ISSN 1409-3871

LANKESTERIANA

VOL. 24, No. 1

APRIL 2024

ANIVERSARIO

UCR

INTERNATIONAL JOURNAL ON ORCHIDOLOGY

LANKESTERIANA
INTERNATIONAL JOURNAL ON ORCHIDOLOGY

Editor-in-Chief (Director)

Diego Bogarín
Universidad de Costa Rica, Costa Rica
diego.bogarin@ucr.ac.cr

Associate Editors

Melissa Díaz-Morales
Universidad de Costa Rica, Costa Rica
melissa.diaz_m@ucr.ac.cr

Franco Pupulin
Universidad de Costa Rica, Costa Rica
franco.pupulin@ucr.ac.cr

Technical Editor

Noelia Belfort Oconitrillo
Universidad de Costa Rica, Costa Rica
noelia.belfort@ucr.ac.cr

Consejo Editorial / Editorial Committee

Diego Bogarín
Universidad de Costa Rica, Costa Rica
Adam P. Karremans
Universidad de Costa Rica, Costa Rica
Gabriela Jones Román
Universidad Estatal a Distancia, Costa Rica

Melania Fernández
Universidad de Costa Rica, Costa Rica
Víctor M. Jiménez
Universidad de Costa Rica, Costa Rica
Jorge Warner
Universidad de Costa Rica, Costa Rica

Comité Científico / Scientific Committee

James D. Ackerman
University of Puerto Rico, U.S.A.
Germán Carnevali
Centro de Investigación Cientifica de Yucatán, Mexico
Phillip Cribb
Royal Botanic Gardens, Kew, U.K.
Carlos F. Fighetti
The American Orchid Society, U.S.A.
Günter Gerlach
Botanischer Garten München-Nymphenburg, Germany
Heiko Hentrich
Deutsche Homöopathie-Union Karlsruhe, Germany
Julián Monge-Nájera
Universidad de Costa Rica, Costa Rica
David L. Roberts
University of Kent, U.K.
André Schuiteman
Royal Botanic Gardens, Kew, U.K.
Jorge Warner
Universidad de Costa Rica, Costa Rica

Franco Bruno
Universitá La Sapienza, Roma, Italia
Mark W. Chase
Royal Botanic Gardens, Kew. U.K.
Robert L. Dressler†
Universidad de Costa Rica, Costa Rica
Lauren Gardiner
Royal Botanic Gardens, Kew, U.K.
Eric Hágsater
Herbario AMO, Mexico
Wesley E. Higgins
The American Orchid Society, U.S.A.
Alec M. Pridgeon
Royal Botanic Gardens, Kew, U.K.
Gustavo A. Romero
Harvard University Herbaria, U.S.A.
Philip Seaton
IUCN/SSC Orchid Specialist Group, U.K.
W. Mark Whitten†
Florida Museum of Natural History, U.S.A.

Norris H. Williams†
Florida Museum of Natural History, U.S.A

LANKESTERIANA
INTERNATIONAL JOURNAL ON ORCHIDOLOGY

Effective publication dates ISSN 2215-2067 (electronic): January 29 – April 25, 2024 (specific dates recorded on the title page of each individual paper)
Effective publication date ISSN 1409-3871 (printed): April 30, 2024

Layout: Jardín Botánico Lankester.
Cover: *Ornithocephalus lankesteri* Ames, named after Charles H. Lankester. This cover is dedicated to commemorating the 50th anniversary of the Lankester Botanical Garden. The garden was established on March 2, 1973. Photo courtesy of Franco Pupulin.
Cover layout: Ibux Sánchez.
Printer: MasterLitho.
Printed copies: 50

Printed in Costa Rica / Impreso en Costa Rica

R Lankesteriana / International Journal on Orchidology
No. 1 (2001)-- . -- San José, Costa Rica: Editorial Universidad de Costa Rica, 2001--
v.
ISSN-1409-3871

1. Botánica - Publicaciones periódicas, 2. Publicaciones periódicas costarricenses

ISSN 1409-3871

LANKESTERIANA

VOL. 24, No. 1 April 2024

INVITED PAPERS FROM THE

50th ANNIVERSARY OF THE LANKESTER BOTANICAL GARDEN

(*continues*)

UNIVERSIDAD DE COSTA RICA
LUCEM ASPICIO

INTERNATIONAL JOURNAL ON ORCHIDOLOGY

(continues)

LANKESTERIANA 24(1): 1–32. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.58079

NOTES ON AUSTRALASIAN ORCHIDS 8: EIGHT NEW SPECIES OF *HYMENOCHILUS* (PTEROSTYLIDINAE) AND CLARIFICATION OF TWO PREVIOUSLY DESCRIBED SPECIES

David L. Jones[1], Heidi C. Zimmer[2,3] & Mark A. Clements[2]

[1]Heron Crescent, Kalaru, New South Wales, 2550, Australia.
[2] Centre for Australian National Biodiversity Research (Joint Venture Between Parks Australia and CSIRO), GPO Box 1700, Canberra, ACT, 2601, Australia.
[3] Corresponding author: Heidi.Zimmer@csiro.au

