exacerbate the already precarious status of TDF orchids through warming, shifts in rainfall regimes, and an increasing frequency of extreme weather events. González-M. *et al.* (2021) studied the effects of the ENSO (El Niño–Southern Oscillation) 2015 and showed that ecological functionality and biomass gain would be reduced if dry conditions increase. For orchids specifically, temperature increases can lead to heat stress, impairing growth and reducing flowering success (Benzing, 1998; Crain &



FIGURE 1. Typical landscape of the geographical Cauca River Valley in Valle del Cauca, Colombia, showing extensive agricultural transformation dominated by sugarcane cultivation. The image illustrates the characteristic matrix of anthropogenic land use in which Tropical Dry Forest remnants are embedded. Photograph by J.S. Moreno.

Tremblay, 2017; Zotz & Bader, 2009). Altered rainfall patterns can cause prolonged droughts, limiting water availability crucial for orchid survival (de la Rosa-Manzano *et al.*, 2014). Recent models highlight that even small shifts in temperature and precipitation patterns can critically impact the persistence of TDF plant communities, particularly given their narrow ecological tolerances and limited dispersal capacity in highly fragmented landscapes (González-M. *et al.*, 2018; Reina-Rodríguez *et al.*, 2017). Elevation is also a key axis structuring orchid occurrence in seasonally dry landscapes because it integrates strong gradients in temperature, humidity, cloud/fog inputs, and canopy microclimate over relatively short geographic distances. For TDF orchids, shifts in these gradients can compress suitable microclimates, making mid-elevation sites critical both as current diversity hotspots and as potential refugia under climate change scenarios (Crain & Tremblay, 2017).

Despite the ecological importance of orchids in TDF remnants, none of these species has been regionally assessed for Valle del Cauca under the IUCN criteria. Regional assessments can provide more decision-relevant information than global categorizations because they explicitly capture localized pressures, habitat configuration, and jurisdiction-specific management constraints. Importantly, conservation priorities may be underestimated when taxa are relatively widespread elsewhere but locally rare within a given jurisdiction, especially because land-use decisions and

conservation actions are frequently implemented at local and regional scales (Crain & White, 2011). In this context, incorporating the concept of local rarity helps to anticipate potential discrepancies between global status and local extinction risk, particularly for taxa confined to small, fragmented habitat patches (Crain & Tremblay, 2012). Currently, it is estimated that 40% of plant species are globally threatened with extinction (Nic Lughadha *et al.*, 2020), yet less than 15% of global plant diversity has been evaluated for the Red List (IUCN, 2024). In Colombia, the first published effort to categorize orchid species using IUCN criteria was conducted by Calderón (1998), which included 128 species. In 2006, Calderón-Sáenz addressed these limitations in volume 6 of the Red Books of Plants of Colombia, evaluating 375 species and categorizing 207 of them as threatened to varying degrees (Ministerio de Ambiente y Desarrollo Sostenible & Universidad Nacional de Colombia, 2015).

Given the critical condition of the TDF in Valle del Cauca, this study aims to systematically categorize the orchid species present in these remnants based on IUCN Criterion B and by applying the EECORisk pipeline to evaluate geographic range metrics, severe fragmentation, and continuing habitat decline (Arango & López-Gallego, 2023). Beyond producing regional IUCN Criterion B assessments, we use the results to identify taxa that emerge as locally critical conservation priorities and to outline actionable management pathways. These pathways include *in situ*

measures (e.g., habitat protection and connectivity) and complementary *ex situ* options (e.g., propagation and population reinforcement) where local extinction risk is elevated.

Materials and methods. *Biological data.*— This study compiled data on the occurrence of orchid species in the Tropical Dry Forest (TDF) of Valle del Cauca Department, Colombia. Data sources included vouchered specimens from national herbaria (CAUP, CUVC, FMB, HPUJ, HUA, JAUM, JBB, MO, SALLE, SEL, VALLE, and TOLI), which were selected due to their extensive collections of plant specimens from the region and their historical importance in documenting orchid diversity, especially in the tropical dry forests of Valle del Cauca Department. Scientific literature, notably studies by Ramos and Silverstone (2018); Reina-Rodríguez (2012, 2016); Reina-Rodríguez *et al.* (2016, 2017), and Vargas (2012). Digital platforms (GBIF, 2025; Tropicos, 2025), and the CEIBA/I2D resource of the Alexander von Humboldt Institute (Instituto Humboldt & Universidad del Valle, 2015), from which only the Orchidaceae subset attributable to Valle del Cauca was incorporated.

Given the high taxonomic complexity of Orchidaceae and the frequency of misidentifications in occurrence datasets, all records were curated individually prior to inclusion. We applied a tiered evidence framework in which records were retained based on the strength of supporting information rather than the presence of any single field. Herbarium records were prioritized because voucher specimens provide taxonomically verifiable evidence even when photographs are unavailable; nonetheless, locality precision and taxonomic reliability were evaluated in each case. For records without herbarium vouchers (i.e., occurrence data compiled from published literature and biodiversity databases), all entries were manually reviewed, including photographs (when available) and coordinates, and records were retained only when images or descriptions allowed diagnostic identification and when locality, habitat, and elevational context were ecologically plausible for TDF orchids. Spatial quality control was conducted in R using CoordinateCleaner (Zizka *et al.*, 2019) to flag common geographic issues, followed by manual verification of flagged records. Records lacking coordinates were georeferenced fol-

lowing Escobar *et al.* (2015). This workflow ensured that the final dataset reflected only records that were taxonomically and spatially defensible for analyses of orchid diversity and conservation status. Generic circumscriptions within Maxillariinae follow the phylogenetic classification of Blanco *et al.* (2007), who segregate several genera from *Maxillaria s.l.*

Mapping and richness patterns.— All orchid distribution records were organized into a database to quantify species richness at the municipal level and to identify endemic species. Mapping was conducted in QGIS v3.28 (QGIS Development Team, 2023).

Elevational patterns of species richness.— To describe elevational patterns in orchid richness within TDF remnants, we analyzed georeferenced orchid records from the study area to assess the relationship between species richness and elevation. Elevation data were assigned from record metadata or extracted from digital elevation models. Data were grouped into 50-meter elevation intervals. Species richness was calculated as the number of unique species present within each elevation interval. We generated a smoothed curve using cubic spline interpolation to visualize trends in species diversity across elevation gradients. A histogram was constructed to depict the distribution of records across elevation intervals.

Categorization based on IUCN criteria.— We applied the IUCN Red List Categories and Criteria (IUCN, 2024) to assess extinction risk under Criterion B (Geographic Distribution). Criterion B evaluates two complementary range metrics: (1) Extent of Occurrence (EOO; B1), which is the area encompassed within the shortest imaginary boundaries containing all known sites of a species, calculated using a minimum convex polygon (IUCN, 2017); (2) Area of Occupancy (AOO; B2), defined as the area effectively occupied by a species within the EOO, estimated by counting occupied 2×2 km grid cells following IUCN standards.

To generate automated conservation assessments for these metrics, the R package ConR v1.2.2 was utilized (Dauby *et al.*, 2017). ConR was chosen for its efficiency in calculating key conservation metrics such as EOO and AOO from georeferenced occurrence data. All range metrics are based on observed occurrences,

with records lacking coordinates georeferenced from locality descriptions following Escobar *et al.* (2015). Species with fewer than three georeferenced records were included in assessments, as habitat decline metrics can be evaluated even for single-locality occurrences using the EECORisk pipeline detailed below.

Under Criterion B, a species qualifies for a threat category when its geographic range falls below established thresholds (B1: EOO < 100 km² for CR, < 5000 for EN, < 20,000 for VU; B2: AOO < 10 km² for CR, < 500 for EN, < 2000 for VU) and at least two of three additional subconditions are met: (a) severely fragmented or number of locations at or below the category threshold (CR ≤ 1, EN ≤ 5, VU ≤ 10); (b) continuing decline observed, estimated, inferred, or projected in any of: (i) EOO, (ii) AOO, (iii) area, extent, and/or quality of habitat, (iv) number of locations or subpopulations, (v) number of mature individuals; (c) extreme fluctuations.

EECORisk pipeline: implementation and improvements.— To evaluate subcriteria B(a) and B(b)(iii) in a transparent and reproducible manner, we built upon the EECORisk pipeline (Arango & López-Gallego, 2023), an R-based framework developed by the Colombian Plant Specialist Group (GEPC) of the IUCN for national Red List assessments of plants in Colombia. The original EECORisk calculates EOO, AOO, number of locations, and subpopulations, and evaluates severe fragmentation B(a) and continuing decline B(b)(iii) using national-scale maps of forest cover (IDEAM, 2016) and the human footprint index (Correa-Ayram *et al.*, 2020), as applied to over 3000 species for the national Red List (López-Gallego & Morales-Morales, 2023; López-Gallego *et al.*, 2024). In the original implementation, severe fragmentation is inferred from forest-patch sizes at occurrence localities, and continuing decline is determined primarily from changes in the human footprint index between two time periods. For the present study, we adapted the pipeline to the regional scale and increased the temporal resolution of the habitat decline assessment by implementing the improvements detailed in each module below. The pipeline operates in four sequential modules:

1. *Geographic metrics (EOO, AOO, locations, subpopulations).* EOO and AOO were calculated as de-

scribed above using ConR. Locations are counted as the number of occupied cells in a threat grid reflecting the spatial scale at which a single threatening event can affect all individuals (default 10 × 10 km). For species whose distributions overlap with intensive agricultural areas (particularly industrial sugarcane monoculture), a 20 km grid cell size was used to reflect the landscape-scale operation of this threat. Subpopulations are identified as clusters of occurrences within a 10 km radius using graph-based connectivity analysis.

2. *Severe fragmentation [B(a)].* Using Hansen Global Forest Change (GFC) treecover2000 data (Hansen *et al.*, 2013)—which provides annual, pixel-level (30 m) information on baseline tree cover and year of forest loss (lossyear, 2001–2023)—the pipeline identifies habitat patches around species occurrences by classifying pixels with ≥30% tree cover as potential habitat. This replaces the national IDEAM forest-cover map used in the original pipeline, providing finer spatial resolution suitable for the small, highly fragmented TDF remnants of Valle del Cauca. Patches are delineated using connected-component analysis, and each patch is characterized by its area and distance to the nearest neighboring patch. A species is considered severely fragmented when >50% of its subpopulations occur in patches that are both small (<1 km²) and isolated (>10 km from the nearest patch), thresholds parameterized specifically for TDF orchids to reflect the characteristically small size of remnants in the region and the limited dispersal capacity of most epiphytic and terrestrial orchid species.

3. *Continuing decline in habitat [B(b)(iii)].* Using Hansen GFC lossyear data, the pipeline quantifies forest loss within a 5 km buffer around all occurrences of each species over the period 2001–2023. Rather than the single metric used in the original pipeline (change in human footprint between two periods), we implemented three independent, complementary criteria applied to the annual loss time series: (C1) forest loss detected in ≥3 of the last 10 years (2014–2023), indicating sustained and ongoing loss; (C2) cumulative forest loss ≥2% AND loss detected in the last 5 years (2019–2023), capturing significant total loss with recent activity; (C3) loss rate in the recent period (2014–2023) exceeding the previous period (2001–2013),

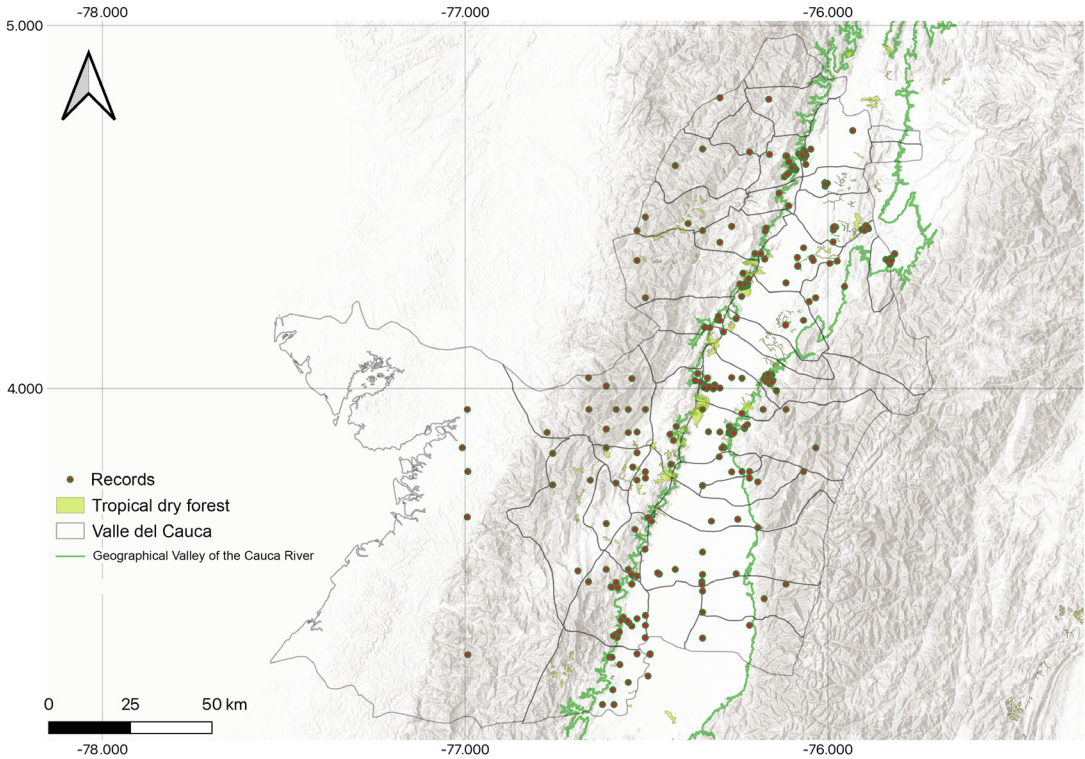


FIGURE 2. Distribution of orchid records within the Tropical Dry Forest remnants of Valle del Cauca, Colombia. The map shows the geographical Cauca River Valley, protected areas (in green), municipalities boundaries (black lines), and the location of 391 georeferenced orchid records (brown dots) used in this study.

detecting accelerating decline. A species is scored as exhibiting continuing decline if any criterion is met. This multi-criteria approach reduces the risk of both false positives (one-time events misclassified as continuing) and false negatives (slow but persistent loss going undetected).

4. Final categorization. Each species is assigned to the most severe IUCN category for which it meets the geographic-range prerequisite (B1 and/or B2) and at least two subconditions from: (a) severely fragmented or number of locations at or below the category threshold, or (b) continuing decline. The subcriteria contributing to the final category are reported explicitly (e.g., EN B1+B2ab(iii)). Per-species maps showing occurrence points, EOO polygons, AOO grids, and forest-loss footprints are generated for complete transparency.

Results. In this study, we compiled a total of 391 records corresponding to 50 species (including six

endemic taxa) distributed across 34 genera in Valle del Cauca (Fig. 2; Supplementary Table S1). Of these, 25 genera were monospecific. *Epidendrum* L. was the most species-rich genus with eight species, followed by *Encyclia* Hook. with three species. Seven additional genera contained two species each: *Catasetum* Rich. ex Kunth, *Cyclopogon* C.Presl, *Eulophia* R.Br., *Heterotaxis* Lindl., *Rodriguezia* Ruiz & Pav., *Sobralia* Ruiz & Pav., and *Vanilla* Mill. Among the endemic taxa recorded, *Catasetum tabulare* Lindl. and *Epidendrum lambeauanum* De Wild. are included here as illustrative examples (Fig. 3–4). The herbarium collection CUVC held the largest share of voucher-based records (n = 170), followed by TULV (n = 9) and VALLE (n = 6), with additional vouchers contributed by SALLE (n = 3), CAUP (n = 1) and COL (n = 1); the remaining records (n = 201) correspond to occurrence data from published inventories and observational sources without herbarium vouchers (Fig. 5).

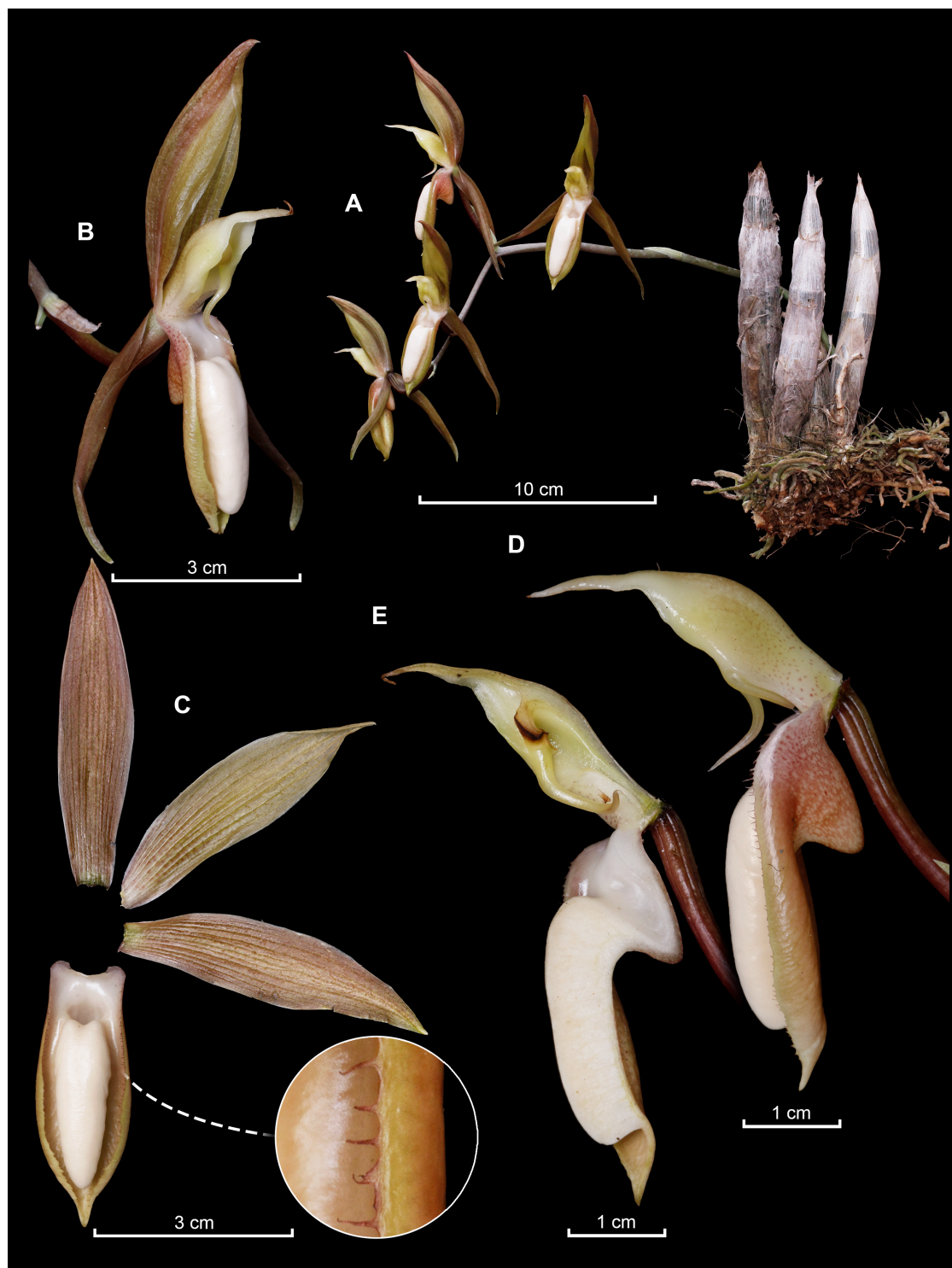


FIGURE 3. Lankester Composite Digital Plate (LCDP) of *Catasetum tabulare*. A. Habit. B. Flower. C. Dissected perianth. D. Column and lip, lateral view. E. Column and lip, longitudinal section. LCDP by E. Restrepo.

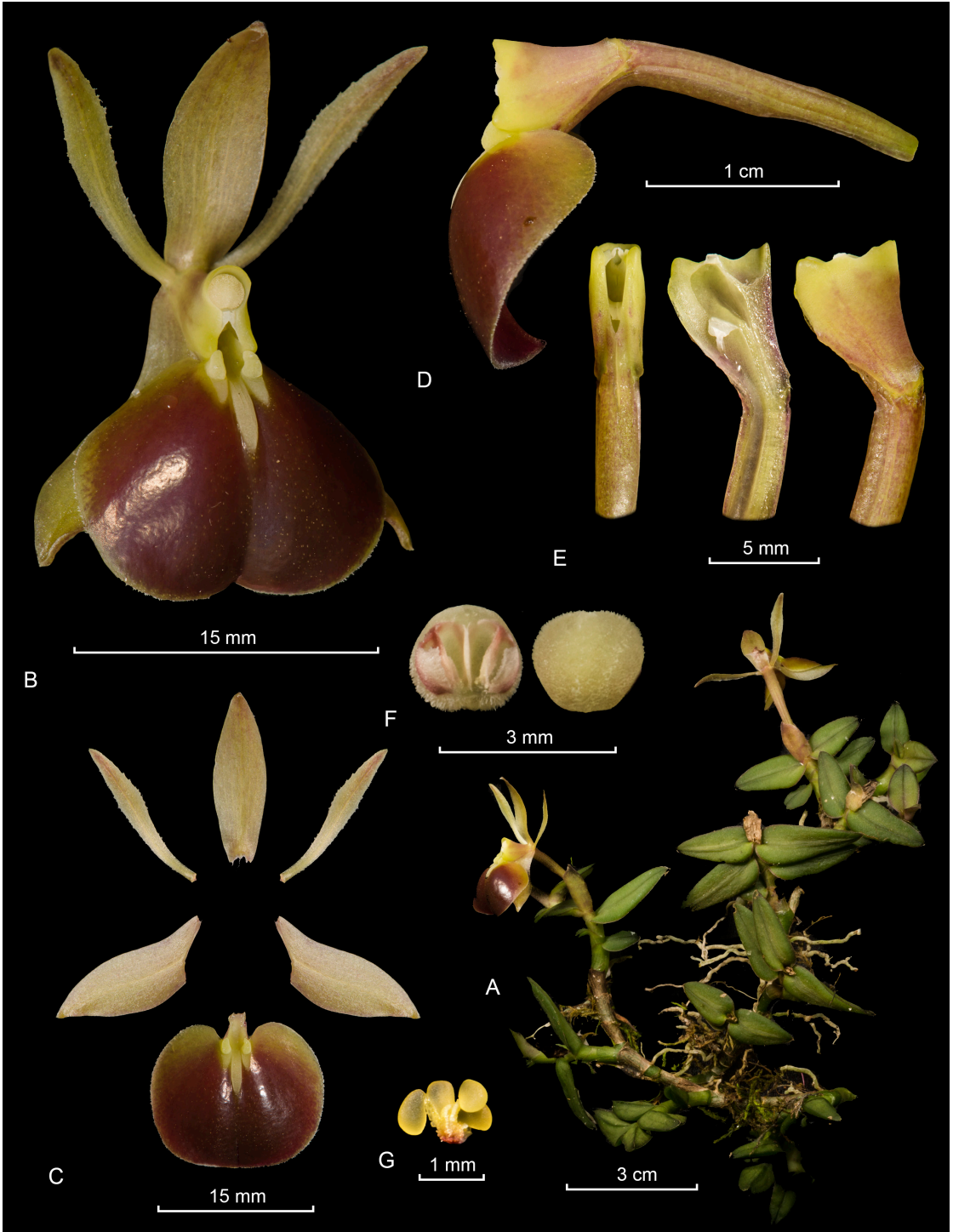


FIGURE 4. Lankester Composite Digital Plate (LCDP) of *Epidendrum lambeauanum*. **A.** Habit. **B.** Flower. **C.** Dissected perianth. **D.** Column and lip, lateral view. **E.** Column, ventral, longitudinal section, and lateral views. **F.** Anther cap. **G.** Pollinarium. LCDP by J.S. Moreno, from Hågsäter (2018: Plate 1633).

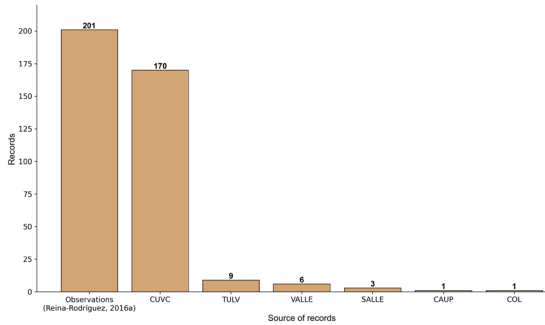


FIGURE 5. Distribution of the 391 orchid records compiled in this study according to source: herbarium vouchers (CUVIC, TULV, VALLE, SALLE, CAUP, COL) and observational records from published inventories and biodiversity databases without herbarium vouchers.

Across municipalities, records were most numerous in Zarzal (23 spp.; $n = 59$), followed by Buga (22 spp.; $n = 37$), Cali (14 spp.; $n = 34$), Toro (17 spp.; $n = 34$), and Yotoco (17 spp.; $n = 31$). Tuluá (21 spp.; $n = 26$), Caicedonia (14 spp.; $n = 24$), and La Victoria (16 spp.; $n = 22$) also showed significant representation. At the locality level, Hacienda El Medio (Zarzal; 944 m a.s.l.) concentrated the highest number of records across the study region, with 17 records representing 12 species, consistent with previous inventories (Reina-Rodríguez, 2016). These values should be interpreted considering the historically intensive sampling effort at this site (Ramos & Silverstone, 2018). Species richness peaked between 900 and 1300 m in elevation (Fig. 6).

Regional categorization according to IUCN criterion B.—A total of 50 orchid species were assessed (Table 1) using the EECORisk pipeline under IUCN Criterion B. Of these, seven species (14%) were categorized as Critically Endangered (CR), 23 (46%) as Endangered (EN), 14 (28%) as Vulnerable (VU), and six (12%) as Least Concern/Near Threatened (LC/NT) (Fig. 7). All species exhibited continuing decline in habitat [B(b)(iii)], with forest loss ranging from 0.9% to 21.8% around their occurrences. The seven CR species (*Encyclia tuluaensis* J.S.Moreno, Tamayo-Cen & Carnevali, *Epidendrum musciferum* Lindl., *Heterotaxis valenzuelana* (A.Rich.) Ojeda & Carnevali, *Liparis nervosa* (Thunb.) Lindl., *Malaxis histionantha* (Link) Garay & Dunst., *Ornithocephalus gladiatus* Hook.,

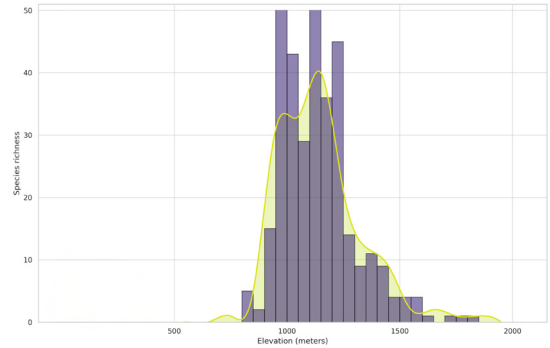


FIGURE 6. Altitudinal distribution of orchid species richness based on the 391 georeferenced records compiled in this study. Purple bars represent the number of records within each 50-meter elevation interval. The yellow smoothed curve was generated using cubic spline interpolation to visualize trends in species richness across elevation gradients, highlighting elevational ranges with highest diversity. The shaded yellow area under the curve represents the cumulative distribution of species richness, indicating the probability density of orchid species occurrence across the elevational gradient.

and *Xylobium foveatum* (Lindl.) G.Nicholson) are each known from a single location (1–2 records) with AOO ≤ 8 km² and confirmed ongoing forest loss, meeting CR thresholds under B2ab(iii). *Encyclia parkeri* Reina-Rodr. & Leopardi, although with four records, has an extremely restricted EOO (9.4 km²) and is categorized as EN.

The six species categorized as LC/NT—*Cyrtopodium paniculatum* (Ruiz & Pav.) Garay, *Dimerandra emarginata* (G.Mey.) Hoehne, *Epidendrum melinanthum* Schltr., *Jacquinella globosa* (Jacq.) Schltr., *Trichocentrum carthagenense* (Jacq.) M.W.Chase, and *Trizeuxis falcata* Lindl.—each had >10 locations and relatively large EOO values. In contrast, *Cattleya quadricolor*, though initially categorized as LC/NT under the standard 10 km threat-grid analysis, is reclassified as VU(B1+B2ab-iii) when the threat grid is adjusted to 20 km to reflect the landscape-scale operation of industrial sugarcane monoculture across the valley floor (EOO = 2,145.1 km², AOO = 88 km², 8 threat-defined locations, 6.4% forest loss).

Discussion. The findings of this study highlight significant conservation concerns for orchid species within the TDF of Valle del Cauca. Of the 50 species assessed, 44 (88%) were categorized in a threat category (CR, EN, or

TABLE 1. Regional conservation assessment results for 50 orchid species from the Tropical Dry Forest of Valle del Cauca (Colombia) under IUCN Criterion B. For each species we report: Extent of Occurrence (EOO; km²), Area of Occupancy (AOO; km²), number of threat-defined locations, number of subpopulations, whether severe fragmentation was detected [B(a)], whether continuing decline in habitat was detected [B(b)(iii)] with percent forest loss, and the final IUCN category with explicit subcriteria. NA indicates EOO could not be calculated (fewer than 3 occurrence points).

Species	EOO (km ²)	AOO (km ²)	Locations	Subpop.	Frag. B(a)	Decline B(b)(iii)	% Forest loss	Category	Subcriteria
<i>Acianthera capillaris</i> (Lindl.) Pridgeon & M.W.Chase	533.0	16	4	4	No	Yes	2.5	EN	B1+B2ab(iii)
<i>Bletia purpurea</i> (Lam.) A.DC.	175.4	12	3	3	No	Yes	5.8	EN	B1+B2ab(iii)
<i>Catasetum ochraceum</i> Lindl.	2059.8	36	7	5	No	Yes	10.5	VU	B1+B2ab(iii)
<i>Catasetum tabulare</i> Lindl.	5241.9	28	7	7	No	Yes	3.2	VU	B1+B2ab(iii)
<i>Cattleya quadricolor</i> B.S.Williams	2145.1	88	8	6	No	Yes	6.4	VU	B1+B2ab(iii)
<i>Cyclopogon elatus</i> (Sw.) Schltr.	2379.4	28	7	7	No	Yes	4.1	VU	B1+B2ab(iii)
<i>Cyclopogon lindleyanus</i> (Link, Klotzsch & Otto) Schltr.	602.3	20	5	3	No	Yes	0.9	EN	B1+B2ab(iii)
<i>Cyrtopodium paniculatum</i> (Ruiz & Pav.) Garay	6777.3	68	17	12	No	Yes	4.3	LC/NT	—
<i>Dimerandra emarginata</i> (G.Mey.) Hoehne	10569.5	84	19	15	No	Yes	5.5	LC/NT	—
<i>Encyclia ceratistes</i> (Lindl.) Schltr.	2417.2	20	5	5	No	Yes	3.5	EN	B1+B2ab(iii)
<i>Encyclia parkeri</i> Reina-Rodr. & Leopardi	9.4	12	2	1	No	Yes	21.8	EN	B1+B2ab(iii)
<i>Encyclia tuluaensis</i> J.S.Moreno, Tamayo-Cen & Carnevali	NA	4	1	1	No	Yes	2.7	CR	B2ab(iii)
<i>Epidendrum flexuosum</i> G.Mey.	35.4	8	2	2	No	Yes	2.8	EN	B1+B2ab(iii)
<i>Epidendrum lambeauanum</i> De Wild.	2168.8	40	10	7	No	Yes	4.1	VU	B1+B2ab(iii)
<i>Epidendrum lanipes</i> Lindl.	1499.1	16	4	4	No	Yes	6.3	EN	B1+B2ab(iii)
<i>Epidendrum melinanthum</i> Schltr.	8387.7	108	23	12	No	Yes	6.0	LC/NT	—
<i>Epidendrum musciferum</i> Lindl.	NA	4	1	1	No	Yes	3.5	CR	B2ab(iii)
<i>Epidendrum porquerense</i> F.Lehm. & Kraenzl.	2977.3	28	7	6	No	Yes	6.6	VU	B1+B2ab(iii)
<i>Epidendrum rigidum</i> Jacq.	4417.0	36	8	7	No	Yes	4.6	VU	B1+B2ab(iii)
<i>Epidendrum ruizianum</i> Steud	2485.1	12	3	3	No	Yes	6.9	EN	B1+B2ab(iii)
<i>Eulophia alta</i> (L.) Fawc. & Rendle	27.0	16	2	2	No	Yes	5.8	EN	B1+B2ab(iii)
<i>Eulophia maculata</i> (Lindl.) Rchb.f.	1646.9	24	6	6	No	Yes	4.7	VU	B1+B2ab(iii)
<i>Galeandra beyrichii</i> Rchb.f.	6584.5	40	9	8	No	Yes	3.6	VU	B1+B2ab(iii)

TABLE 1. *continues...*

<i>Heterotaxis equitans</i> (Schltr.) Ojeda & Carnevali	1293.5	20	5	3	No	Yes	5.1	EN	B1+B2ab(iii)
<i>Heterotaxis valenzuelana</i> (A.Rich.) Ojeda & Carnevali	NA	4	1	1	No	Yes	4.2	CR	B2ab(iii)
<i>Jacquiella globosa</i> (Jacq.) Schltr.	3612.8	52	13	11	No	Yes	5.7	LC/NT	—
<i>Laelia splendida</i> (Schltr.) L.O.Williams	NA	8	2	2	No	Yes	9.7	EN	B2ab(iii)
<i>Liparis nervosa</i> (Thunb.) Lindl.	NA	4	1	1	No	Yes	8.3	CR	B2ab(iii)
<i>Malaxis histioantha</i> (Link) Garay & Dunst.	NA	4	1	1	No	Yes	1.5	CR	B2ab(iii)
<i>Maxillariella guareimensis</i> (Rchb.f.) M.A.Blanco & Carnevali	329.5	20	5	5	No	Yes	4.8	EN	B1+B2ab(iii)
<i>Mormolyca tenuibulba</i> (Christenson) M.A.Blanco	12.3	12	3	2	No	Yes	6.0	EN	B1+B2ab(iii)
<i>Nemaconia striata</i> (Lindl.) Van den Berg, Salazar & Soto Arenas	981.3	16	4	4	No	Yes	5.2	EN	B1+B2ab(iii)
<i>Notylia sagittifera</i> (Kunth) Link, Klotzsch & Otto	986.2	16	4	4	No	Yes	4.6	EN	B1+B2ab(iii)
<i>Oncidium pictum</i> Kunth	855.5	24	5	5	No	Yes	4.7	EN	B1+B2ab(iii)
<i>Ornithocephalus gladius</i> Hook.	NA	8	1	1	No	Yes	3.8	CR	B2ab(iii)
<i>Pabstiella aryster</i> (Luer) F.Barros	NA	8	2	2	No	Yes	3.3	EN	B2ab(iii)
<i>Pelexia olivacea</i> Rolfe	2971.8	32	8	7	No	Yes	6.4	VU	B1+B2ab(iii)
<i>Polystachya foliosa</i> (Hook.) Rchb.f.	3007.6	20	5	4	No	Yes	4.9	EN	B1+B2ab(iii)
<i>Prosthechea livida</i> (Lindl.) W.E.Higgins	1023.8	20	5	4	No	Yes	5.0	EN	B1+B2ab(iii)
<i>Rhetinantha friedrichsthalii</i> (Rchb.f.) M.A.Blanco	1259.4	28	7	6	No	Yes	4.4	VU	B1+B2ab(iii)
<i>Rodriguezia granadensis</i> (Lindl.) Rchb.f.	577.0	16	4	3	No	Yes	2.3	EN	B1+B2ab(iii)
<i>Rodriguezia lanceolata</i> Ruiz & Pav.	1133.9	20	5	5	No	Yes	5.4	EN	B1+B2ab(iii)
<i>Scaphyglottis prolifera</i> (R.Br.) Cogn.	3303.5	40	9	8	No	Yes	6.8	VU	B1+B2ab(iii)
<i>Sobralia densifoliata</i> Schltr.	NA	8	2	2	No	Yes	5.0	EN	B2ab(iii)
<i>Sobralia roezlii</i> Rchb.f.	541.5	16	4	4	No	Yes	4.3	EN	B1+B2ab(iii)
<i>Trichocentrum carthagenense</i> (Jacq.) M.W.Chase & N.H.Williams	7488.2	72	17	14	No	Yes	5.3	LC/NT	—
<i>Trizeuxis falcata</i> Lindl.	3045.7	56	13	8	No	Yes	5.7	LC/NT	—
<i>Vanilla calyculata</i> Schltr.	1305.8	44	10	8	No	Yes	4.7	VU	B1+B2ab(iii)
<i>Vanilla odorata</i> C. Presl.	3105.5	32	7	7	No	Yes	5.8	VU	B1+B2ab(iii)
<i>Xylobium foveatum</i> (Lindl.) G.Nicholson	NA	4	1	1	No	Yes	3.5	CR	B2ab(iii)