Abstract. Eight new species of *Hymenochilus* from Australia are described and illustrated. Six of the new species have affinities to (and are here compared with) *H. cycnocephalus*: *H. anemophilus, H. calcicola, H. cymbellus*, *H. longipes, H. nemoralis* and *H. pachylus*. *Hymenochilus anemophilus* is shorter (2–8 cm)*,* with dark green strongly veined rosette leaves, crowded dark green flowers, oblong to obovate labellum lamina and, a broader blunter beak on the labellum appendage; *H. calcicola* is shorter (3–12 cm), crowded green flowers with prominent dark green stripes, ovate petals with a strongly developed basal flange on the anterior side and narrow elliptic labellum lamina with a broad pointed beak on the labellum appendage; *H. cymbellus* differs by its sparser basal rosette with narrower rosette leaves, thinner scapes, flowers with distinct darker green stripes and shallowly saccate lateral sepals that narrow inwards to a distinctly pointed apex; *H. longipes* differs by its thin-textured rosette leaves, widely spaced darker green flowers with darker green veins, elliptic-obovate labellum lamina and a longer labellum basal appendage which protrudes prominently from the flower in side view; *H. nemoralis* has longer rosette leaves, thicker scape and darker green flowers with prominent narrow dark green stripes; *H. pachylus* has thicker rosette leaves, taller, thicker scape, flowers prominently striped, elliptic-obovate labellum lamina and labellum appendage with a short thick beak. Two of the new species have affinities (and are here compared) with *H. muticus*: *H. pagophilus* and *H. pisinnus*. *Hymenochilus pagophilus* differs by its moderately crowded to crowded flowers, broader, shinier flowers and rectangular-obovate labellum and *H. pisinnus* differs by its smaller rosette with smaller, narrower leaves, thinner scape, smaller flowers, that are often on long pedicels, shorter, shallowly saccate lateral sepals, smaller rhomboid petals and, smaller obovate labellum. In addition, *Hymenochilus cycnocephalus* and *H. muticus,* are characterised in the strict sense with full descriptions, distribution, and habitat.

Keywords / Palabras clave: Arid orchid, Australia, conservation status, Cranichideae, estado de conservación, *Hymenochilus cycnocephalus*, *Hymenochilus muticus*, orquídea árida, *Pterostylis,* taxonomía, taxonomy

Introduction. *Hymenochilus* D.L.Jones & M.A.Clem. is a genus of tuberous terrestrial orchids classified in the subtribe Pterostylidinae, tribe Cranichideae. Orchids in Pterostylidinae typically have green to greenish-white flowers with a hooded appearance, due to an inflated dorsal sepal which overlaps the petals to form a galea (hood), which encloses the column. They are often referred to as ‘greenhood orchids’.

Hymenochilus is a genus segregated from the genus *Pterostylis* (Jones & Clements 2002). Species in *Hymenochilus* are characterised by having basal, sessile or subsessile, scape-encircling rosette leaves, multiflowered racemes of small, spirally arranged greenish flowers with a short galea, weakly fused, recurved, arcuated, thin-textured lateral sepals, cupped (or rounded inward to a cup shape) towards the base, and with short blunt convergent apices, unlobed, thin-textured labellum lamina with an emarginate apex, vestigial callus and basal appendage more or less at right angles to the lamina, the apical part with thickened margins and a central ridge which can extend as a beak.

Three groups can be distinguished morphologically within *Hymenochilus*. Group one: *Hymenochilus muticus* group which is characterised by a pale green or

ORCID of the Author: HCZ
Received 5 August 2023; accepted for publication 29 October 2023. First published online: 29 January 2024.

whitish labellum with a darker green recurved oblong appendage which has thickened margins and a short protruding ridge ending below the apex of the appendage. Group two: *Hymenochilus cycnocephalus* group which is characterised by the labellum appendage arising nearly at right angles to the labellum lamina and bearing a prominently protruding apical beak. Group three: *Hymenochilus bicolor* group which is characterised by a labellum with swollen dark blackish green appendage recurved at a steep angle and with thickened margins and short blunt protruding ridge ending below the apex of the appendage.

Currently *Hymenochilus* comprises of 24 species, with 22 species endemic to Australia, most in the south-east, and two species which are endemic in New Zealand (Jones 2008, 2009, 2021). A further eight new species, previously included as *ineditus* in Jones (2021), are described here, six in the *H. cycnocephalus* group and two in the *H. muticus* group. Because of substantial taxonomic changes in the genus, the opportunity is taken to characterise *Hymenochilus cycnocephalus* and *H. muticus* in the strict sense with full descriptions, distribution and habitat details.

Materials and Methods. This study is based on the morphological examination of living plants and fresh flowers, examination of dissected flowers mounted on cards, dried and spirit-preserved herbarium specimens and images of living flowers. Herbarium collections, spirit and dried or photographs, were examined from the following herbaria: AD, BRI, BM, CANB, CBG, HO, MEL, NSW and QVM. Protologues were reviewed, including Brown (1810) and Fitzgerald (1876), and descriptions of these (and related) taxa in other sources (e.g., Backhouse 2023, Brown 2022, Copeland & Backhouse 2022, Hoffman *et al.* 2019, Jones 2021, Neijalke 2022). Descriptions of the new taxa were made from fresh specimens. Drawings were prepared using ink and/or pencil on paper, based on study of living plants and fresh flowers, examination of dissected flowers mounted on cards, dried and spirit-preserved herbarium specimens and images of living flowers. Unless otherwise indicated, all types of *Hymenochilus* relevant to this study (or photographs thereof) have been seen by the senior author. Measurements given in the descriptions are from living plants or dissected flowers on cards. Notes on distribution, habitat and ecology were derived from the senior author's own observations, from those of colleagues, or from herbarium labels. Suggestions on conservation status are based on field work, comments from colleagues and publications, and are evaluated using the IUCN Red List categories and criteria (IUCN 2022)

Taxonomic treatment

1. *Hymenochilus anemophilus* D.L.Jones, ***sp. nov***. (Fig. 1–2).