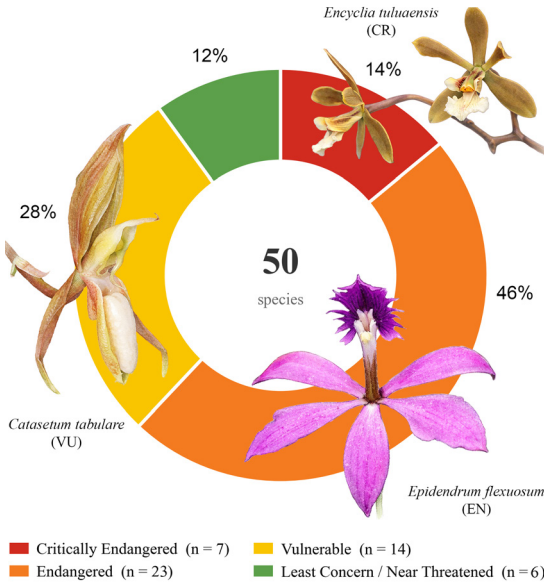


FIGURE 7. Conservation status of orchid species assessed in this study, based on IUCN Criterion B. Figure prepared by J.S. Moreno

VU) under IUCN Criterion B, and continuing habitat decline was confirmed for all species through the Hansen GFC analysis. These results reflect the extreme fragmentation and ongoing degradation of TDF remnants in the region, where less than 8% of the original forest cover remains (Pizano & García, 2014). Importantly, such spatial configurations heighten the risk of local extinction (extirpation); species that may not be globally threatened can nonetheless disappear from specific remnants when isolation reduces demographic rescue and constrains reproduction and recruitment (Tremblay & Ackerman, 2001; Swarts & Dixon, 2009). These processes help explain why regional conservation priorities must emphasize not only protecting remaining fragments but also restoring connectivity through corridors and habitat recovery (Crain & White, 2011; Reina-Rodríguez *et al.*, 2016).

It is important to note that although some previous studies reported higher orchid diversity in the region, they often included larger geographic areas encompassing multiple departments, such as Valle del Cauca, Risaralda, Cauca, and Quindío, all part of the Geographical Valley of the Cauca River. For example, Reina-Rodríguez (2016) documented 71 species in the Geographical Valley of the Cauca River. This may be explained by the fact that studies covering multiple

sites often inherently include a broader range of habitats and microclimatic conditions (Kolanowska, 2014). Conversely, Ramos and Silverstone (2018) recorded 36 orchid species across this broader geographic area. In comparison, our study, which focused solely on Valle del Cauca, recorded 50 species. Distinguishing differences in scale among the studies is crucial for interpreting the conservation needs of orchids within the TDF of Valle del Cauca and underscores the significance of finer geographic scales in revealing locally relevant patterns of orchid diversity that broader regional assessments may overlook.

Sampling structure and institutional data concentration.— Patterns in records and richness should be interpreted considering the historical and institutional structure of botanical collecting in Valle del Cauca. The dominance of CUVIC records reflects the sustained activity of this herbarium in the region. Municipality-level richness rankings (Zarzal, Buga, Tuluá) are concordant with previous inventories (Reina-Rodríguez, 2016) and likely reflect both biological patterns and heterogeneous sampling effort; more standardized surveys across other TDF remnants could reveal additional taxa at those localities.

Mid-elevation zones and their ecological role.— The peak in orchid richness between 900 and 1300 m a.s.l. is consistent with mid-elevation diversity hotspots documented for orchids in other tropical regions, including New Guinea (Schuiteman & de Vogel, 2007) and Costa Rica (Crain & Fernández, 2020). These elevational zones integrate favorable microclimatic conditions—moderate temperatures, higher humidity, and reduced drought stress—that support epiphytic orchid communities even in seasonally dry landscapes (Crain & Tremblay, 2017). Reina-Rodríguez *et al.* (2016) identified mid-elevation areas in Valle del Cauca as potential climatic refugia for dry forest orchids under future scenarios and proposed the implementation of altitudinal migration corridors (AMCs) to connect lowland forest remnants with more stable mid-elevation habitats. Initiatives such as the Yaguarundi Corridor (Hernández, 2021), which aim to restore connectivity across the Geographical Valley of the Cauca River, are essential for maintaining these elevational gradients and the ecological processes they support.

Historical context of the Tropical Dry Forest.— The extreme fragmentation detected in our analyses has deep historical roots. The TDF of Valle del Cauca has undergone intensive transformation since the late 19th century, driven primarily by sugarcane expansion, cattle ranching, and urbanization (Giraldo Díaz, 2010; Uribe-Castro, 2015; Montano Fuentes *et al.*, 2022). Large-scale land transformation drastically reduced and subdivided dry-forest cover, with estimates suggesting that major losses accumulated rapidly between 1870 and 1950 and that only a small fraction of the original ecosystem remains today (Giraldo Díaz, 2010). This legacy of conversion helps explain why many orchid taxa now persist as small, spatially discontinuous populations embedded within an intensive agricultural matrix: once-continuous habitat has become several ecological “islands” where dispersal, recolonization, and demographic rescue are constrained (Haddad *et al.*, 2015; Soto-Medina *et al.*, 2023). In this context, management actions that stabilize habitat quality within the remaining remnants are essential, alongside broader landscape-scale restoration efforts (Niessen & Calderón, 2002).

Restoration challenges and climate-driven range shifts.— Ecological restoration of the TDF presents unique challenges due to the inherently limited water availability characteristic of the ecosystem, a condition further exacerbated by climate change. Changes in temperature and precipitation have been shown to shift the elevational distribution of species, potentially resulting in the loss of suitable habitats for orchids in the lowlands where they currently thrive (Feeley & Silman, 2010; Lutz *et al.*, 2013). Additionally, habitat fragmentation and loss of connectivity between TDF remnants diminish the resilience of these species, limiting their ability to adapt and survive in a rapidly changing environment (González-M. *et al.*, 2018; Haddad *et al.*, 2015). New approaches to restoration emphasize the importance of socio-ecological monitoring platforms that integrate local communities and adaptive management strategies (Norden *et al.*, 2021).

Importance of Hacienda El Medio.— The prominence of Hacienda El Medio in our dataset reinforces its relevance as a key locality for orchid diversity within the tropical dry forest of Valle del Cauca. This pattern is

consistent with prior intensive inventories in the area (Ramos & Silverstone, 2018; Reina-Rodríguez, 2016). Importantly, this consistency strengthens confidence in Zarzal/El Medio as a persistent diversity nucleus, while also highlighting a broader conservation message: high recorded richness can coexist with severe fragmentation and isolation, underscoring the need for site-based protection coupled with landscape-scale connectivity measures. The ecological value of El Medio is further supported by historical descriptions indicating that former cacao plantations transitioned into secondary forests dominated by native canopy trees such as *Anacardium excelsum* (Bertero & Balb. ex Kunth) Skeels, generating structurally complex habitats that function as refugia for orchids and other epiphytes (Ramos & Silverstone, 2018). Together, the convergence of historical and contemporary evidence emphasizes that remnant mid-elevation habitats, such as those in Hacienda El Medio, are disproportionately important for maintaining orchid diversity in the Cauca Valley and therefore merit priority attention within regional conservation and restoration strategies.

Data Deficiency reassessment.— Nine species in our dataset are known from a single locality (1–2 records), yielding AOO ≤ 8 km² and EOO not calculable (<3 points). The EECORisk pipeline enabled formal categorization of these species under B2 by evaluating B(b)(iii) habitat decline via Hansen GFC data, even for single-locality occurrences. Of these, seven species are categorized as CR under B2ab(iii) (e.g., *Liparis nervosa*: 1 location, AOO = 4 km², 8.3% forest loss; *Xylobium foveatum*: 1 location, AOO = 4 km², 3.5% forest loss), and two are categorized as EN under B2ab(iii) (*Laelia splendida* (Schltr.) L.O. Williams, *Sobralia densifoliata* Schltr.). Nonetheless, targeted field expeditions to historically documented localities and nearby suitable remnants remain essential to verify persistence, assess habitat condition, and obtain population metrics for these poorly known species.

Ongoing discovery and the role of protected areas and local institutions.— A key implication of working in highly fragmented TDF landscapes is that orchid diversity can remain underestimated even at relatively local scales. The recent description of *Encyclia tuluaensis* (Moreno *et al.*, 2024) (Fig. 8) from



FIGURE 8. *Encyclia tuluaensis*, recently discovered in the Juan María Céspedes Botanical Garden (Tuluá), representing ongoing taxonomic discoveries in fragmented tropical dry forests. Despite decades of surveys, this endemic species remained undiscovered until recent fieldwork. Categorized as Critically Endangered (CR; AOO = 4 km², single location), its discovery was translated into local conservation action: declared municipal flower of Tuluá through collaboration between botanical institutions and local government. Photograph by J.S. Moreno.

the Juan María Céspedes Botanical Garden (Tuluá), here categorized as CR(B2ab(iii)) with AOO = 4 km² and a single known location, illustrates the ongoing potential for taxonomic discoveries that immediately qualify as critically threatened. Importantly, the subsequent declaration of *E. tuluaensis* as the municipal flower of Tuluá—promoted through local leadership involving the botanical gardens (including Cali and Juan María Céspedes Botanical Gardens) and the Municipal Council—shows how scientific discovery can be translated into cultural identity and civic recognition, strengthening social appropriation, environmental education, and political momentum for local conservation action. This underscores that site-based conservation (e.g., private reserves, riparian buffers, and botanical institutions) is not only relevant for safeguarding known populations but can also reveal previously unrecognized endemic diversity.

Focal species.— *Cattleya quadricolor* (Fig. 9) presents an instructive case of divergence between formal Criterion B assessment and regional conservation concern. Under our EECORisk analysis with a standard 10 km threat grid, this species yielded 14 locations and was categorized as LC/NT. However, in Valle del Cauca, the dominant threat—industrial sugarcane monoculture—operates at a landscape scale that exceeds the standard 10 km cell, uniformly affecting all remnants across the valley floor. When the threat grid is adjusted to 20 km to reflect this spatially correlated threat, the number of locations decreases to 8, and the species is categorized as VU(B1+B2ab(iii)), with an EOO of 2145.1 km², an AOO of 88 km², and 6.4% continuing forest loss around occurrences. This adjusted categorization is more consistent with other evidence: Resolution 0126 (Ministerio de Ambiente y Desarrollo Sostenible, 2024) classifies the species nationally as

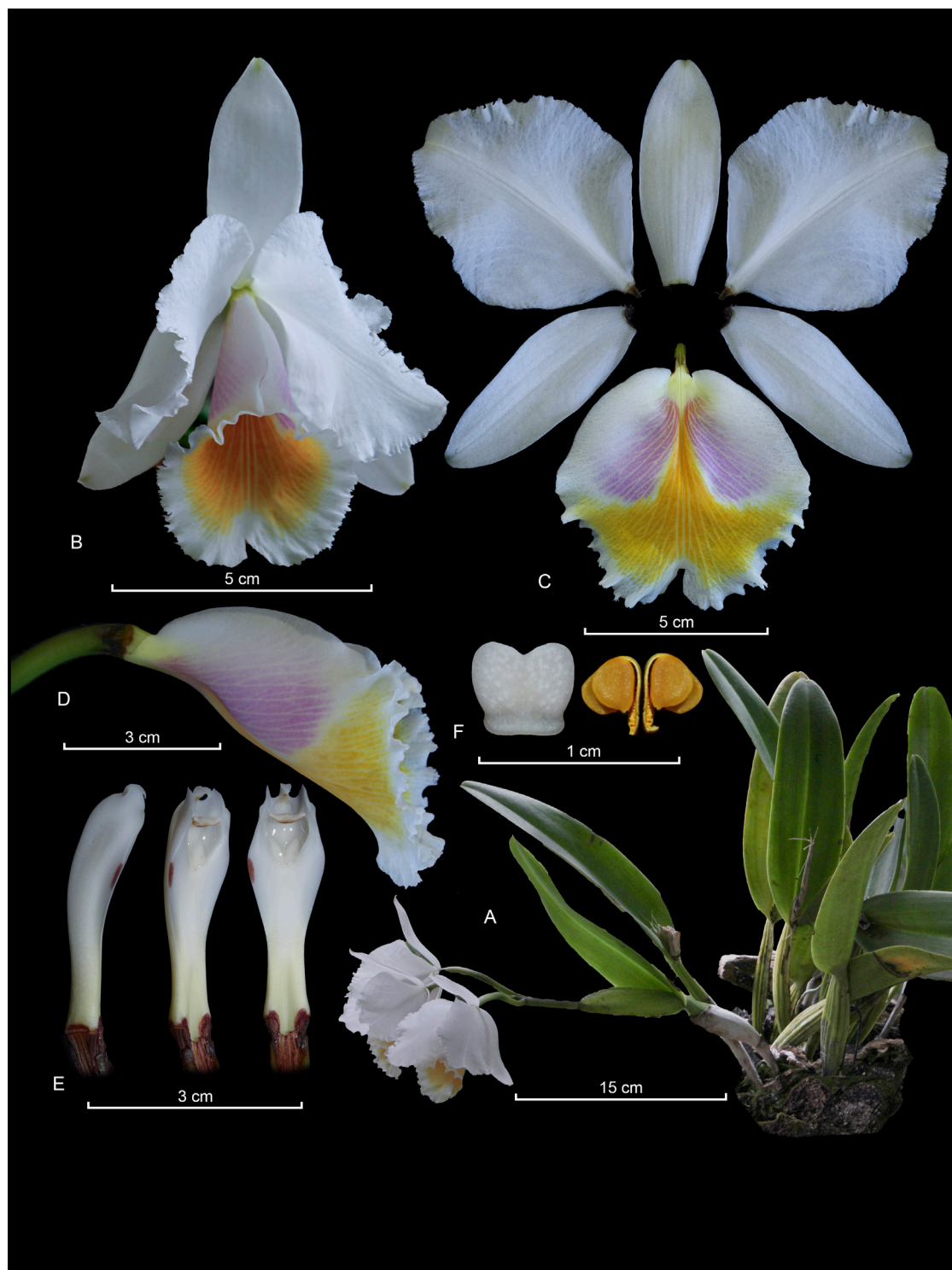


FIGURE 9. Lankester Composite Digital Plate (LCDP) of *Cattleya quadricolor*. **A.** Habit. **B.** Flower. **C.** Dissected perianth. **D.** Ovary, column, and lip, lateral view. **E.** Column, lateral, $\frac{3}{4}$, and ventral views. **F.** Anther cap and pollinarium. LCDP by J.S. Moreno.

Endangered under criteria not evaluated here (population decline, overexploitation), and the Management Plan for the Conservation of 22 Focal Plant Species in Valle del Cauca classified it as Critically Endangered under criterion A2cd (CVC, 2011; Reina-Rodríguez, 2012). The species' 6 subpopulations are embedded in a landscape where >92% of TDF has been converted, and the ongoing forest loss indicates that habitat quality continues to deteriorate. This case illustrates that Criterion B assessments based on geographic range metrics alone may underestimate threat levels for species facing spatially correlated, landscape-scale pressures, and that the definition of "location" sensu IUCN must carefully consider the spatial grain of the most plausible threat. Furthermore, the conservation of *Cattleya quadricolor* is not only vital because of its intrinsic ecological significance but also because it serves as a representative umbrella species for broader conservation efforts aimed at safeguarding the remaining fragments of the Inter-Andean Tropical Dry Forest.

In this context, botanical gardens play a pivotal role in the *ex situ* conservation of *Cattleya quadricolor* and other threatened orchids, as outlined in the management pathways proposed in this study. The Cali Botanical Garden has led initiatives in the propagation and conservation of native orchid species, including *in vitro* propagation of *C. quadricolor*, offering a practical avenue for future reintroduction and population reinforcement efforts. Beyond propagation, botanical gardens serve as hubs for research, conservation planning, and environmental education, contributing significantly to the maintenance of genetic diversity. Strengthening collaboration among botanical institutions, universities, and conservation organizations is essential to implement integrated strategies that bridge *in situ* and *ex situ* efforts and enhance the long-term viability of focal species.

Small, fragmented orchid populations face elevated risks of demographic stochasticity and genetic erosion, as documented for *Lepanthes caritensis* Tremblay & Ackerman in Puerto Rico, where a rare endemic survives in only two fragmented forest patches (Crain & Tremblay, 2012). Similar dynamics likely apply to the CR and EN species identified in our study, reinforcing the urgency of both habitat protection and population-level monitoring.

Conclusion. This study demonstrates the utility of the EECORisk pipeline (Arango & López-Gallego, 2023; López-Gallego *et al.*, 2024) for transparent, reproducible regional conservation assessments of orchids in highly fragmented landscapes. By integrating automated calculation of IUCN Criterion B metrics with satellite-derived habitat analysis (Hansen GFC), the pipeline enables the formal evaluation of subcriteria—including severe fragmentation B(a) and continuing decline B(b)(iii)—that are often assessed only qualitatively or omitted in regional studies. The application of this framework to 50 orchid species in the TDF of Valle del Cauca revealed that 88% of species qualify for a threat category at the departmental scale, and all species show ongoing habitat loss. These findings underscore the urgency of conservation actions: prioritizing habitat protection of remaining TDF remnants, restoring ecological connectivity between fragments—including altitudinal migration corridors linking lowland and mid-elevation habitats—and implementing targeted monitoring programs for the most critically threatened species, including the seven CR species known from single localities. The methodological approach presented here is directly transferable to other taxonomic groups and fragmented ecosystems where regional conservation assessments are needed to inform locally actionable management decisions.

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AUTHOR CONTRIBUTION. J.S.M. conceived the study, designed the methodology, conducted field surveys, processed and analyzed all data, created visualizations, and wrote the original manuscript. A.Z. contributed to methodological framework development, data interpretation, and manuscript revision. C.L. provided critical input on tropical dry forest ecology and context and contributed to manuscript writing and revision. All authors reviewed and approved the final version of the manuscript.

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CONFLICT OF INTEREST. The authors declare that they have no conflicts of interest.

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SUPPORTING INFORMATION: Additional material related to this article is available in the online Supporting Information section.

SUPPLEMENTARY TABLE S1. Occurrence records of orchids (Orchidaceae) from the Tropical Dry Forest of Valle del Cauca, Colombia, used in this study (n = 391 records; 50 species across 34 genera). The source/reference column identifies the origin of each record; “Observ.” denotes observations without herbarium vouchers. The abbreviation “s.n.” (*sine numero*) indicates records without an assigned collection number. Place names are given in Spanish as proper toponyms.

FLORA OF GAYO PLATEAU IV: A NEW SPECIES OF *BRYOBIUM* (ORCHIDACEAE) FROM GAYO PLATEAU, SUMATRA

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ABSTRACT. A new species of *Bryobium* is described based on specimens collected in northern Gayo Plateau, Sumatra. It differs from *B. hyacinthoides* in the morphology of the calli on the lip, flower colour, and in the broader leaves. It is provisionally assessed as Critically Endangered (CR) due to its narrow range and imminent threats to its habitat. A detailed description, photographs, an illustration, and a key to Sumatran *Bryobium* species are provided.

KEYWORDS/PALABRAS CLAVE: clave, epífita, epiphyte, key, Lista Roja, Red List, taxonomía, taxonomy, Indonesia

Introduction. *Bryobium* Lindl. is a genus of usually epiphytic herbs with about 27 accepted species (Ng *et al.*, 2018; POWO, 2026). The genus used to be included in a broader concept of *Eria* Lindl., which was shown to be polyphyletic (Ng *et al.*, 2018). *Bryobium* is difficult to distinguish from *Pinalia* Lindl., as discussed by Ng *et al.* (2018), even though it was found to be more closely related to *Ceratostylis* Blume. The latter is easily distinguished by the lack of pseudobulbs, which are always present in *Bryobium*. In addition, *Bryobium* has inflorescences with two or more flowers, whereas those of *Ceratostylis* are always single-flowered. We refer to Ng *et al.* (2018) for a discussion of the differences between *Bryobium* and *Pinalia*. The centre of diversity of *Bryobium* is in New Guinea with 10 or 11 species (De Vogel *et al.*, 2025).

Excluding the new species described below, Sumatra is home to four species of *Bryobium* with one of them endemic, *B. rubiferum* (J.J.Sm.) Schuit., Y.P.Ng & H.A.Pedersen (Mustaqim *et al.*, 2021-onwards). The most recent taxonomic account of Sumatran *Bryobium* was published by Comber (2001), who included its species in *Eria*. Since then, no fur-

ther taxonomic studies were carried out on the genus in Sumatra.

In 2021, a plant belonging to *Bryobium* was collected by local orchid enthusiasts from northern Gayo Plateau, Sumatra. It was then cultivated in Bali by JC and subsequently flowered there. An analysis of the flowers showed that the plant differed from the known species of *Bryobium* from Sumatra. Further attempts at identification showed that our plant was superficially similar to *B. pululum* (Schltr.) Schuit., Y.P.Ng & H.A.Pedersen, a Sulawesi endemic (Schlechter, 1911; 1934, as *Eria pulla* Schltr.), but the common and widespread *B. hyacinthoides* (Blume) Y.P.Ng & P.J.Cribb is perhaps the most similar in terms of lip structure. It was concluded that our plant belonged to an undescribed species.

Further explorations in 2024 and 2025 in the original habitat in northern Gayo Plateau were made and three wild populations of the new *Bryobium* species were located. Unfortunately, it was found that the small populations were already threatened by habitat conversion. Here, we describe the new species and provisionally assess its conservation status.

Material and methods. Material used in this study was gathered during expeditions carried out by WAM in northern Gayo Plateau since 2022, where he and his team finally rediscovered the species in September 2025. A living specimen from the original gathering was cultivated by JC in Bedugul, Bali; unfortunately, it proved impossible to ascertain the exact collecting locality of this specimen. Voucher specimens were prepared following Davies *et al.* (2023). Identifications were made by comparing the description of the plant to protologues and relevant literature (e.g., Comber, 1990, 2001; Seidenfaden & Wood, 1992). Specimens including types were observed in BO and K or in digital herbaria accessed through JSTOR Global Plants (JSTOR, 2026). The IUCN Red List conservation status assessment was prepared by calculating Area of Occupancy (AOO) and Extent of Occurrence (EOO) using GeoCAT (Bachman *et al.*, 2011; <https://geocat.iucnredlist.org/>) following IUCN guidelines (IUCN, 2012; IUCN Standards and Petitions Committee, 2024).

TAXONOMIC TREATMENT

Bryobium scutatatum Mustaqim, J.Champion & Schuit., *sp. nov.* (Fig. 1–3).

TYPE: INDONESIA. Aceh: Aceh Tengah, Jagong Jeget, Paya Tungel (4°21'24.3"N 96°44'59.4"E), 1850 m, 29 Sep 2025, Mustaqim *et al.* 4045 (holo: UIDEP; iso: FIPIA).

DIAGNOSIS: The new species is superficially similar to *B. pullum* from Sulawesi but differs in having larger floral parts (e.g., sepals 9.5–10.0 vs. 6 mm), a lip mid-lobe (epichile) with a central callus and two calli at the base (vs. mid-lobe without calli), lip not constricted (vs. lip abruptly constricted near the middle), basal calli of the lip shield-like (vs. basal calli ridge-like). The base of the lip is dark reddish maroon in *B. scutatatum*, pinkish red in *B. pullum*. In the structure of the lip the new species is most similar to *B. hyacinthoides*, but *B. scutatatum* has the basal calli of the lip mid-lobe transverse, not decurrent on the mid-lobe (vs. longitudinal and decurrent on the mid-lobe in *B. hyacinthoides*, so that the central callus on the mid-lobe is situated between the ridges of the basal calli in *B. hyacinthoides*, whereas the

central callus on the mid-lobe of *B. scutatatum* is isolated); the calli on the hypochile of the lip are flat and shield-like in *B. scutatatum* but raised and ridge-like in *B. hyacinthoides*. The lip is dark reddish maroon at the base in *B. scutatatum*, whitish at the base in *B. hyacinthoides*. *Bryobium scutatatum* usually has relatively broader leaves (5.6–8.0 cm vs. 3–6 cm wide) while of similar length, and the floral bracts are up to twice as long as in *B. hyacinthoides* (ca. 9 vs. ca. 4.5–6.0 mm).

Epiphytic, sympodial herb, up to ca. 40 cm tall. Rhizome creeping, ca. 6 mm across, with numerous roots; roots up to 1.2 mm across, white pubescent-papillose. Pseudobulbs ca. 1 cm apart, bifoliate at the apex, ovoid, 3–11 × 1–2 cm, covered by up to 9 sheaths; sheaths triangular, conduplicate, shorter at the base of the pseudobulb, becoming longer toward the apex, 2–14 × 1.5–4.4 cm, brown and papery, marcescent, becoming fibrous with age. Leaves petiolate, petiole 6.5–22.1 cm long, sheathing for ca. 2/5 of the petiole length, articulated above the rigid sheath, glabrous; lamina narrowly elliptic, 29.6–38.2 × 5.6–8.1 cm, base tapering, apex shortly acuminate, shallowly bilobed, unequal, glabrous, medium green above, pale green beneath; midrib and lateral veins prominent beneath, sunken above, two larger longitudinal lateral veins with 3 smaller veins in between. Inflorescence patent to arching, with peduncle 3 cm long, rachis 6.5 to 13 cm long, bearing 17 to 20 flowers; peduncle and rachis pinkish, very shortly white-tomentose; peduncle-scales 5–6, white, or with margin pink-tinged; floral bracts ovate or ovate-oblong, 8–9 × 3–4 mm, acute, dorsal side pubescent. Pedicel-and-ovary 5–6 mm long, densely white tomentose, ovary slightly wider than pedicel, bluntly 6-ribbed. Flowers non-resupinate, spreading, ca. 1.6 long, ca. 2.0 cm wide, white, with apical abaxial side of sepals purplish-pink, petals white. Dorsal sepal hooded, oblong, 9.5–10.0 × 5.0–5.5 mm, apex obtuse, 5-veined, abaxially appressed pubescent. Lateral sepals obliquely triangular, 10–11 × 10–11 mm, free part 8.5–9.5 × 7–8 mm, 5-veined, sometimes with additional smaller veins, apex obtuse; abaxially with a strong keel and pubescent, adaxially glabrous. Petals narrow-



FIGURE 1. *Bryobium scutatatum* showing a plant in the wild (A) and flowers (B). Photographs by Wendy A. Mustaqim.

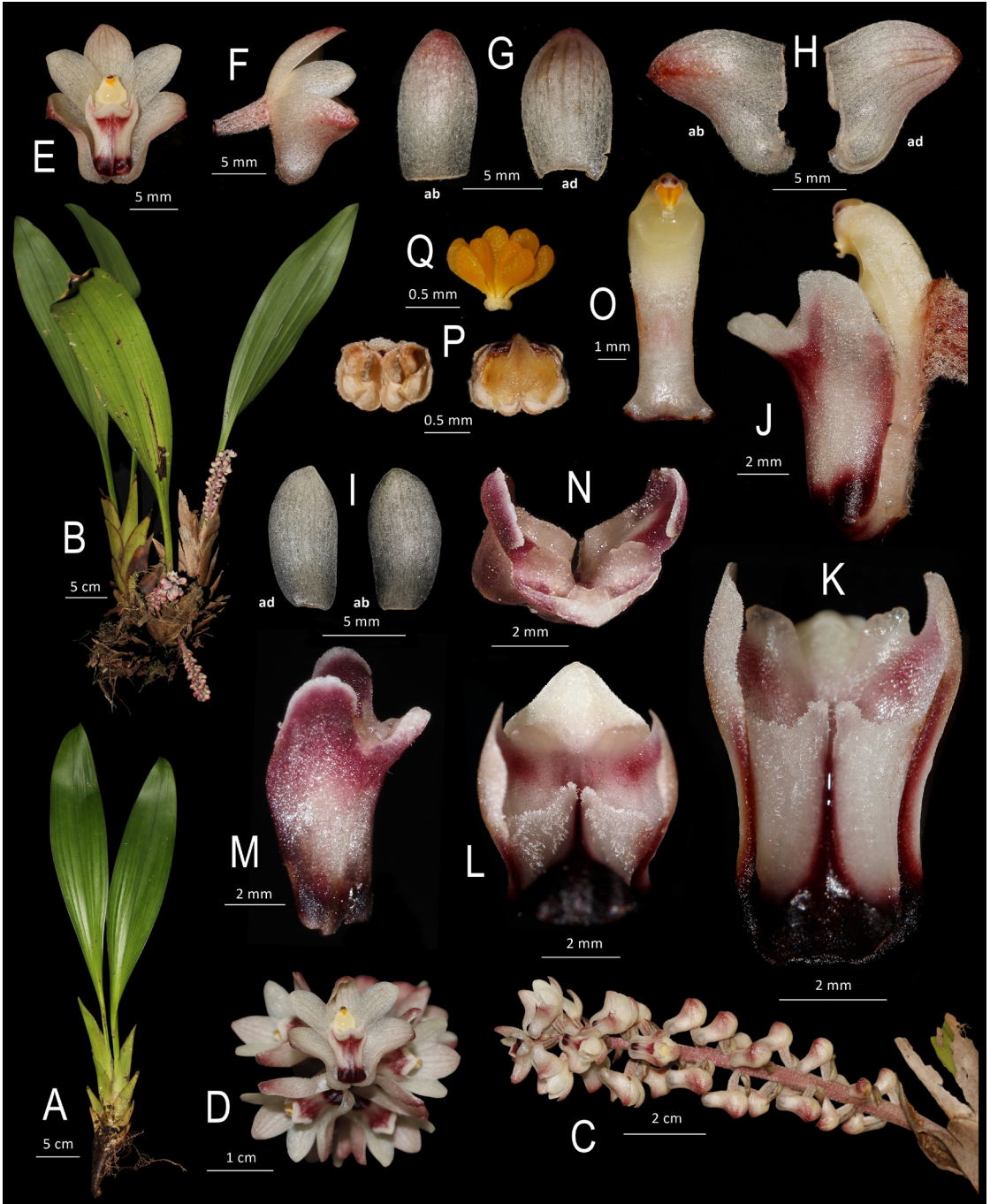


FIGURE 2. Morphology of *Bryobium scutatum*. **A**. Sterile stem. **B**. Plant in flower. **C**. Inflorescence. **D**. Flowers. **E**. Flower, front view. **F**. Flower, lateral view. **G**. Dorsal sepals, abaxial and adaxial views. **H**. Lateral sepals, abaxial and adaxial views. **I**. Petals, adaxial and abaxial views. **J**. Column and lip, lateral view. **K**. Lip, adaxial view. **L**. Lip, adaxial view. **M**. Lip, lateral view. **N**. Lip, front view. **O**. Column and column-foot, ventral view. **P**. Anther cap, ventral views without and with the pollinarium. **Q**. Pollinia. Photographs after *Mustaqim et al.* 4045 by Wendy A. Mustaqim (A–L and O–P) and after *cult. J. Champion s.n.* by Jeffrey Champion (M–N).

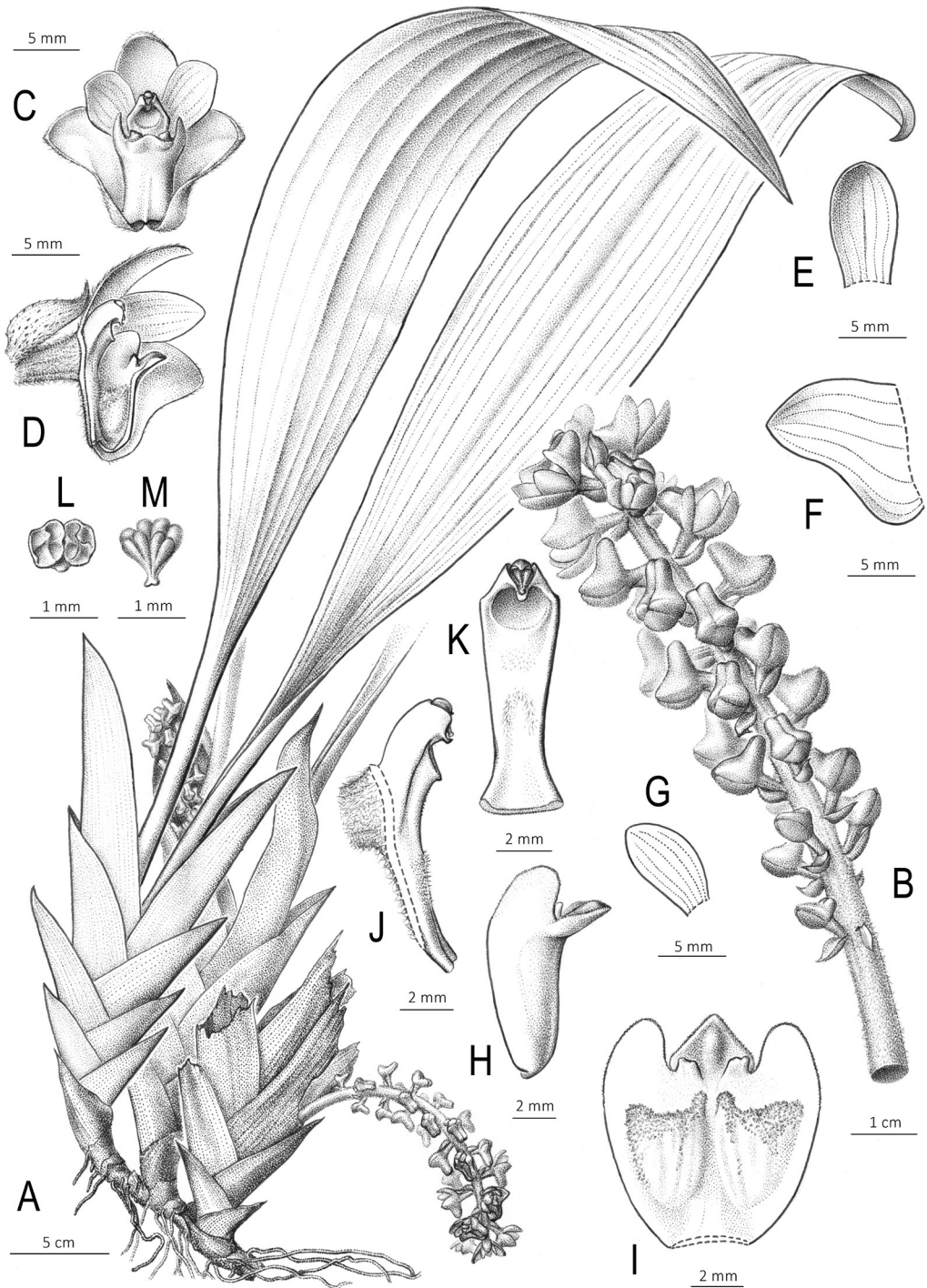


FIGURE 3. Morphology of *Bryobium scutatatum*. A. Plant. B. Inflorescence. C. Flower, front view. D. Flower, lateral view with lateral sepal and petal removed on one side. E. Dorsal sepal. F. Lateral sepal. G. Petal. H. Lip, lateral view in natural position. I. Lip, flattened. J. Column and column-foot, lateral view. K. Column and column-foot, ventral view. L. Anther cap. M. Pollinia. Drawing by Yuanito Eliazar after *Mustaqim et al.* 4045.