TYPE: Australia. South Australia: Mokota Grassland Reserve, 1 km N of Mt Cone, 25 Aug. 2000, *R.J.Bates 57244* (holotype, CANB 621066; isotype, AD).

Diagnosis: With affinity to *H. cycnocephalus* but it differs by its by dwarf habit (2–8 cm tall *cf.* 8–20 cm tall in *H. cycnocephalus*), dark green strongly veined rosette leaves (paler green and faintly veined leaves in *H. cycnocephalus*), crowded dark green flowers (moderately crowded to separated paler green flowers in *H. cycnocephalus*), oblong to obovate labellum lamina (oblong to elliptic in *H. cycnocephalus*) and, a broader blunter beak on the labellum appendage (narrower blunt or pointed beak in *H. cycnocephalus*).

Leaves 5–10; *lamina* elliptical, 10–25 mm long, 5–12 mm wide, dark green, fleshy, shiny, strongly veined, margins entire, apex acute to apiculate. *Scape* 2–8 cm tall, 2–3 mm wide, 2–12-flowered. *Sterile bracts* 1–2, closely sheathing to spreading, elliptic when flattened, 5–11 mm long, 3–5 mm wide, fleshy, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 4–7 mm long, straight, slender. *Ovaries* oblong to elliptic, 3–5 mm long, *ca.*1.5 mm wide. *Flowers* porrect, crowded, 8–10 mm long, 4–5 mm wide, pale green, faintly striped. *Dorsal sepal* 9–11 mm long, 4–6 mm wide, slightly gibbous at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, shallowly saccate, dorsally gibbous, when flattened 6–7 mm long, 6–7 mm wide, points subacute, *ca.* 4 mm apart. *Petals* asymmetrical, more or less ovate, 7–8 mm long, 3.5–4.0 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, with a dorsal gibbosity above the middle, ventral margin smooth. *Labellum claw* irritable, ligulate, *ca.*1.6 mm long, *ca.*1.3 mm wide. *Labellum lamina* oblong to obovate, 2.2–2.5 mm long, 1.8–2.2 mm wide, green

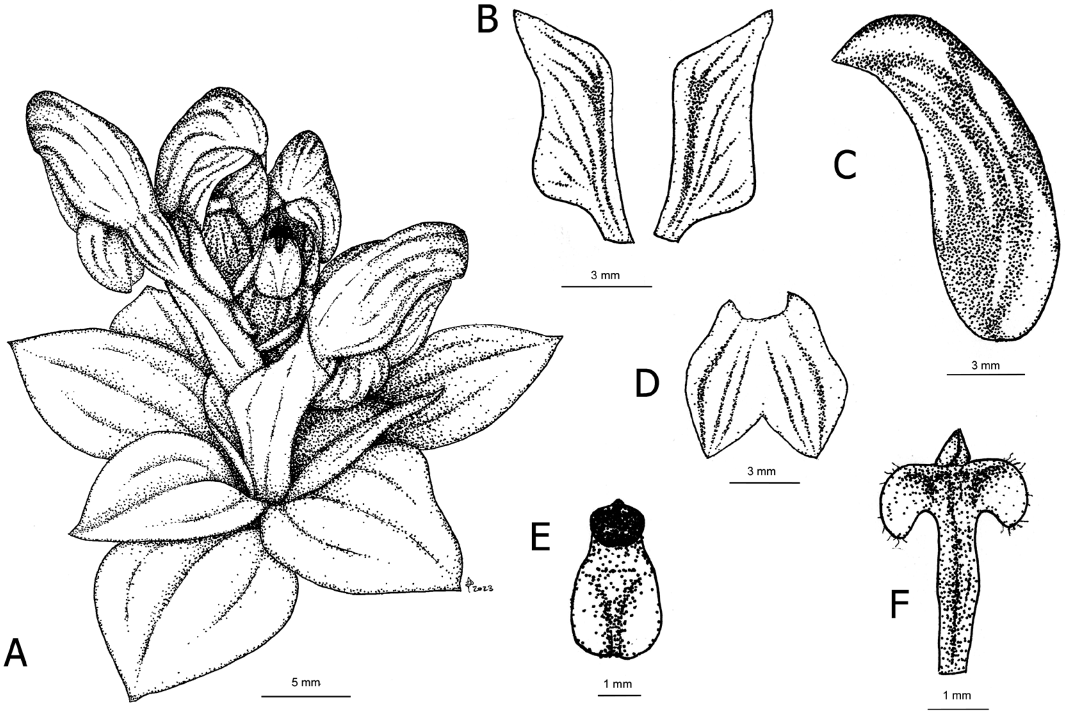


FIGURE 1. *Hymenochilus anemophilus* D.L.Jones. **A**. Habit. **B**. Petals. **C**. Flower, side view. **D**. Synsepal. **E**. Labellum flattened, from above. **F**. Column, front view. Illustration by Z. Groeneveld. Mokota Grassland Reserve SA, *R. Bates 57244*, 25 Aug. 2000.

with a dark green basal appendage, membranous, apex emarginate. *Basal appendage* recurved at right angles, oblong–tapered, 1.0–1.5 mm long, *ca.*1 mm wide, margins dark green, thickened, central ridge narrow, raised above the margins, dark green, ending in a broad, blunt beak 0.8–1.3 mm long. *Callus* a thickened, darker green, tapered medial ridge on the labellum lamina. *Column* obliquely erect, 5–7 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2.3 mm long, *ca.*1.3 mm wide, basal lobe deltate, inner margins sparsely ciliate; barrier cilia *ca.*0.3mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, scutiform, *ca.* 3 mm long, *ca.*1.5 mm wide, raised. *Capsules* not seen.