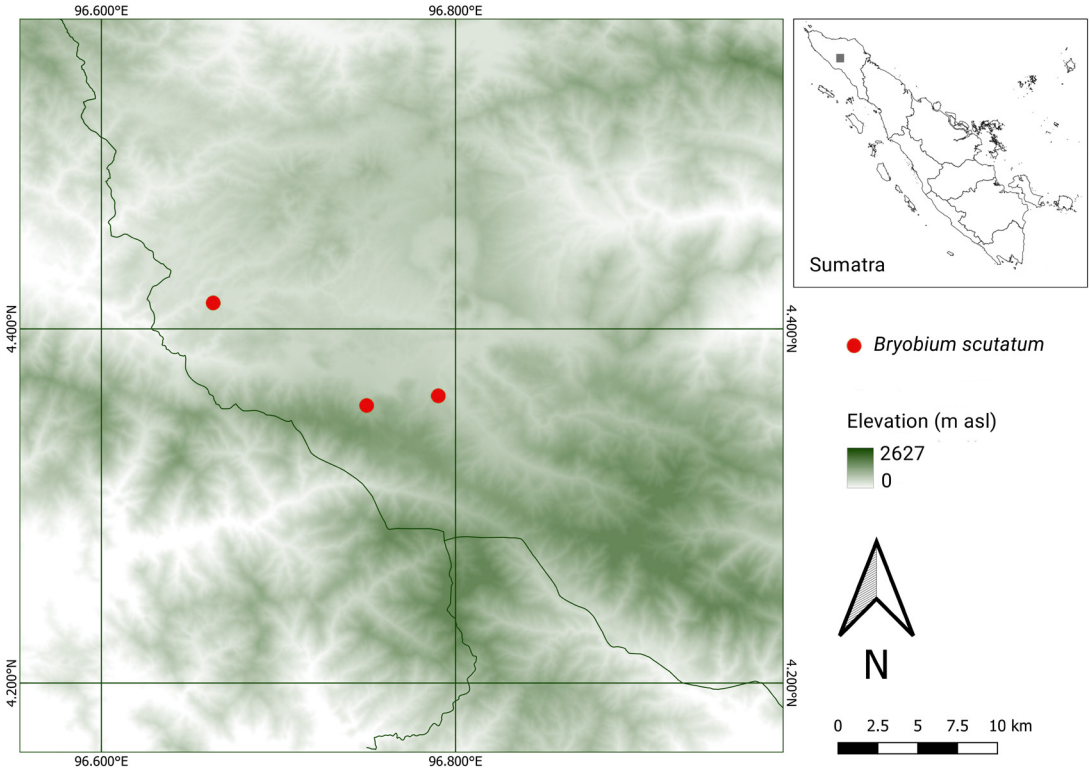


FIGURE 4. Geographic distribution of *Bryobium scutatum*. Map created by Wendy A. Mustaqim using QGIS (2026).

ly obovate, $9.0\text{--}9.5 \times 4.0\text{--}4.5$ mm, slightly falcate, slightly convex, apex obtuse, 3-veined, glabrous. *Lip* firmly attached to the column-foot, $8\text{--}9 \times 5.0\text{--}5.5$ mm, about the same length and *ca.* 8 mm wide when spread, more or less flabellate in outline, 3-lobed, when flattened 8.5×8 mm; lateral lobes erect, when flattened porrect, $2.2\text{--}2.5 \times 2.0\text{--}2.5$ mm, oblong, slightly falcate, apex rounded; epichile between the lateral lobes with two flat, obliquely trapezoid, papillose, shield-like calli separated by a deep groove and extending from a little above the base of the lip to a little below the base of the mid-lobe, the calli obliquely truncate at apex with their longest side along the groove; mid-lobe broadly triangular, $2.5\text{--}3.0 \times 3.8\text{--}4.0$ mm, obtuse, decurved, finely papillose, with a median, longitudinal, oblong callus along most of its length, at the base with two transverse, smooth, slightly bilobed calli that are not decurrent on the mid-lobe. *Column* straight, slightly curved at apical part, $3.5 \times 2.8\text{--}3.0$ mm, dorsally without keel, without steli-

ia; stigma transversely broadly elliptic, with protruding lower margin; column-foot straight, $6.0\text{--}6.5$ mm long. *Anther* transversely oblong, 0.6×1.0 mm; pollinia 8, orange, pyriform, in two clusters; caudicles and viscidium very small.

DISTRIBUTION: Endemic to Sumatra; only known from the northern Gayo Plateau (Fig. 4).

ADDITIONAL SPECIMENS EXAMINED: Sumatra, Aceh, Aceh Tengah, Linge, Wih Keruh ($4^{\circ}21'43.0''\text{N}$ $96^{\circ}47'58.0''\text{E}$), 1520 m, 13 Oct 2025, *W.A. Mustaqim et al.* 4046 (FIPIA, UIDEP, paratype of *B. scutatum*); ibid. Aceh Tengah, no detailed locality, cultivated at Bedugul, Bali, *J. Champion s.n.* (UIDEP, paratype of *B. scutatum*); Java, Mt. Salak, Blume [249], (L, L0059858, holotype of *B. bicristatum* (Blume) Schuit., Y.P.Ng & H.A.Pedersen); Java, Mt. Salak, *Blume s.n.* (L, L0059876, holotype of *B. hyacinthoides* (Blume) Y.P.Ng & P.J.Cribb); without locality, 1907, *Bogor cult.* 152 (L L0059908, probable isosyntype of *B. punctatum*

(J.J.Sm.) Schuit., Y.P.Ng & H.A.Pedersen); Sumatra, Ophir District, Talu [Taloe], *Groeneveldt cult.* 387 (L0059899, syntype of *B. rubiferum* (J.J.Sm.) Schuit., Y.P.Ng & H.A.Pedersen). Photographic records: Aceh, Aceh Tengah, Pegasing, Berawang Baro (4°24'52.8"N 96°39'47.3"E), 1425 m, captured on 29 Sep 2025 by W.A. Mustaqim (see image 1 and image 2, not coll.).

HABITAT AND ECOLOGY: In montane forest on gravel, also in montane riverine as well as bog forest, usually growing on the lower part of tree trunks in light shaded to rather exposed positions. Elevation 1425 to 1850 m.

PHENOLOGY: Flowering observed in September and October in the wild, in cultivation at Bedugul (Bali) in February. Fruiting period unknown.

ETYMOLOGY: From the Latin *scutatus*, 'carrying a shield', referring to the shield-like calli on the lip.

IUCN RED LIST CONSERVATION STATUS: This species is known from three locations in northern Gayo Plateau with an EOO of 20.67 km² reaching a Critically

Endangered (CR) threshold and an AOO of 12.00 km² falling within the Endangered (EN) threshold. The total number of plants seen is less than 10 spread across three populations. Two populations are sited in small and isolated forest fragments, which are highly threatened by future clearing due to forest conversion to agricultural land, i.e., coffee plantations, and by associated activities such as road building. Based on multiple years of exploration by WAM and colleagues in northern Gayo Plateau, this species appears to be rare. Therefore, *Bryobium scutatum* is assessed here as Critically Endangered according to IUCN criteria (CR B2ab(iii, iv)).

NOTES: *Bryobium scutatum* is the fifth member of the genus in Sumatra. Although *B. pullum* from Sulawesi is superficially similar, the nearest relative appears to be the well-known *B. hyacinthoides* from Peninsular Malaysia, Sumatra, Java, Borneo and Bali, at elevations between 1100 and 1700 m. The latter is the most similar in the number and configuration of the callosities on the lip. The differences between the species mentioned are listed in the diagnosis.

KEY TO *BRYOBIUM* IN SUMATRA

- 1a. Pseudobulbs 1-leaved; flowers spotted, resupinate..... *B. punctatum*
- 1b. Pseudobulbs 2–3-leaved; flowers not spotted, not resupinate..... 2
 - 2a. Leaves less than 2 cm wide; inflorescence less than 2 cm long; dorsal sepal less than 4 mm long; flowers uniformly dark reddish..... *B. rubiferum*
 - 2b. Leaves more than 2 cm wide; inflorescence more than 5 cm long; dorsal sepal more than 6 mm long; flowers for the most part whitish..... 3
 - 3a. Dorsal sepal *ca.* 7 mm long; lip calli consisting of two ridges..... *B. bicristatum*
 - 3b. Dorsal sepal 9–13 mm long; lip with 5 separate calli (2 on hypochile, 3 on epichile)..... 4
 - 4a. Lip whitish at base; the two calli on hypochile raised, ridge-like *B. hyacinthoides*
 - 4b. Lip dark reddish maroon at base; the two calli on hypochile shield-like, separated by a groove..... *B. scutatum*

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AUTHOR CONTRIBUTIONS. WAM and AS wrote the text, WAM created the distribution map and provided photographs, JC provided cultivated material and photographs, and commented on the manuscript.

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CONFLICT OF INTEREST: No conflicts of interest declared.

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***CATASETUM* × *GUARAYENSE* (ORCHIDACEAE: CATASETINAE), FIRST FORMALLY DESCRIBED AND DOCUMENTED NATURAL HYBRID OF THE GENUS FOR BOLIVIA**

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ABSTRACT. *Catasetum* × *guarayense* is described and illustrated as the first natural hybrid of *Catasetum* reported from Bolivia. The material was collected in the municipality of El Puente, Guarayos province, Santa Cruz department, in the central eastern region of the country. In addition, data on its geographical distribution, habitat, and phenology are provided. The available evidence suggests that the hybrid results from the natural crossing between *C. rooseveltianum* and *C. semicirculatum*, species occurring within the limits of the Bolivian territory. As expected for any natural hybrid, compared to its probable parents, *C. × guarayense* presents a set of intermediate morphological characters, a point discussed in detail in this study. Besides, we propose an identification key to the Bolivian *Catasetum* species with symmetrical and parallel antennae.

RESUMEN. *Catasetum* × *guarayense* se describe e ilustra como el primer híbrido natural de *Catasetum* registrado en Bolivia. El material fue recolectado en el municipio de El Puente, provincia de Guarayos, departamento de Santa Cruz, en la región centro-oriental del país. Además, se proporcionan datos sobre su distribución geográfica, su hábitat y su fenología. La evidencia disponible sugiere que el híbrido resulta del cruzamiento natural entre *C. rooseveltianum* y *C. semicirculatum*, especies que se encuentran dentro de los límites del territorio boliviano. Como es esperable en cualquier híbrido natural, en comparación con sus probables parentales, *C. × guarayense* presenta un conjunto de caracteres morfológicos intermedios, aspecto que se discute en detalle en este estudio. Además, se propone una clave de identificación para las especies bolivianas de *Catasetum* con antenas simétricas y paralelas.

KEYWORDS / PALABRAS CLAVE: Bolivia oriental, Bosque Seco Chiquitano, Chiquitano Dry Forest, Cymbidieae, Eastern Bolivia, hibridación, hybridization, Neotrópico, Neotropics, taxonomía, taxonomy

Introduction. According to the biological species concept, a species can be defined as a group of individuals capable of interbreeding and that, under natural conditions, remain reproductively isolated

from other similar groups (Mallet, 2001). However, under certain circumstances, populations of distinct species may come into contact and, when reproductive barriers are partially or temporarily overcome,

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natural hybridization may occur. Therefore, a “natural hybrid” refers to an organism resulting from spontaneous crossing between two distinct species in the wild, without human intervention. Its recognition may be supported by a combination of morphological and genetic evidence, together with similarities or intermediate patterns in ecology, habitat, phenology, and floral fragrance between the hybrid and its putative parents (Wang, 2017). This is therefore based on the premise that these plants present, especially in their phenotypic traits, a set of intermediate characters compared to their putative parents (*e.g.*, Cantuária *et al.*, 2021; Krahling *et al.*, 2020; Pansarín, 2025). We may add that this process can occur between congeneric species (*e.g.*, Barrera-Rojas & van den Berg, 2025; Krahling *et al.*, 2021; Menezes & Viotti, 2024; Vieira *et al.*, 2024) and, though more rarely, between non-congeneric species (*e.g.*, Braga, 1978; Cetzal-Ix *et al.*, 2012; Engels & Canestraro, 2017; Engels *et al.*, 2025; Pupulin *et al.*, 2025; Ramos-Roldán *et al.*, 2025; Salueda & Arrondeau, 2020).

Hybridization, when it is enabled by the natural breakdown of reproductive barriers, plays a significant role in the evolution and diversification of various plant lineages, promoting the emergence and selection of new taxa (Arnold, 2006). Within Orchidaceae, there are many pre- and post-zygotic barriers whose main role is to prevent hybridization events (Melo *et al.*, 2011; Smidt *et al.*, 2006; van der Pijl & Dodson, 1966). However, when these barriers are weak or overcome, hybridization can occur naturally — a phenomenon widely documented in the family (*e.g.*, Barrera-Rojas & van den Berg, 2025; Braga, 1978; Cetzal-Ix *et al.*, 2012; Christenson, 2006; Krahling *et al.*, 2021; Menezes & Viotti, 2024; Mó *et al.*, 2014; Pansarín, 2025; Pupulin *et al.*, 2025; Ramos-Roldán *et al.*, 2025; Salueda & Arrondeau, 2020; Silva *et al.*, 2024; Vieira *et al.*, 2024) and especially in the genus *Catasetum* Rich. ex Kunth (*e.g.*, Krahling *et al.*, 2020; 2023a; 2024a,b; 2025a,b,c; Pabst, 1975; Petini-Benelli, 2014; 2016; Romero & Carnevali, 1989; 1991; Romero & Jenny, 1992; 1993; Romero-González & Carnevali, 2024).

Hitherto, the genus comprises 193 species and 47 hybrids described and accepted (Krahling *et al.*, 2023a,b,c,d; 2024a,b,c,d; 2025a,b,c,d,e; POWO,

2025; Romero-González & Carnevali, 2024). They are distributed from Mexico to southern Brazil and northern Argentina (Romero-González & Carnevali, 2009). The species are characterized by fusiform, elliptical, ovate, or conical pseudobulbs; leaf sheaths covering the entire pseudobulb; deciduous and plicate leaves, usually elliptical or oblanceolate; and lateral, racemose inflorescences bearing unisexual (pistillate or staminate), rarely hermaphrodite flowers (sterile). Only the staminate flowers exhibit sufficient morphological variation to distinguish among species. Furthermore, the presence of structures called “antennae” on the staminate flowers contributes to the traditional infrageneric subdivision of the genus into two subgenera, two sections, and three subsections (Bicalho & Barros, 1988; Senghas, 1990; 1991).

However, recent phylogenetic results (Mauad *et al.*, 2022) indicate that this traditional classification, which relies mainly on antenna morphology, does not faithfully reflect the evolutionary history of *Catasetum*, because similar antenna structures have evolved independently in different lineages, resulting in morphological convergence and homoplasy. Nevertheless, these morphological groupings remain useful for conveniently describing and identifying species based on shared characters. In contrast, biogeographical patterns appear to provide a more robust framework for interpreting relationships within the genus, with clades broadly associated with major geographical regions, including the Amazon, Guiana Shield, Atlantic Forest, and both eastern and western slopes of the Andes. For example, the *C. naso* Lindl., *C. lucis* P. Ortiz & Arango and *C. planiceps* Lindl. group is associated with the eastern Andean slopes, whereas other lineages, such as those including *C. expansum* Rchb.f. and *C. macroglossum* Rchb.f., occur on the western slopes. These patterns suggest that historical processes of dispersal and vicariance have played a central role in the diversification of *Catasetum*.

Bolivia, the fifth-largest country in South America, houses a remarkable diversity of environments due to its wide range of altitudes and climates. The Bolivian territory is made of different biomes, in-

cluding the Amazon rain forests, the savannas of the Chiquitania, the Andean Altiplano, the Gran Chaco, represented by dry forests, and the Pantanal, represented by extensive wetlands, as well as the Yungas (humid mountain forests which stretch along the eastern slopes of the Andes and rank among the most biodiverse regions of the country) (Werneck, 2011). Despite this environmental heterogeneity, Bolivia stands out as one of the most under-sampled tropical countries in terms of biodiversity, a fact particularly evident in the family Orchidaceae. Although about 80% of the territory is still without any collections (regarding plants), *ca.* 1500 species, of which about a third is endemic, distributed in 191 genera, are already recorded. Diversity is mainly concentrated in the Yungas and other humid montane forests along the eastern slopes of the Andes, including areas referred to as “ceja de la montaña” and the Andean foothills, which are recognized as major centers of diversity and evolution for Neotropical orchids. These figures highlight the biogeographical significance of the country as well as the urgent need to expand research and conservation efforts (Vásquez *et al.*, 2003). In this context, *Catasetum*, represented in the country by 21 species, accounts for approximately 11% of the 193 currently accepted species in the genus and therefore represents a substantial component of the genus’ diversity in Bolivia. Hitherto, there is no confirmed record of natural hybrids, and the relatively limited number of collections and published records of *Catasetum* from Bolivia suggests that its diversity and occurrence in the country may still be under-sampled, particularly given the extensive areas that remain botanically unexplored (POWO, 2025; Vásquez & Dodson, 1982, 1989a,b; Vásquez *et al.*, 2003, 2014).

This work aims to describe and record the first natural hybrid of *Catasetum* for the Bolivian flora. We provide a detailed description of the taxon, along with data on its geographical distribution, habitat, and phenology. We also discuss the pollinator sharing and the phenological overlap of its probable parents. In addition, we compare the new taxon morphologically with its supposed parents and propose an identification key to the species and hybrids of *Catasetum* with symmetrical and parallel antennae occurring in Bolivia.

Materials and methods. The putative nothospecies proposed here was collected by C. A. S. Miranda-Zapata and L. A. Mercado-Menacho during an occasional expedition in the municipality of El Puente, province of Guarayos, department of Santa Cruz, central-eastern region of Bolivia. The material, first sterile, was kept in cultivation until its blooming and then herborized according to the standardized procedures of Mori *et al.* (1989) to be included in the collections of the INPA and HUAM herbaria (acronyms according to Thiers, 2025). The description and photographic illustrations of the taxon are based on living material from the type specimen. The morphological characterization follows the terminology of Dressler (1993), Harris & Harris (2001), and Gonçalves & Lorenzi (2007). Observations regarding the habitat were recorded *in situ*, and the flowering period was recorded during the cultivation of the specimen. The distribution map was built with the software QGIS 3.40.11 “Bratislava” (QGIS, 2025), and the identification key was prepared based on the data found in Vásquez & Dodson (1982, 1989a,b), Vásquez *et al.* (2003; 2014), POWO (2025) and on actual specimens deposited in the AMES, BOLV, BHZB, F, FLAS, L, LPB, MO, NY, SP, UFMT, US and USZ herbaria (acronyms according to Thiers, 2025). The specific epithet follows the International Code of Nomenclature for algae, fungi and plants (ICN) (Turland *et al.*, 2025).

The new putative nothospecies was compared to its putative parental species through the analysis of the original protologues (Hoehne, 1916; Miranda, 1986), of the type material of *C. semicirculatum* F.E.L.Miranda (RB00542573!), as well as the specialized literature (*e.g.*, Hoehne, 1942; Krahl *et al.*, 2025f; Petini-Benelli, 2025; Vásquez & Dodson, 1989b (pl. 309)). Notably, for *C. rooseveltianum* Hoehne, no physical type material is known (see Krahl *et al.*, 2025f; Romero & Jenny, 1993), and Krahl *et al.* (2025f) designated a lectotype (the original illustration). Aiming to locate possible additional materials related to the hybrid here described, we referred to the data banks SpeciesLink (Canhos *et al.*, 2022) and GBIF (2025) as well as the collections of the main Bolivian herbaria (BOLV, LPB and USZ).

TAXONOMIC TREATMENT

Catasetum × **guarayense** C.A.S.Miranda-Zapata, L.A.Mercado-Menacho, Chiron & Krah, **nothosp. nov.** Fig. 1.

TYPE: BOLIVIA. Santa Cruz: Guarayos, El Puente, 16°07'30" S; 62°53'11" W, fl. ♂, 2 February 2023, C.A.S.Miranda-Zapata & L.A.Mercado-Menacho sub A.H. Krah 1681 (holotype: INPA306828; isotype: HUAM12810).

DIAGNOSIS: *Hybrida naturalis cum characteribus intermediis inter suos probabiles parentes, C. rooseveltianum et C. semicirculatum. Planta cum characteribus vegetabilibus majori parti specierum congenericarum similibus. Inflorescentia erecta-arcuata cum 10–13 floribus non resupinatis (ut in C. rooseveltianum), luteolis vel leviter virellis cum maculis transversalibus brunneolis. Sepala oblonga-elliptica et petala elliptica (ut in C. semicirculatum). Labellum integrum, ovatum, cum margine irregulariter denticulato, callum basalem (ut in C. semicirculatum) callumque apicalem ferens. Callus basalis transversaliter lunatus utrinque elevatus cum depressione centrali parva parvo apiculo instructa. Callus apicalis deltatus-triangularis obtusus.*

Plant epiphytic, caespitose. *Rhizome* short and inconspicuous. *Pseudobulb* 6.9–12.1 × 1.4–3.1 cm, fusiform, erect, 9–11-leaved, covered by the leaf sheaths. *Leaves* 11.9–31.1 × 2.6–3.7 cm, narrowly elliptical, plicate, 5–7-nerved, margin entire, apex acute. *Staminate inflorescence* 29.6–32.1 cm long, basal/lateral, erect to sub-erect, racemose, 10–13-flowered; peduncle cylindrical, greenish; *floral bract* ca. 0.8 × 0.4 cm, lanceolate, yellowish green, margin entire, apex acute. *Staminate flowers* yellowish and slightly greenish with transverse brownish spots, grouped together on the two distal thirds, non-resupinate, pedicelled; *pedicel* ca. 2.9 cm long, cylindrical, erect to sinuate, greenish. *Sepals* ca. 2.6 × 1.1 cm, oblong-elliptical, the dorsal one symmetrical and the lateral ones slightly asymmetrical, concave, margin entire, apex acute. *Petals* ca. 2.4 × 1.2 cm, elliptical, symmetrical, convex, margin entire, apex acute. *Lip* ca. 2.5 × 2.2 cm, entire, ovate, margin irregularly denticulate, concave, with a basal callus and an api-

cal one; *basal callus* ca. 0.5 × 1.1 cm, transverse, half-moon shaped, raised on both sides, and with a small central depression provided with a small apiculus; *apical callus* 0.4 × 0.3 cm, deltoid to triangular, fleshy, obtuse. *Column* ca. 1.8 × 0.7 cm, subtriangular, slightly contracted at base, yellowish green with brownish spots, apex rostrate; *antennae* ca. 0.8 cm long, filiform, symmetrical and parallel, yellowish. *Anther cap* ca. 0.7 × 0.3 cm, subtriangular, greenish yellow with wine-colored spots, apiculate. *Pollinia* 2, ca. 0.3 × 0.1 cm, oblong, hard, compressed, sulcate, yellowish; *stipe* ca. 0.4 × 0.2 cm, laminar, rolled inward, yellowish; *viscidium* ca. 0.2 × 0.2 cm, rounded, sticky, whitish. *Pistillate structures* unknown. *Fruits* unknown.

ETYMOLOGY: The specific epithet “guarayense” refers to the province of Guarayos, department of Santa Cruz (Bolivia), where the new hybrid has been found. The epithet follows the norms established in Article 60, Recommendation 60D of the ICN (Turland *et al.*, 2025).

DISTRIBUTION, HABITAT AND ECOLOGY: To date, *C. × guarayense* is known only from the municipality of El Puente (Fig. 2). It occurs within the limits of the dry forest of Chiquitania (Floresta Seca Chiquitania), one of the largest and best-preserved dry forest formations in South America. It mainly stretches through eastern Bolivia and is characterized by a tropical climate with a pronounced dry season, deciduous to semi-deciduous tree vegetation, high floristic diversity, and a strong presence of endemic species (Pennington *et al.*, 2009; Prado, 2000). This ecoregion also serves as a biogeographical transition zone between the Amazon, the Cerrado, and the Chaco, with a distinct floristic composition and high structural heterogeneity. Thus, it plays an essential role in regional ecological connectivity and in maintaining evolutionary processes associated with seasonal forests (Killeen *et al.*, 2006; Pennington *et al.*, 2009).

The type locality is near the areas of occurrence of *C. rooseveltianum* and *C. semicirculatum*, species considered the probable parents of the nothospecies. *Catasetum rooseveltianum* also occurs in the department of Santa Cruz (Krah *et al.*, 2025f), in the same

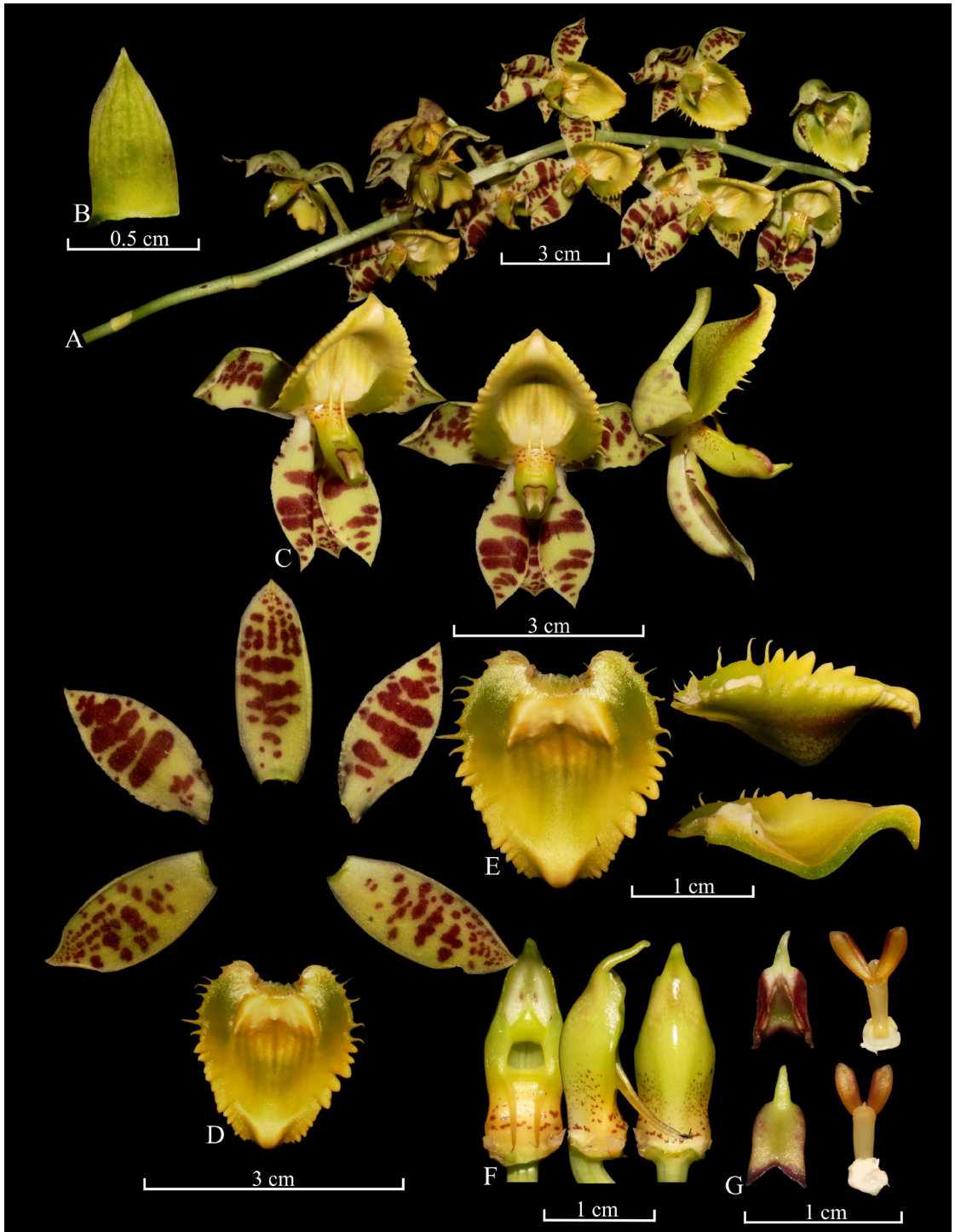


FIGURE 1. *Catasetum* $\times$ *guarayense* (male structures). **A**. Inflorescence. **B**. Floral bract. **C**. Flower in different views. **D**. Dissected perianth. **E**. Lip, front and side views, and longitudinal section. **F**. Column, ventral, lateral and dorsal views. **G**. Anther cap and pollinarium, ventral and dorsal views. Photographs and plate by A.H. Krahl based on the type material (holotype).

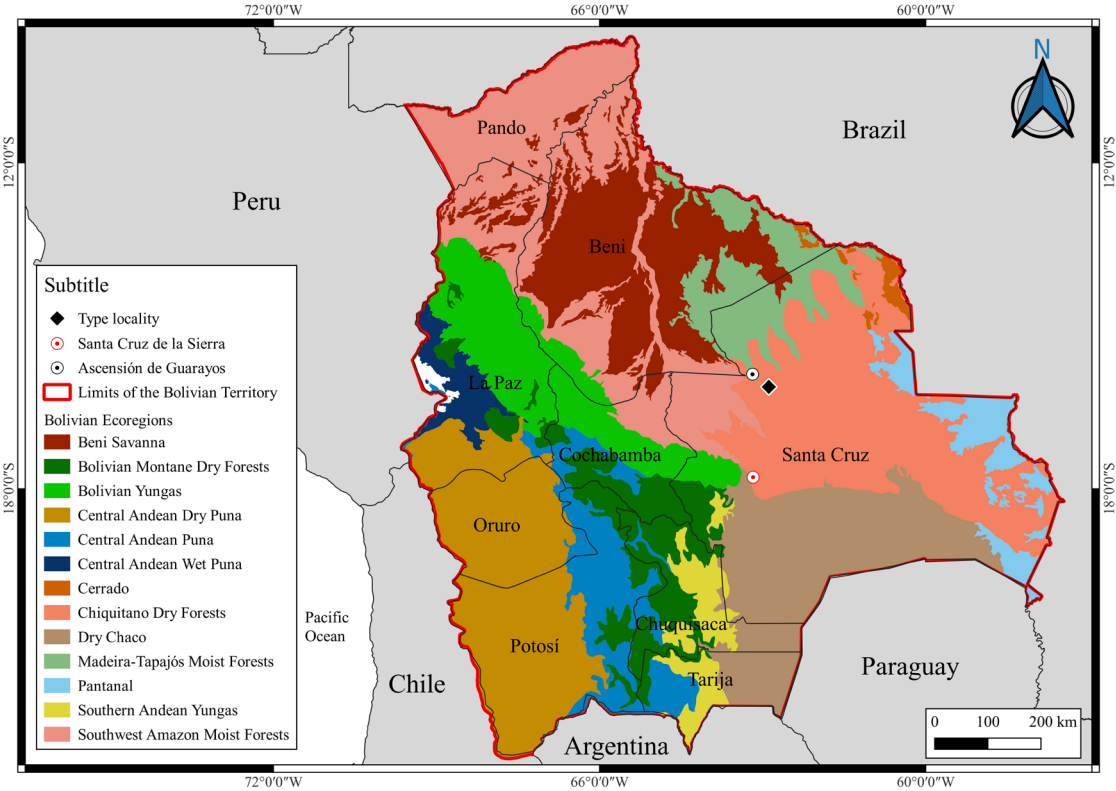


FIGURE 2. Location of the type locality of *C. × guarayense* (black rhombus). Map by A.H. Krah1.

administrative unit where *C. × guarayense* has been observed. As for *C. semicirculatum*, it has a distribution extending from the Brazilian states Acre, Amazonas and Rondônia (Lacerda, 1998; Miranda, 1986; Petini-Benelli, 2025) to the far west of Bolivia, in La Paz department, as evidenced by the material deposited in the herbarium LPB (*J. Jiménez* 5287). Such a geographical proximity suggests favorable conditions for cross-pollination between the two parent species. It should also be noted that the actual distribution of these species, as with a large part of the Bolivian flora, is probably underestimated (Vásquez *et al.*, 2003), which may hide the actual overlap between their areas of occurrence.

PHENOLOGY AND FLORAL VISITORS: The blooming of *C. × guarayense* was observed during the first half of the year, more precisely in February. We also observed an overlap in the blooming periods of the probable parent species, both beginning anthesis in February and extending their blooming period until mid-July

(Hoehne, 1916; Krah1 *et al.*, 2025f; Miranda, 1986). This phenological coincidence supports the possible occurrence of cross-pollination between the two putative parents.

The putative parent species are also visited by the same group of pollinators, mainly Euglossini bees. *Euglossa* species visit *C. semicirculatum* (Milet-Pinheiro & Gerlach, 2017), as reported for *C. roosevelitianum* by Krah1 *et al.* (2025f). This shared pollinator assemblage further supports the possibility of natural hybridization between the two species.

CONSERVATION STATUS: The IUCN (2024) does not recommend assessing the extinction risk for hybrids because such forms do not represent evolutionarily independent lineages and, consequently, do not meet the criteria for species categorization on the Red List. Natural hybrids often have a recent origin, and their populations may be small and ephemeral, making demographic assessments challenging. However, they may arise repeatedly

whenever the parental species occur in sympatry and pollinators occasionally visit flowers of both species, resulting in recurrent hybrid formation. Moreover, their inclusion may distort conservation priorities by diverting efforts away from the really threatened species. Thus, under IUCN directives, hybrids should not be formally assessed unless there is strong evidence of population stability and widely accepted taxonomic recognition.

MORPHOLOGICAL AFFINITIES: The discovery of *C. × guarayense* provides further evidence that hybridization may contribute to the evolutionary diversification of *Catasetum* (Mauad *et al.*, 2022). This interpretation is supported by previous molecular studies, such as Oliveira *et al.* (2010), which revealed substantial inter- and intraspecific genetic similarity among several *Catasetum* species based on RAPD markers. The authors also found high genetic similarity between some morphologically distinct species, indicating that morphological differentiation does not always correspond to genetic divergence. These findings, together with the occurrence of natural hybrids, suggest that reproductive barriers among some *Catasetum* species may be permeable, although direct evidence of gene flow or introgression is still needed to test this hypothesis. Therefore, the geographical and phenological overlap of the parent species in Guarayos, combined with the sharing of the same group of pollinators, creates an ecological scenario favorable to the emergence of natural hybrids. Thus, the identification of *C. × guarayense* not only documents a specific hybridization event but also comes within a wider evolutionary context in which the reproductive permeability between sympatric species has the potential to generate new arrangements of phenotypic characters, increase genetic variability within the concerned populations and, perhaps, alter the course of evolutionary diversification within the genus *Catasetum*. Finally, describing *C. × guarayense* contributes to documenting natural diversity beyond the recording of “pure” species, especially in Bolivia. Therefore, each new record — including natural hybrids — plays a crucial role in expanding the country’s floristic knowledge, improving the understanding of the true diversity within regions still little explored. Moreover, in a situation where most of Bolivia’s territory lacks taxo-

nomic inventories, such records contribute to a more robust database for future taxonomic, biogeographic, and conservation studies, strengthening initiatives to monitor and protect biodiversity.

As noted, *C. × guarayense* presents floral characters clearly intermediate between those observed in its putative parents (Table 1, Fig. 3), supporting its interpretation as a natural hybrid. As usually observed in most *Catasetum* species (Holst, 1999), the new hybrid proposed here does not present diagnostic vegetative characters: it shares the typical vegetative morphology of its probable parents and most other members of the genus. This vegetative homogeneity, widely documented in *Catasetum*, highlights the importance of the floral traits as the main source of taxonomic differentiation and, consequently, the role of reproductive structures for identifying hybrids within the group.

The inflorescence of *C. × guarayense* is erect to sub-erect, with non-resupinate flowers, a character that makes it more similar to *C. rooseveltianum*. In contrast, *C. semicirculatum* has an arched inflorescence with resupinate flowers. The color pattern of the hybrid also reflects the parental combination: the flowers strongly show a yellowish-green hue, as in *C. rooseveltianum*, a species whose flowers are predominantly yellowish and slightly greenish, with occasional subtle brownish streaks inside the lip. However, the hybrid also presents well-defined transverse brownish spots clearly inherited from *C. semicirculatum*, whose flowers are typically whitish to greenish with transverse spots.