DISTRIBUTION AND ECOLOGY: Restricted to small areas of montane grassland near Mount Bryan and Spalding in the Northern Lofty district of South Australia, between 550–750 m elevation. Grows in bleak situations on high windswept grassy hills in heavy, moisture-retentive red clay loam. Winter snowfalls and strong winds are relatively frequent at these sites (R. Bates pers. comm.).

FLOWERING: August and September.

RECOGNITION: *Hymenochilus anemophilus* is characterised by dwarf habit (to 8 cm tall); relatively large, dark green, fleshy, strongly veined rosette leaves; short, thick scape; crowded, pale green flowers with faint darker stripes; deeply saccate lateral sepals; ovate to oblong petals; and an oblong to obovate labellum lamina and labellum appendage with a blunt beak.

SIMILAR SPECIES: Compared with *Hymenochilus anemophilus, H. cycnocephalus* is taller growing, with thinner-textured, paler, faintly veined rosette leaves and broader, moderately crowded to separated, paler green, faintly striped flowers, oblong to elliptic labellum with a narrower, blunt or pointed beak. *Hymenochilus calcicola*, which grows on limestone, is slightly taller growing (to 12 cm tall) than *H. anemophilus* with strongly

FIGURE 2. *Hymenochilus anemophilus* D.L.Jones. Bungaree, SA. Photo by R. Bates.

striped flowers and a narrow elliptic labellum lamina and labellum appendage with a broad, pointed beak. *Hymenochilus spissus* grows to about 12 cm tall and can be distinguished from *H. anemifolius* by its smaller, paler, faintly striped flowers, shallowly saccate lateral sepals and smaller oblong labellum. *Hymenochilus pratensis* grows to about 15 cm tall and can be distinguished from *H. anemifolius* by its broad, almost round, rosette leaves and smaller, boldly striped flowers.

CONSERVATION STATUS: Of restricted distribution but occurring in a conservation reserve. A preliminary extinction risk assessment, based known occurrences of these species, yields an estimated extent of occurrence of 240 km^2 and area of occupancy of 28 km^2. The species is at risk of continuing decline as a result of the impacts of feral animals and drought on its montane grassland habitat. This indicates that the species may be eligible for listing as Endangered (B1+2ab).

ETYMOLOGY: From the Greek *anemos*, wind, and *philos*, loving, in reference to the bleak windswept habitat where this species grows.

ILLUSTRATIONS: Page 549, Jones (2021); page 238, Niejalke (2022).

2. *Hymenochilus calcicola* D.L.Jones, ***sp. nov***. (Fig. 3–4).

TYPE: Australia. South Australia: Belvedere, private property called Wombat Plains, 9 Sep. 1999, *D.L.Jones 16800, M.Garratt & J.Eckert* (holotype, CANB 606695; isotype, AD).

DIAGNOSIS: With affinity to *H. cycnocephalus* but it differs by its short habit (3–12 cm tall *cf.* 8–20 cm tall in *H. cycnocephalus*), crowded green flowers with prominent dark green stripes (moderately crowded to separated faintly striped flowers in *H. cycnocephalus*), ovate petals with a strongly developed basal flange on the anterior side (small basal flange in *H. cycnocephalus*) and narrow elliptic labellum lamina with a broad pointed beak on the labellum appendage (narrower blunt or pointed beak in *H. cycnocephalus*).

Leaves 5–12; *lamina* elliptical, 5–22 mm long, 3–12 mm wide, pale green to green, thick, fleshy, dull, veins raised, margins entire or slightly wavy, apex acute to acuminate. *Scape* 3–12 cm tall, 2–3 mm wide, 3–11-flowered. *Sterile bracts* 2–4, often in a crowded basal group, closely sheathing to spreading, elliptic when flattened, 5–12 mm long, 3–6 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 3–5 mm long, straight, slender. *Ovaries* oblong to elliptic, 3–5 mm long, *ca.*1.5 mm wide. *Flowers* porrect, crowded, 8–11 mm long, 3.0–4.5 mm wide, green with prominent darker green stripes. *Dorsal sepal* 7–9 mm long, 4–5 mm wide, very slightly gibbous at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, deeply saccate, dorsally gibbous, when flattened 4–5 mm long, 4–5 mm wide, points subacute, 2–3 mm apart. *Petals* asymmetrical, more or less ovate, 6–7 mm long, 3.0–3.5 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, with a dorsal gibbosity above the middle, ventral margin smooth, with a prominent basal flange. *Labellum claw* irritable, ligulate, *ca.*1.5 mm long, *ca.*1.3 mm wide. *Labellum* *lamina* elliptic, 2.0–2.3 mm long, 2.4–2.6 mm wide, whitish green with a dark green basal appendage, membranous, apex emarginate. *Basal appendage* recurved at right angles, oblong–tapered, *ca.* 1.5 mm long, *ca.*1 mm wide, margins dark green, thickened, central ridge narrow, weakly raised above the margins, dark green, ending in a broad, pointed beak 1–1.3 mm long. *Callus* a thickened tapered medial ridge. *Column* obliquely erect, 6.5–7.5 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2.3 mm long, *ca.*1.3 mm wide, basal lobe deltate, inner margins strongly incurved, sparsely ciliate; barrier cilia *ca.* 0.4 mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* oblong–clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 3 mm long, *ca.*1.3 mm wide, raised. *Capsules* 5–7 mm long, 3–4 mm wide, on pedicels to 6 mm long. Capsules not seen.

Distribution and ecology: Occurs in western Victoria and the Murray district of South Australia (where widespread and common), the Southern Lofty district and on Yorke Peninsula, between 30–180 m of elevation. Grows in mallee woodland, *Callitris* woodland, mallee–broombush association, shrubland, and bare open areas along with sparse tussocks of *Lomandra* Labill. and *Lepidosperma* Labill. The common factor seems to be limestone in the soil profile either subterranean or as outcrops and pavements, with the soils being sands and terra rossa.

Flowering: July to September.

Recognition: *Hymenochilus calcicola* is characterised by short habit (to 12 cm tall); pale green to green, thick, fleshy, dull rosette leaves with raised veins; thickish scape; crowded green flowers with prominent dark green stripes; deeply saccate lateral sepals; ovate petals with a strongly developed basal flange on the anterior side; and narrow elliptic labellum lamina with a broad pointed beak on the basal appendage.

Similar species: *Hymenochilus cycnocephalus* is taller growing than *H. calcicola* (to 20 cm tall) with a thinner scape, less crowded paler green flowers with inconspicuous stripes, narrower petals without a prominent basal flange and an elliptical labellum with a narrower blunt or pointed beak on the basal appendage. *Hymenochilus anemifolius* is even shorter growing than *H. calcicola* (to 8 cm tall), and has dark green, fleshy, strongly veined rosette leaves, crowded but less conspicuously striped flowers, an obovate labellum and labellum appendage with a broad blunt beak. *Hymenochilus spissus* grows to about 12 cm tall and can be distinguished from *H. calcicola* by its smaller, paler, faintly striped flowers, shallowly saccate lateral sepals and smaller oblong labellum. *Hymenochilus pratensis* grows to about 15 cm tall and can be distinguished from *H. calcicola* by its broad, almost round, rosette leaves and smaller, boldly striped flowers.

Notes: The leaves of *Hymenochilus calcicola* are generally extant at flowering time. This species exhibits variation that may warrant further study. Some populations have a condensed inflorescence with the lowermost flowers opening while still partly enclosed by the sterile bracts and after anthesis the inflorescence ends up no more than 5–7 cm tall (for example *R.Bates 20422* from the Woodchester area [CANB 631710]). Most collections do not exhibit this extreme growth habit and this dwarfism may be an adaptation to highly exposed sites. Some specimens with a very thin scape (e.g. North Wolseley, D.Hunt s.n. (AD)) may warrant further investigation. A collection from Cherry Gardens (Herb. *R.S.Rogers 4044)* has unusually large foliose bracts.

Conservation status: This species has a widespread distribution, including within protected areas, with estimated extent of occurrence 65,000 km^2 and a population size of >10,000 individuals. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Etymology: From the Latin *calci* for lime or limestone, and *cola* a dweller, in reference to the typical habitat of the species.

Specimens examined: **VICTORIA**: Bats Ridges, Portland, Oct. 1948, *A.C.Beauglehole 4845* (MEL); Terrick Terrick State Park, 4 Sep. 1985, *A.C.Beauglehole 80022* (MEL); Kiata Flora Reserve, 14 Sep. 1986, *A.C.Beauglehole 84382* (MEL); reserve just S of old Kiata school, 19 Sep. 1990, *D.L.Jones 6567 & C.H.Broers* (CANB). **SOUTH AUSTRALIA**: Monarto, 14 Sep. 1976, *C.R.Alcock 5422* (AD); Woodchester area, 3 Sep. 1989, *R.Bates 20422* (CANB); Chilton Scrub, Langhorne Creek, 6 Aug. 2000, *R.Bates 57151* (CANB); Melton South, 13 Aug. 2000, *R.Bates 57194*