Sepals and petals of *C. × guarayense* present a predominantly elliptical shape similar to that observed in *C. semicirculatum*, although slightly broader (see Fig. 3B, 3J, Table 1). The lip, resulting from the combination of the parent characters, is entire — a trait shared by both parent species presumably concerned — and shows an ovate shape, intermediate between the cymbiform lip ovate in outline typical of *C. rooseveltianum* and the sub-ovate lip of *C. semicirculatum*. The lip margin also gives evidence of a hybrid heritage: in *C. × guarayense*, it is irregularly denticulate, reflecting the influence of *C. semicirculatum*, which presents a usually fimbriate and irregular margin, whereas in *C. rooseveltianum* it is entire, smooth and thickened.

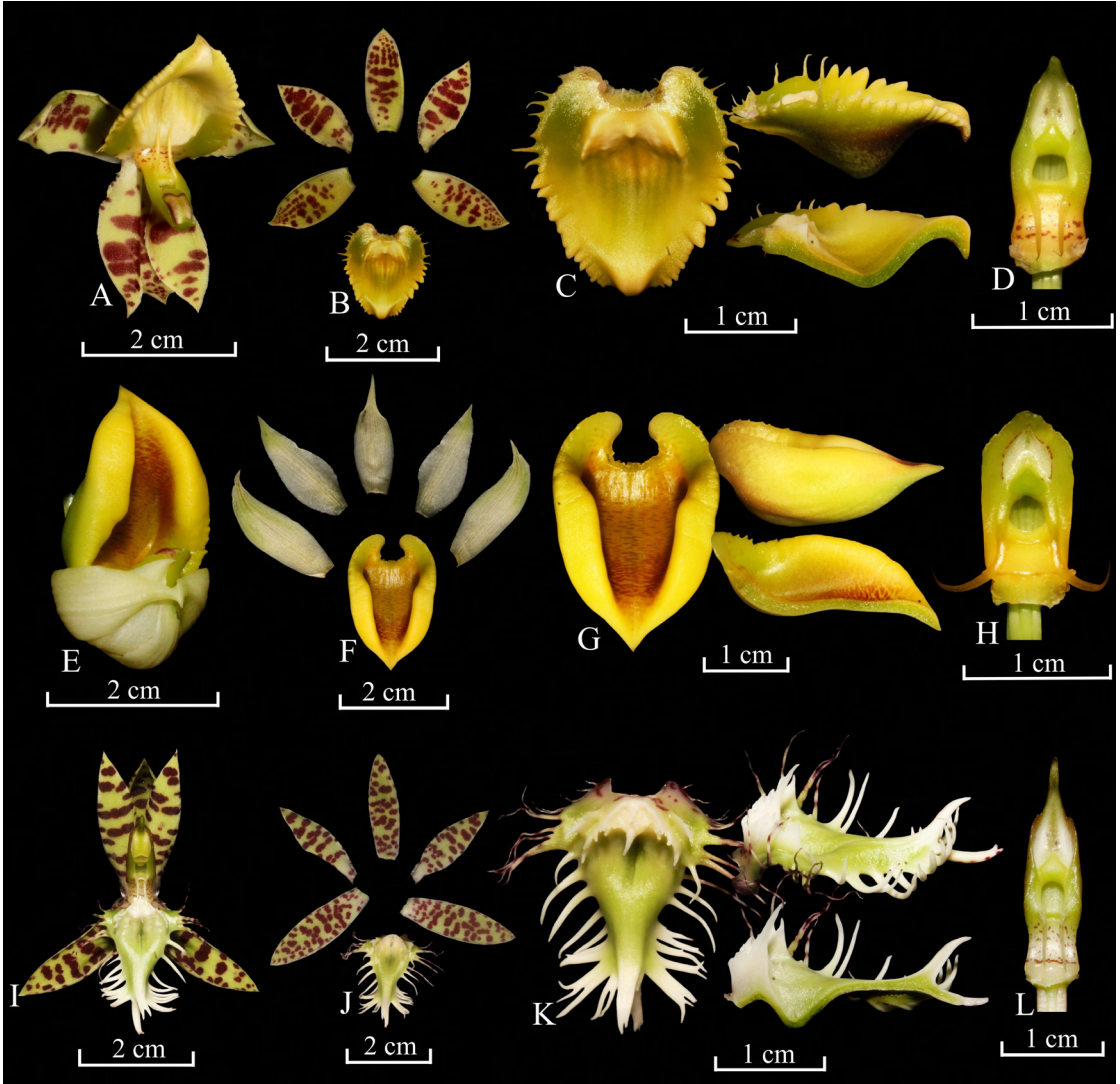


FIGURE 3. Comparative illustration between *C. × guarayense* and its probable parents. A–D. *C. × guarayense*. E–H. *C. rooseveltianum*. I–L. *C. semicirculatum*. A, E, I. Flower. B, F, J. Dissected perianth. C, G, K. Lip, front and side views, and longitudinal section. D, H, L. Column, ventral view. Photographs and plate by A.H. Krahll based on type material (A–D, INPA), samples collected in southern Amazonas, Brazil (E–H, INPA), and cultivated material from Rondônia, Brazil (I–L, not deposited).

As a heritage coming exclusively from *C. semicirculatum* — a species presenting well-developed callosities contrasting with the full absence of such structures on the lip of *C. rooseveltianum* — we observe in *C. × guarayense* the presence of a basal callus and an apical one. The basal callus is significantly modified compared to the parental state, appearing diluted in a crescent-shaped transverse structure that

is laterally elevated and has a discreet central depression housing a small apicule. In *C. semicirculatum*, the basal callus consists of a central acute protuberance from which three or four semicircular rows of small denticles radiate laterally. The apical callus of the hybrid appears as a deltoid to triangular protuberance, apically obtuse and little raised, contrasting with the apical callus of *C. semicirculatum* that is typ-

TABLE 1. Comparison between *C. × guarayense*, *C. rooseveltianum* and *C. semicirculatum*, based on the taxonomic concepts of ⁽¹⁾this study, ⁽²⁾Hoehne (1916), ⁽³⁾Hoehne (1942), ⁽⁴⁾Miranda (1986), ⁽⁵⁾Vásquez & Dodson (1989b; pl. 309), ⁽⁶⁾Krahl *et al.* (2025f), ⁽⁷⁾Petini-Benelli (2025).

Characters	<i>C. × guarayense</i> ¹	<i>C. rooseveltianum</i> ^{2,3,5,6,7}	<i>C. semicirculatum</i> ^{4,7}
Staminate inflorescence	29.6–32.1 cm long, erect to suberect, 10–13-flowered	20–40 cm long, erect to hanging with the flower weight, 5–8-flowered	15–30 cm long, arched, up to 15-flowered
Staminate flowers	Yellowish and slightly greenish with transverse brownish spots, non-resupinate.	Uniformly yellowish and slightly greenish, possibly with slight brownish streaks inside the lip; non-resupinate.	Whitish to greenish with transverse brownish spots, resupinate.
Sepals	ca. 2.6 × 1.1 cm, oblong-elliptical, acute apex	1.8–2.8 × 0.8–1.4 cm, elliptical to oblong-elliptical, acute apex	2.8–3.0 × 0.7–0.9 cm, oblong-elliptical, acute apex
Petals	ca. 2.4 × 1.2 cm, elliptical, acute apex	1.8–2.5 × 0.9–1.4 cm, ovate to elliptical, apex acute	2.8–3.0 × 0.7–0.8 cm, narrowly elliptical to oblong-lanceolate, acute apex
Lip	ca. 2.5 × 2.2 cm, entire, ovate, irregularly denticulate margin	2.5–3.0 × 1.5–2.0 cm, entire, cymbiform, ovate in outline, margin entire and thickened	2.2–2.5 × 1.9–2.2 cm, entire, sub-ovate, margin irregularly toothed to fimbriate (usually fimbriate)
Basal callus of the lip	transverse, half-moon shaped, raised on both sides, and with a small central depression provided with a small apiculus	Absent	Made of a central acute protuberance from which 3–4 semicircular rows of small denticles laterally start
Apical callus of the lip	Deltoid to triangular, obtuse	Absent	Claw-shaped to tooth-like, acute or irregularly apiculate
Antennae	Symmetrical and parallel	Symmetrical and divergent	Symmetrical and parallel

ically claw-shaped or tooth-shaped, with an acute or irregularly apiculate apex.

Finally, *C. × guarayense* also represents the probable result of a cross between species traditionally placed in distinct subsections within the subgenus *Catasetum*. *Catasetum semicirculatum*, characterized by symmetrical and parallel antennae, is placed in the section *Isoceras*, subsection *Isoceras*, whereas *C. rooseveltianum*, which shows antennae also symmetrical but divaricate, belongs to the subsection *Divaricatae* of the same section (Bicalho & Barros, 1988; Senghas, 1991). In the hybrid, the antenna morphology unequivocally corresponds to the model observed in *C. semicirculatum*, i.e., symmetrical parallel structures. Therefore, under the traditional morphology-based infrageneric classification, *C. × guarayense* can be provisionally associated with subgenus *Catasetum*,

section *Isoceras*, subsection *Isoceras*, as is *C. semicirculatum*, one of its probable progenitors. This placement is based solely on shared morphological characters and should not be interpreted as evidence of a corresponding phylogenetic position, given that the traditional infrageneric classification does not fully reflect the evolutionary relationships within the genus.

Catasetum × guarayense is the first natural hybrid described and documented for Bolivia, among 47 hybrids accepted for the genus, most of which occur exclusively in Brazilian territory (Krahl *et al.*, 2020; 2023a; 2025a,b,c,d). However, we consider it unlikely that this is an isolated case in the country, as at least two additional Bolivian species have morphology suggesting a hybrid origin. The first is *C. ricii* R.Vásquez & Dodson, known only from type material native to the province of Velasco, department

of Santa Cruz (Vásquez & Dodson, 1997). It shows floral characters — especially transverse brownish spots on the lip and denticulate margin of the lateral lobes — compatible with a primary hybrid or with an introgression pattern, involving *C. fuchsii* Dodson & R.Vásquez and some taxon belonging to the species complex of *C. barbatum* (for example *C. barbatum* or *C. semicirculatum*, both reported from Bolivia according to POWO, 2025; Vásquez & Dodson, 1982; Vásquez *et al.*, 2003, 2014).

Another potentially hybrid species is *C. kempfi* Dodson & R.Vásquez, described for the central and eastern Bolivian regions (Cochabamba and Santa Cruz) (Vásquez & Dodson, 1989b, pl. 308). Based on the flower resupination, the lip shape, the antenna morphology, and the apparently rare occurrence

of the species, we may raise the hypothesis that *C. kempfi* can be the result of crossing between two other Bolivian taxa only known from the type materials — *C. justinianum* R.Vásquez & Dodson (Vásquez & Dodson, 1997) and *C. longiantennatum* R.Vásquez & G.A.Romero (Vásquez & Romero-González, 2009). However, these hypotheses remain preliminary as their validation will require additional integrated analyses in the future, including a critical reexamination of the type materials and protologues, analysis of the geographical and phenological overlap, verification of the sharing of flower visitors, more detailed comparative morphological evaluation and even the use of *in vitro* germination to examine the result of the manual crossing between the supposed parent species involved (*e.g.*, Krahel *et al.*, 2024a).

KEY TO THE *CATASETUM* SPECIES
WITH SYMMETRICAL AND PARALLEL ANTENNAE OCCURRING IN BOLIVIA

1. Flowers non-resupinate.....	2
2. Greenish flowers with a subglobose lip with a minutely denticulate margin.....	<i>C. longiantennatum</i>
2a. Flowers yellowish to slightly greenish, with transverse brownish spots; lip ovate, with a distinctly defined margin bearing irregular denticles.....	<i>C. × guarayense</i>
1a. Flowers resupinate.....	3
3. Lip margin smooth.....	4
4. Lip entire.....	<i>C. callosum</i>
4a. Lip 3-lobed.....	<i>C. fuchsii</i>
3a. Lip margin fimbriate, ciliate, denticulate, crenulate, papillose or warty.....	5
5. Lip apex with a callosity.....	6
6. Basal callus of the lip tripartite.....	<i>C. barbatum</i>
6a. Basal callus of the lip consisting of an acute central protuberance from which 3-4 semicircular rows of small denticles extend laterally.....	<i>C. semicirculatum</i>
5a. Lip apex without callosity.....	7
7. Lip apex obtuse, rounded or truncate.....	<i>C. parguazense</i>
7a. Lip apex apiculate.....	<i>C. cochabambanum</i>

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AUTHOR CONTRIBUTIONS. DRPK and AHK wrote the text, AHK took the photographs and created the map and photographic plates, CASMZ and LAMM collected the type material, CASMZ, PS, GC, JBFS, and PCC commented on and revised the manuscript.

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CONFLICT OF INTEREST. No conflicts of interest were declared.

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A NEW ALIEN ORCHID AMONG US: A RECORD OF *PONTHIEVA FERTILIS* (CRANICHIDINAE) IN THE BRAZILIAN ATLANTIC FOREST

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ABSTRACT. During a field expedition in the state of Paraná, southern Brazil, a population of *Ponthieva fertilis* was found growing in a ravine alongside a commercial *Pinus* plantation. *Ponthieva fertilis* is an Andean species, naturally occurring from Bolivia to Venezuela, and it is here recorded for the first time in Brazil. High fruiting rates were observed, highlighting its potential as an invasive exotic species. Additionally, a description, photographs, illustrations and comments on its ecological and distributional characteristics are provided to facilitate its recognition, given its “alien” status in Brazil.

RESUMO. Durante expedição de campo no Estado do Paraná, Sul do Brasil, foi encontrada uma população de *Ponthieva fertilis* vegetando em um barranco ao longo de um plantio comercial de *Pinus*. *Ponthieva fertilis* é uma espécie dos Andes, encontrada naturalmente da Bolívia até a Venezuela, sendo registrada pela primeira vez para o Brasil. Foram observadas altas taxas de frutificação, ressaltando seu potencial como exótica invasora. Adicionalmente, são fornecidas sua descrição, fotografias, ilustrações e comentários sobre suas características ecológicas e de distribuição, a fim de facilitar seu reconhecimento, visto seu *status* “alienígena” no Brasil.

KEYWORDS / PALAVRAS-CHAVE: Cranichideae, exotic, exótica, invasive, invasora, new record, novo registro, Paraná

Introduction. Orchidaceae is one of the taxonomically most diverse families of Angiosperms, with representatives distributed across nearly all regions of the world. The family exhibits a wide spectrum of growth habits, life forms, morphological adaptations and ecological strategies, enabling its taxa to colonise an extensive range of environments and ecological niches, thereby establishing Orchidaceae as a floristically significant component within plant communities (Dressler, 1993; Pessoa *et al.*, 2025; Pridgeon *et al.*, 1999).

Brazil, a vast country in South America, harbours 2659 species and 246 genera of Orchidaceae (Flora e Funga do Brasil, 2026). The Atlantic Forest

Domain is the richest in orchid diversity and also the most threatened and deforested among Brazilian vegetation formations (see Flora e Funga do Brasil, 2026; Pessoa *et al.*, 2025; Ribeiro *et al.*, 2009). Recognised as a biodiversity hotspot (Myers *et al.*, 2000), the Atlantic Forest, despite being one of the most extensively studied domains, continues to yield significant taxonomic novelties, including new distribution records and newly described species (e.g., Barberena & Gonzaga, 2016; Engels & Smidt, 2022; Engels *et al.*, 2023; Morales *et al.*, 2023, 2025; Pessoa *et al.*, 2016, 2025; Santos & Azevedo, 2022; Santos & Smidt, 2023, 2024; Sousa *et al.*, 2025). Despite this remarkable diversity and

Brazil's territorial dimensions, only five orchid species are currently regarded as naturalised (Flora e Funga do Brasil, 2026).

Human interventions significantly alter the composition of natural environments, both through the removal of the native vegetation cover and the introduction and management of exotic species for diverse purposes. Although many of these species are cultivated and depend on human management, some encounter favorable conditions for reproduction and dispersal, enabling them to colonize and occupy natural habitats. In numerous cases, such species replace native taxa and, under these circumstances, are classified as invasive alien species (Leão *et al.*, 2011; Moro *et al.*, 2012; Sampaio & Schmidt, 2013).

Although still scarcely investigated, documented cases show exotic orchids benefiting from novel environments, maintaining interactions with pollinators, and achieving reproductive success. Such success is highly variable, ranging from the spontaneous occurrence of a few epiphytic plants in urban arborization (e.g., Pemberton & Downing, 2025) to sporadic presence in natural habitats (e.g., Pemberton *et al.*, 2008) or frequent occurrence with wide distribution (e.g., Menini Neto *et al.*, 2011; Wetterer & Wetterer, 2022), thereby generating different types of impacts on native flora.

The present study aims to report the first record in Brazil of the Andean *Ponthieva fertilis* (F.Lehm. & Kraenzl.) Salazar, providing data for its identification, and discuss its invasive potential in the country.

Material and methods. We collected and processed material following the protocol of Fidalgo & Bononi (1989) and deposited in the UPCB and EFC herbaria, with acronyms according to Thiers (2026). The confirmation of the material's identity was undertaken through the study of previously identified herbarium specimens (i.e., online database of K), as well as consultation of bibliographic sources (i.e., Pridgeon *et al.*, 2003; Szlachetko & Kolanowska, 2018). For terminology and concepts of exotic species, we adopted the definitions proposed by Moro *et al.* (2012). The description and illustration were prepared based on the examination of both fresh and herbarium-collected material. Morphological terminology followed Gonçalves & Lorenzi (2011).

TAXONOMIC TREATMENT

Ponthieva fertilis (F.Lehm. & Kraenzl.) Salazar in Ann. Bot. (Oxford) 104: 416. 2009. $\equiv$ *Goodyera fertilis* F.Lehm. & Kraenzl. in Bot. Jahrb. Syst. 26: 498. 1899. $\equiv$ *Cranichis fertilis* (F.Lehm. & Kraenzl.) Schltr. in Repert. Spec. Nov. Regni Veg. Beih. 8: 115. 1921. (Fig. 1–2).

$\equiv$ *Cranichis koehleri* Schltr. in Repert. Spec. Nov. Regni Veg. Beih. 9: 55. 1921.

$\equiv$ *Cranichis pycnantha* Schltr. in Repert. Spec. Nov. Regni Veg. Beih. 7: 62. 1920.

$\equiv$ *Ophrys parviflora* C.Presl in Reliq. Haenk. 1: 92. 1827. $\equiv$ *Exalaria parviflora* (C.Presl) Garay & G.A.Romero in Harvard Pap. Bot. 4: 480. 1999.

Terrestrial herb, 8–33 cm in total height. *Roots* 1–12 cm $\times$ 0.07–0.12 cm, cylindrical, sparsely pilose, brown to whitish. *Rhizome* compact, indistinct, ca. 5 mm long. *Leaves* 2.7–16.0 $\times$ 0.7–2.1 cm, 3 to 7 contemporaneous, elliptic, narrowly elliptic to narrowly oblanceolate, base attenuate and decurrent into the pseudopetiole, margin entire, apex obtuse to acute, glabrous, green. *Inflorescence* with peduncle 53–216 $\times$ 0.7–2.0 mm, covered by sheathing bracts. *Rachis* 1.0–9.4 $\times$ 0.7–2.0 cm, multiflorous, bearing 11–73 flowers; floral bract 2.5–3.0 $\times$ 1.0–1.2 mm, lanceolate to ovate, base obtuse to rounded, margin entire and ciliate, apex obtuse to acute, light green. *Tector trichomes* present on peduncle, rachis, bracteoles and flowers. *Flowers* non-resupinate; pedicel and ovary ca. 2.5 $\times$ 0.7 mm, oblanceoloid to ellipsoid, pilose, green. *Dorsal sepal* 2.0–2.2 $\times$ 1.0 mm, lanceolate to ovate, base cuneate to rounded, margin entire, apex obtuse to rounded, concave, glabrous to pilose at the apical region of the abaxial surface, white. *Lateral sepals* 2.0–2.2 $\times$ 1.25 mm, ovate, base rounded, margin entire, apex rounded and concave, pilose at the distal half of the abaxial surface, white. *Petals* 2.0–2.2 $\times$ 0.7 mm, elliptic, basioscopic margin auriculate, base cuneate to subrounded, margin entire, apex rounded, glabrous, white. *Labellum* 2.0–2.2 $\times$ 3.0 mm, transversely elliptic, cymbiform, trilobed, glabrous, white with light green striae; midlobe 0.5 $\times$ 0.5 mm, ovate to deltoid, obtuse; lateral lobes ca. 1.5 mm long, semi-orbicular. *Column* ca. 1.2 mm long; stigma bilobed; rostellum triangular, acute. *Anther cap* ca. 0.7 mm long, lanceolate-ovate, brown. *Pollinari-*

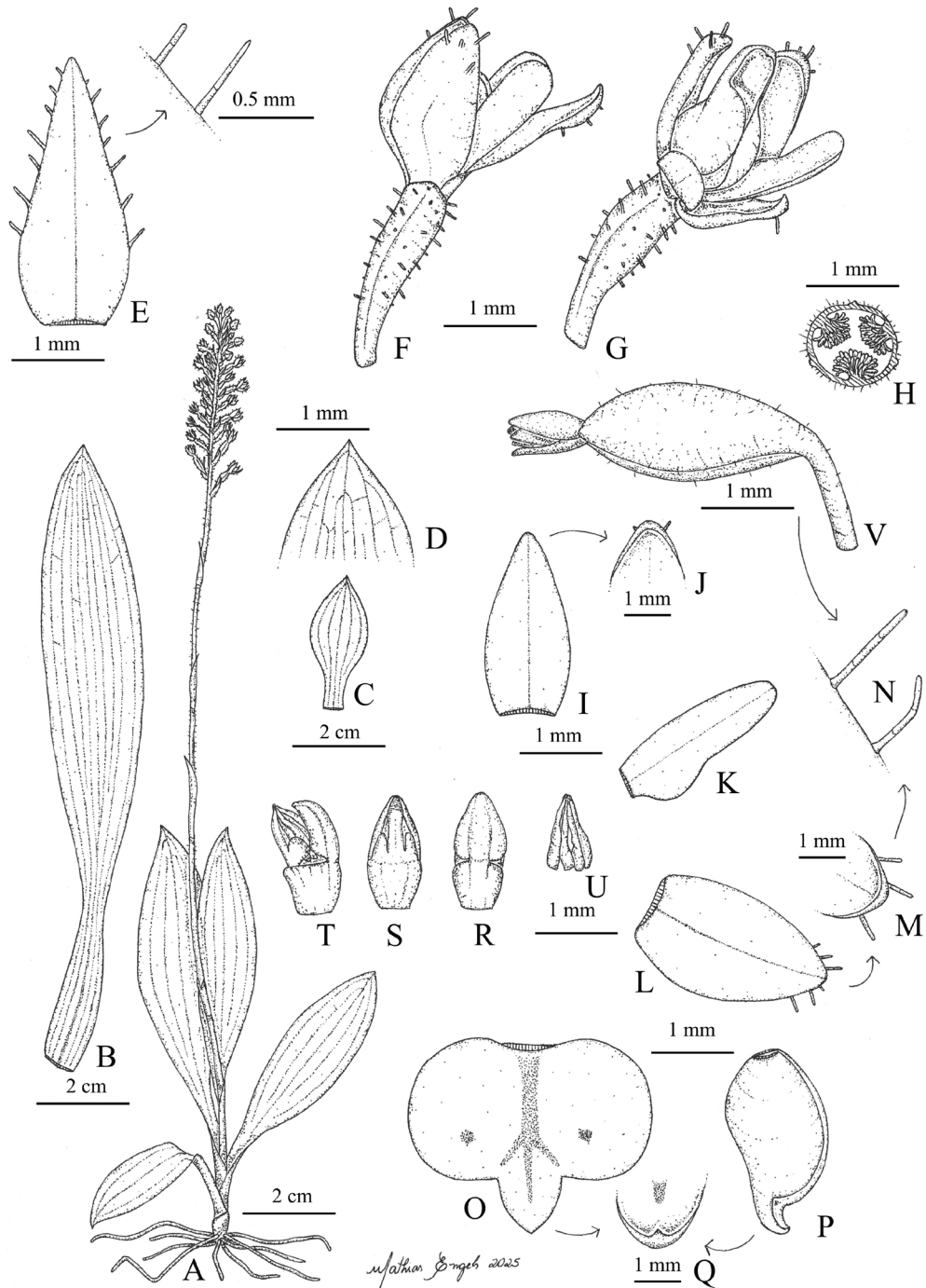


FIGURE 1. Line drawing of *Ponthieva fertilis*. A. Habit. B–C. Leaves. D. Leaf apex, detail. E. Floral bract. F. Flower, lateral view. G. Flower, diagonal view. H. Ovary and placentation, detail of cross-section. I. Dorsal sepal. J. Dorsal sepal apex, detail. K. Petal. L. Lateral sepal. M. Lateral sepal apex, detail. N. Trichomes of the flower, detail. O. Flattened lip. P. Lip, lateral view. Q. Lip apex, detail. R. Column, dorsal view. S. Column, lateral view. T. Column, diagonal view. U. Pollinarium. V. Immature fruit. Drawn by M. E. Engels, based on Engels *et al.* 13289.

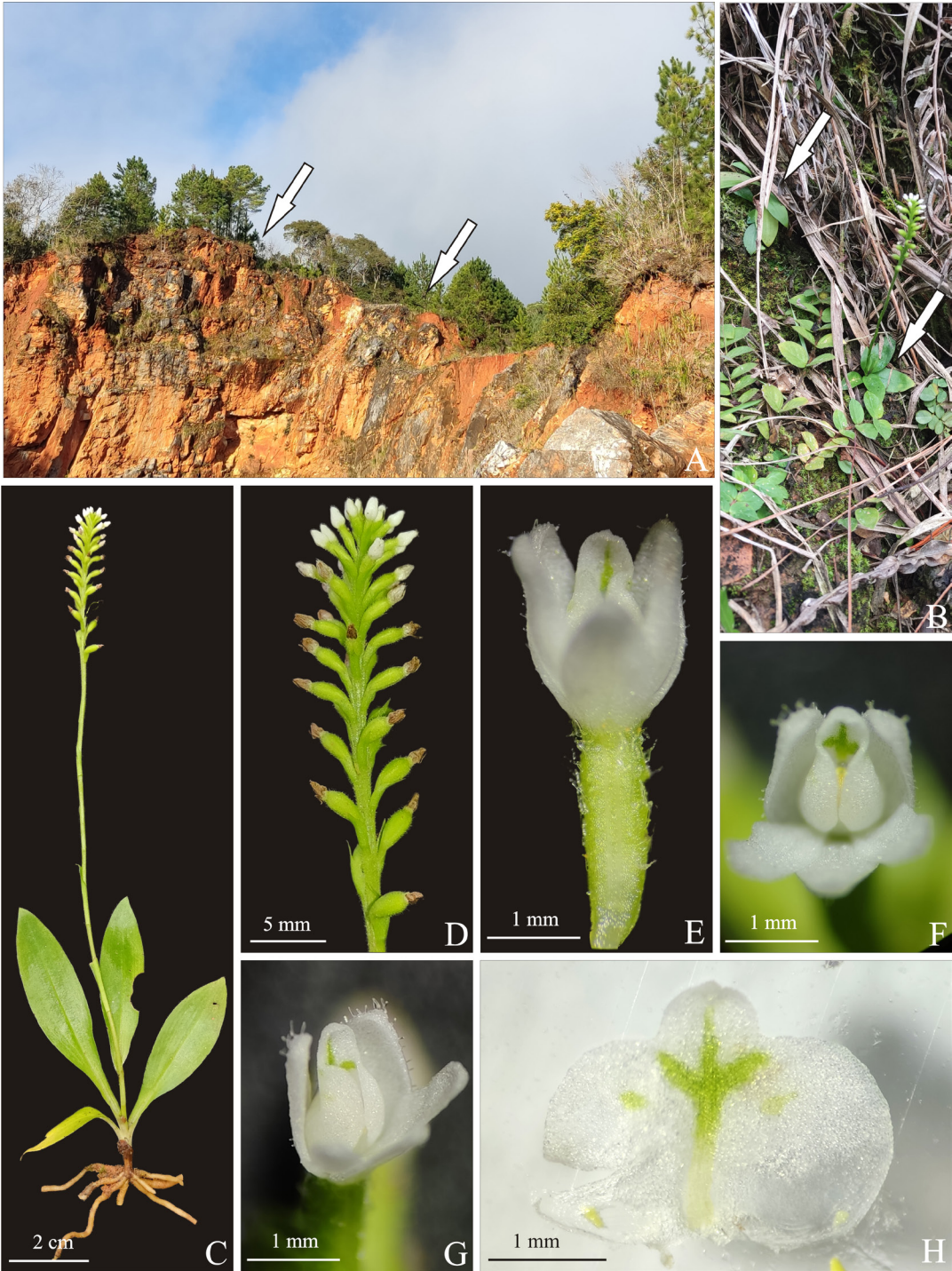


FIGURE 2. Photos of *Ponthieva fertilis*. **A.** Anthropogenic environment, with ravines and *Pinus* sp., arrows indicate where the orchid individuals were found. **B.** Habitat, arrows indicate the individuals. **C.** Habit. **D.** Inflorescence with buds, flowers and young fruits. **E.** Flower, dorsal view. **F.** Flower, frontal view. **G.** Flower, diagonal view. **H.** Flattened lip. Photos by M. E. Engels from *Engels et al.* 13289.

um with four pollinia, 0.75 mm long, yellow; viscidium deltoid, brown. Immature *fruits* 5.0–7.0 × 2.0–2.5 mm, ellipsoid, pilose, green; perianth persistent, dry, paleaceous.

EXAMINED MATERIAL: BRAZIL. Paraná: Tunas do Paraná, Atlantic Forest, Araucária Forest, fl. and fr., 04 July 2025, *Engels et al.* 13289 (EFC, UPCB).

DISTRIBUTION AND ECOLOGY: *Ponthieva fertilis* occurs naturally in the Andes, in Bolivia, Colombia, Ecuador, Peru and Venezuela (POWO, 2026), and it is reported here for the first time in Brazil as a naturalised exotic species. In the Andean region (natural occurrence), *P. fertilis* occurs in woodland or bushland on graminoid vegetation, rocky sandy areas near forest, or on cliffs over rivers, at elevations between 700 and 2400 m a.s.l. (Pridgeon *et al.*, 2003). In Brazil, it was recorded in the municipality of Tunas do Paraná, Paraná State, within the Vale do Ribeira region. This area lies within the Araucaria Forest (Mixed Ombrophilous Forest – Atlantic Forest Domain) and is characterised by gently to strongly undulating relief, with silviculture as a significant land use. The species was found growing terrestrially in an open site, on the slope of a commercial *Pinus* L. (Pinaceae) plantation at approximately 900 m a.s.l., forming a considerable population (estimated to comprise at least 400 individuals).

In the Andes, *P. fertilis* has been recorded in flower and fruit between March and December. In Brazil, it was found in flower and fruit in July.

TAXONOMIC NOTES: *Ponthieva* R.Br. is an American genus with about 76 species (POWO, 2026). Its flowers are usually quite distinctive and differ from other genera by their non-resupinate flowers, clawed petals, and a lip usually attached to the column through a claw, usually trilobed and much smaller than the petals and sepals (Meneguzzo, 2020). *Ponthieva fertilis* can be distinguished from *P. phaenoleuca* (Barb.Rodr.) Cogn., the only congener species occurring in Brazil as a native species, by the following combination of characters: multiflorous, dense inflorescences (vs. pauciflorous, lax); small flowers (4.0–5.0 mm in diameter vs. 7.0–9.0 mm); petals with a reduced basioscopic auricle (vs. developed); and the morphology of the labellum, which is non-unguiculate (vs. unguiculate).

Discussion. The plants examined showed a notably high fruit set (Fig. 2B–D). Although the flowers reach anthesis and allow for cross-pollination, manipulation of the flowers revealed the occurrence of spontaneous self-pollination (i.e., upon dissecting the flower and removing the pollinarium, part of the pollinia was found adhering to the margin of the stigmatic lobes), resulting in elevated fruiting rates and reinforcing the invasive potential of the species. Given the presence of a well-established and reproducing population, the species may be regarded as a “naturalised exotic”. However, owing to its high fruiting rates and the production of minute seeds dispersed by wind, there exists the possibility of colonization and occupation of new sites, both nearby and more distant, indicating the potential for the species to become an “invasive exotic”.

We believe that *P. fertilis* may, in the future, be found occupying other anthropogenic environments (as observed in the recorded population), given that ecosystems in the Atlantic Forest domain are severely fragmented and degraded (Ribeiro *et al.*, 2009). In addition, owing to the ecological characteristics of the species, it also has the potential to invade open natural ecosystems (i.e., native grasslands, vegetational refuges, and rocky fields). *In situ* observations revealed that winter frosts had damaged part of the population. Nevertheless, despite these injuries, the individuals survived, suggesting that frost is not a climatic limiting factor for the species’ establishment in subtropical regions of the Atlantic Forest. This is the first record of *P. fertilis* for Brazil, with no other records or citations of the species reported from other localities within the national territory to date (i.e., Centro de Referência em Informação Ambiental [CRIA], 2026; Flora e Funga do Brasil, 2026; Jabot, 2026).

Exotic species with the potential to reproduce and establish in new environments have been observed across different plant groups worldwide, and today 16,429 taxa are recognised as “alien” species outside the original distribution (Davis *et al.*, 2025). In Brazil, there are exotic species ranging from gymnosperms (*Pinus taeda* L. – Pinaceae, Falleiros *et al.*, 2011); monocotyledons (various grasses – Poaceae, Horowitz *et al.*, 2013; *Hedychium coronarium* J.Koenig – Zingiberaceae, Pereira *et al.*, 2024; Pupin & Mendes, 2020; Santos *et al.*, 2005); to eudicotyledons (*Crotalaria retusa* L. – Fabaceae, Santana & Figueire-

do, 2019; *Darcya vandelliioides* (Benth.) Scatigna – Plantaginaceae, Koch *et al.*, 2025; *Ligustrum lucidum* W.T.Aiton – Oleaceae, Nunes *et al.*, 2018; Oliveira *et al.*, 2016). These species compete and behave differently, ranging from secondary anthropogenic environments (e.g., lawns, peridomiliary areas) to preserved natural habitats (e.g., forests and grasslands, including conservation units).

Although several records document exotic orchid species establishing in natural environments, research on their occurrence remains incipient (Grenié *et al.*, 2025). Nevertheless, some studies have examined new occurrences and their autecology (Menini Neto *et al.*, 2011; Pemberton & Downing, 2025; Pemberton *et al.*, 2008; Wetterer & Wetterer, 2022), their inclusion in floras (Engels *et al.*, 2016), or listings focused on exotic species within specific areas (Horowitz *et al.*, 2013; Silva Machado *et al.*, 2020).

However, some species have been more thoroughly investigated, and their histories of occupation and invasion are better understood. This is the case for *Oeceoclades maculata* (Lindl.) Lindl. (= *Eulophia maculata* (Lindl.) Rchb.f.) (see Wetterer & Wetterer, 2022) and *Zeuxine strateumatica* (L.) Schltr. (see Martín *et al.*, 2024; Menini Neto *et al.*, 2011), both Old World

species that are now widely distributed in the New World.

In this context, documenting this new distribution record contributes to knowledge of the alien orchid flora by including *P. fertilis* among the species recorded in Brazil.

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CONFLICT OF INTEREST. The authors declare no conflict of interest.

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 5. Journal article: Nobody, A. B. (1991). The effect of light on growth. *Title of Journal*, 3(1), 15–20. doi: insert DOI when it is available.
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Outer floral bract. E. Inner floral bract. F. Petal. G. Column, profile view (left) and 3/4 dorsal view (right). H. Pollinarium. (Drawn from the holotype). Illustration by Who Nobody. Figure 2. *Luisia inedita*. A. Habit. B. Fruit (Somebody 567, CR). Illustration by Who Nobody. Note that labels on the figure ("A") should be in upper case and match that on the legend. Italicize the collector's name and number.

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