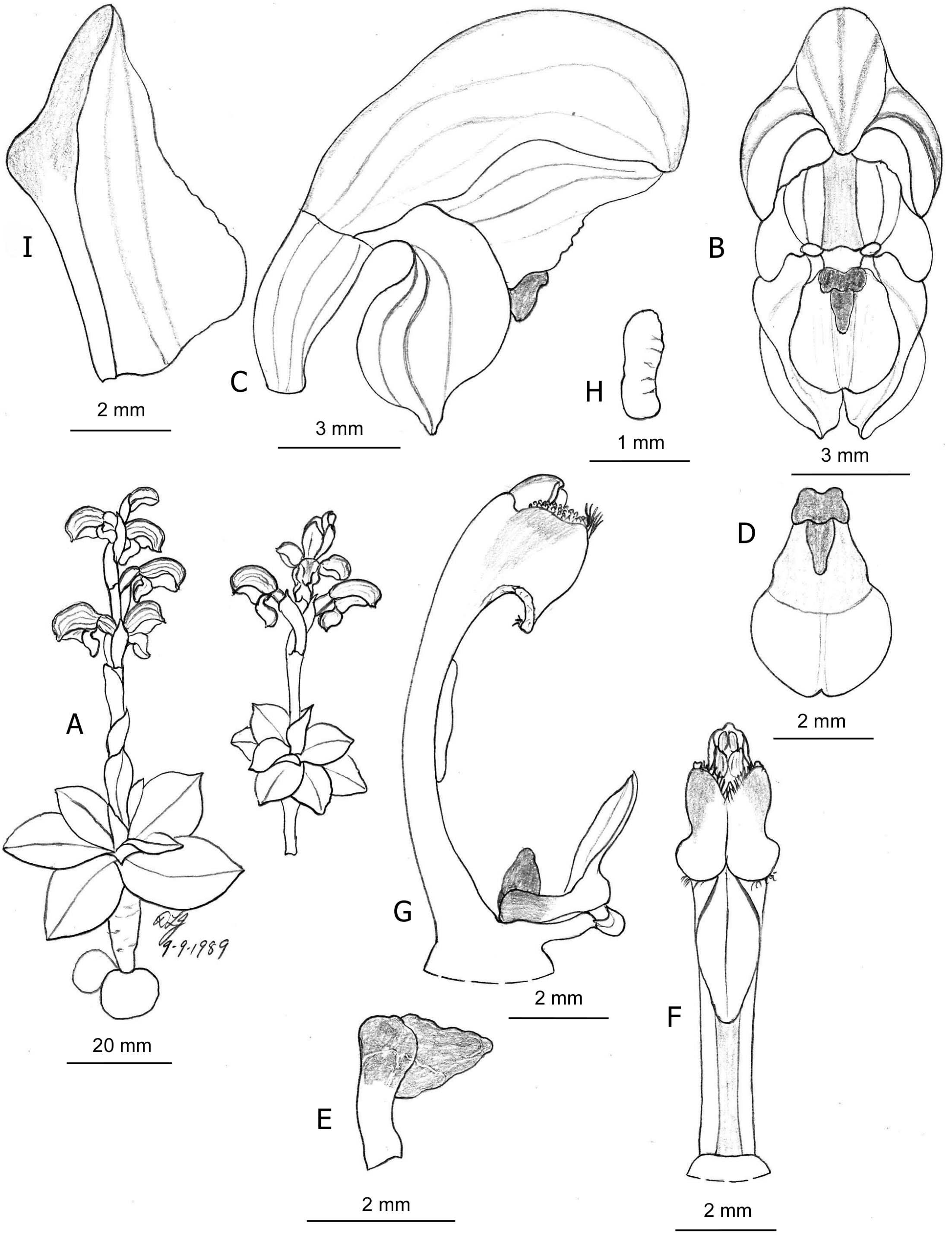


FIGURE 3. *Hymenochilus calcicola* D.L.Jones. **A**. Habit. **B**. Flower, front view. **C**. Flower, side view. **D**. Labellum flattened, from above. **E**. Labellum appendage, side view. **F**. Column, front view. **G**. Column and labellum, side view. **H**. Pollinium. **I**. Petal. Illustration by D. Jones. Woodchester SA, *R. Bates 20422*, 9 Sep. 1989.

(CANB); Monarto New Town area, 4 Sep. 1974, *J.Carrick 3589* (AD); 15 km W of Murray Bridge, 1 Oct. 1974, *J.Carrick 4713* (AD); Kinchina, 17 Sep. 1927, *J.B.Cleland* (AD); Middle Yorke Peninsula, 2 Oct. 1957, *Hj. Eichler 14226* (AD); Mt Monster, 26 Aug. 1969, *D.Foster* (CANB); Brinkley Station, 22 Sep. 1967, *N.Gemmell* (AD); Murray Bridge, Oct. 1943, *H.Goldsack* (AD); Monarto South, Oct. 1950, *H.Goldsack* (AD); near Milang, 5 Sep. 1966, *D.Hunt 2669* (AD); Monarto South, 28 Aug. 1919, *E.H.Ising* (AD); Tailem Bend Forest Reserve, 31 Aug. 1999, *D.L.Jones 16563 & M.Garratt* (CANB); Monarto Conservation Park, 31 Aug. 1999, *D.L.Jones 16569 & M.Garratt* (CANB); Hartley, 9 Sep. 1999, *D.L.Jones 16805, M.Garratt & J.Eckert* (CANB); Monarto, 1 Sep. 1897, *M.Menzel* (AD, NSW); 3 km S of Hartley on Langhorne Creek, 2 Sep. 1967, *R.C.A.Nash* (AD); Wolseley, Sep. 1943, *K.Ridgeway 668* (AD); Monarto, Sep. 1906, *R.S.Rogers* (NSW); Monarto South, 3 Oct. 1906, *R.S.Rogers* (AD, NSW); Monarto, 15 Sep. 1917, *R.S.Rogers* (AD); Kinchina, 17 Sep. 1927, *R.S.Rogers* (AD); Cooke Plains, 18 Aug. 1960, *M.C.R.Sharrad 720* (AD); Braendlers Scrub near Monarto South, 3 Sep. 1978, *P.Short 730* (AD); Sanderston, 29 Sep. 1968, *T.J.Smith 2275* (AD); near Tailem Bend, 1 Sep. 1967, *J.Warcup* (AD); Chaunceys Line, 4 km SE of Hartley, 6 Sep. 1958, *D.J.Whibley 216* (AD).

ILLUSTRATIONS: Page 549, Jones (2021); page 239, Niejalke (2022); page 242, Backhouse (2023), where it is labelled *Pterostylis calcicola*.

3. *Hymenochilus cycnocephalus* (Fitzg.) D.L.Jones & M.A.Clem., Austral. Orch. Res. 4: 74 (2002); *Pterostylis cycnocephala* Fitzg., Austral. Orch. 1(2): t.7 (1876). (Fig. 5–6).

TYPE: Australia. New South Wales: Molong, *Dr. Ross* (lectotype, BM [BM000048410], specimen (a), *fide* Clements 1989, photo!). Residual syntype, Boorowa, *G.H.Sheaffe s.n.* (not seen).

Leaves 5–9; *lamina* ovate to elliptical, 5–25 mm long, 3–15 mm wide, green, fleshy, dull; margins entire or slightly wavy; apex acute to apiculate. *Scape* 8–20 cm tall, 2–3 mm across, 3–12-flowered. *Sterile bracts* 2–4, closely sheathing, ovate to elliptic, 5–12 mm long, 3–5 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing the pedicel. *Pedicels* 3–5 mm long, straight, slender, mostly hidden within the bract. *Ovaries* oblong to elliptic, 3–5 mm long, *ca*. 1.5 mm wide. *Flowers* porrect, moderately crowded to separated, 8–10 mm long, *ca*. 3–4 mm wide, translucent green with faint darker green stripes. *Dorsal sepal* 7–9 mm long, 4–5 mm wide, very slightly gibbous at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, deeply saccate, dorsally gibbous, when flattened 6–7 mm long, 5–6 mm wide, points subacute, 3–4 mm apart. *Petals* asymmetrical, more or less ovate, 5.5–7.0 mm long, 3.0–3.5 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, a dorsal gibbosity above the middle, ventral margin smooth. *Labellum claw* irritable, ligulate, *ca.* 1.2 mm long, *ca.* 1 mm wide. *Labellum lamina* oblong to elliptic, 2.0–2.3 mm long, 2.0–2.2 mm wide, whitish green with a dark green appendage, membranous, apex emarginate. *Basal appendage* recurved at an acute angle, oblong–tapered, *ca.* 1.5 mm long, *ca.* 0.8 mm wide, margins dark green, thickened; central ridge narrow, raised weakly above the margins, dark green, ending in a narrow, blunt or pointed beak *ca.* 1 mm long. *Callus* a shallowly thickened, tapered medial

FIGURE 4. *Hymenochilus calcicola* D.L.Jones. Tailem Bend SA. Photo by J. Niejalke.

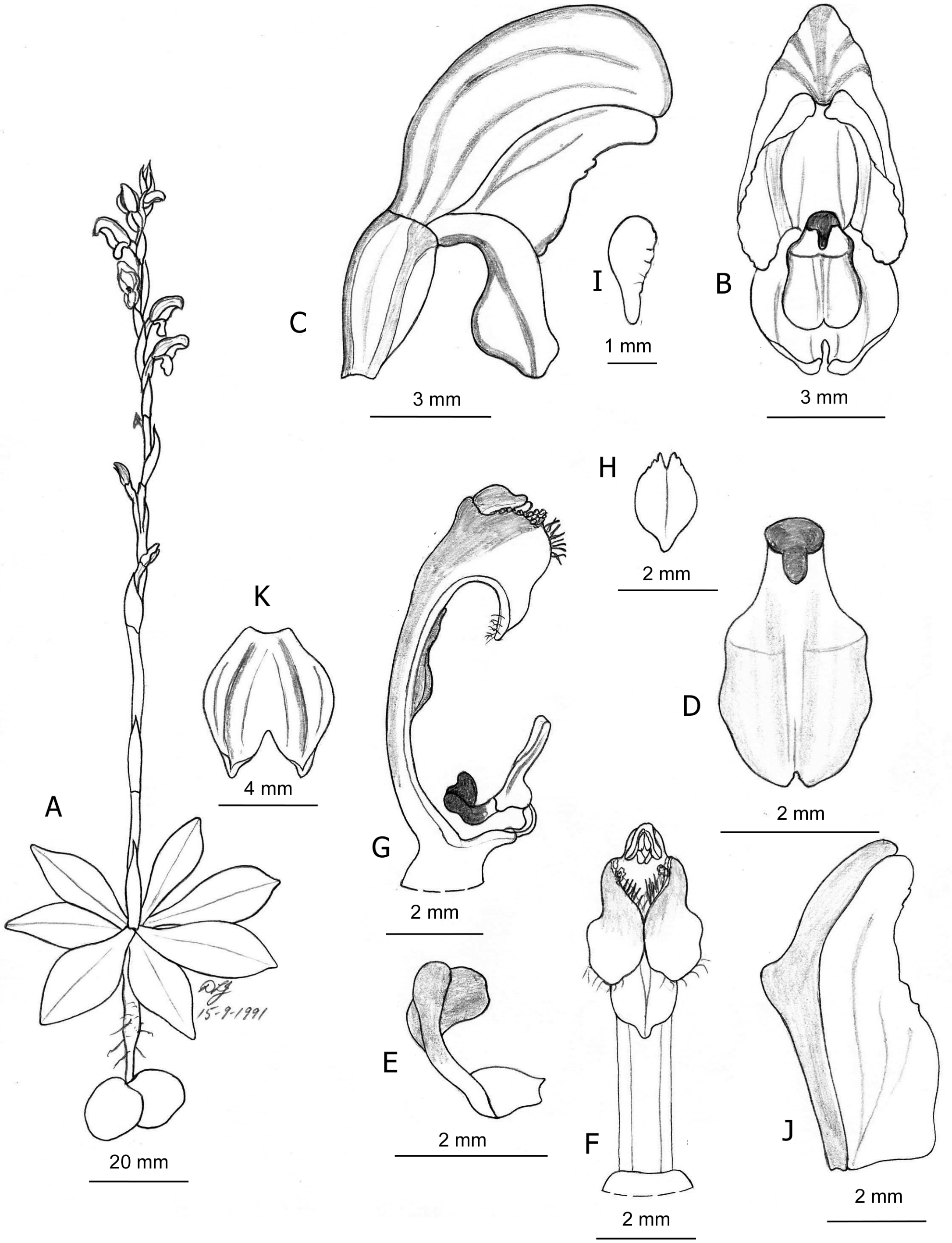


FIGURE 5. *Hymenochilus cycnocephalus* (Fitzg.) D.L.Jones & M.A.Clem. **A**. Habit. **B**. Flower, front view. **C**. Flower, side view. **D**. Labellum flattened, from above. **E**. Labellum appendage, side view. **F**. Column, front view. **G**. Column and labellum, side view. **H**. Stigma. **I**. Pollinium. **J**. Petal. **K**. Synsepal. Illustration by D. Jones. Kangarooby NSW, cult H. Richards ex D.L. Jones collection, 15 Sep. 1991.

ridge on the labellum lamina. *Column* obliquely erect, 6–7 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2.3 mm long, *ca.* 1.3 mm wide, basal lobe deltate, inner margins strongly incurved, sparsely ciliate; barrier cilia *ca.* 0.4 mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* clavate, *ca.* 1 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 2 mm long, *ca.* 1.3 mm wide, raised. *Capsules* oblong elliptic, 5–8 mm long, 3–4 mm wide, on pedicels to 6 mm long.

Distribution and ecology: Occurs in New South Wales (from the Northern Tablelands to Wagga Wagga), Australian Capital Territory and Victoria (mainly north and central, from east to west), between 50–800 m of elevation. However, its exact range needs confirmation (see Notes). Although occurring in coastal districts, its main occurrence is to be found in ranges well inland from the coast, extending to the inland plains. Grows in open forest, woodland, shrubland and grassland in shallow, well-drained to moisture–retentive clay loam and sandy loam.

Flowering: September to November.

Recognition: *Hymenochilus cycnocephalus* is characterised by relatively large, faintly veined rosette leaves (to 25 × 15 mm); moderately tall, slender scape (to 20 × 0.3 cm); relatively large, moderately crowded to separated translucent green flowers (to 10 × 4 mm) with faint darker green stripes; deeply saccate lateral sepals; relatively broad ovate petals without an obviously expanded basal area; and, an oblong to elliptic labellum with a narrow blunt or pointed beak.

Similar species: The morphology of *Hymenochilus cycnocephalus* is similar to the following species described as new species in this paper: *Hymenochilus nemoralis*, which has larger rosette leaves (to 40 × 15 mm) and thicker scapes than *H. cycnocephalus* with more numerous relatively crowded to well-spaced flowers, deeply saccate lateral sepals and an oblong labellum lamina with a short labellum appendage and narrow beak; *Hymenochilus cymbellus¸* differs from *H. cycnocephalus* by its smaller, sparse rosette leaves, thinner scapes, narrower striped flowers and shallowly saccate lateral sepals that narrow inwards to a distinctly pointed apex; *Hymenochilus pachylus*, which has larger crowded, fleshier rosette leaves than *H. cycnocephalus*, thicker scape, widely spaced darker green flowers with darker green veins and broadly obovate labellum with a short broad appendage with a thick beak; *Hymenochilus longipes*, which has larger rosette leaves than *H. cycnocephalus*, slender scape and broader, less prominently striped flowers with a longer stalk on the labellum appendage which can be seen protruding prominently from the flower in sideview.

Figure 6. *Hymenochilus cycnocephalus* (Fitzg.) D.L.Jones & M.A.Clem. Inglewood, Victoria. Photo by G. Backhouse

Hymenochilus anemophilus and *H. calcicola*, both also described as new in this paper, *H. pratensis* (D.L.Jones) D.L.Jones & M.A.Clem. from the Central Highlands of Tasmania and *H. spissus* D.L.Jones from basalt outcrops in central-western Victoria can all be distinguished from *H. cycnocephalus* by shorter habit and densely crowded flowers. Also, *Hymenochilus crassicaulis* D.L.Jones & M.A.Clem. from subalpine areas in south-eastern New South Wales, Australian Capital Territory and north-eastern Victoria is more robust than *H. cycnocephalus* with greyish rosette leaves, thicker scapes and larger crowded bluish-green and white flowers with a large beak on the labellum appendage.

Notes: The exact range of *H. cycnocephalus* is uncertain, and the following observations are pertinent and may assist future research. Plants from the Northern Tablelands of New South Wales are very similar to typical *H. cycnocephalus* but tend to have an obovate labellum and a basal appendage with a shallow beak about 0.3 mm deep. Plants from rain shadow sites in high montane areas in the Australian Capital Territory, southern New South Wales, and north-eastern Victoria (Cravensville, Wulgulmerang) grow taller than *H cycnocephalus* from lower sites, have relatively small flowers and a prominent flange-like extension on the petal base. The labellum beak, however, is a good match for that of typical *H. cycnocephalus*. Plants from western Victoria and south-eastern South Australia (e.g. Mt Boothby, R.Bates (AD)) have pale green flowers with fairly prominent darker green stripes and a relatively larger labellum appendage. These approach *H. nemoralis,* but in the absence of fresh material I am uncertain if they are conspecific.

Conservation status: This species has a widespread distribution, including in protected areas, with estimated extent of occurrence 326,000 km^2, area of occupancy of 980 km^2, a population size of >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, this species places it in the least concern category.

Specimens examined: **NEW SOUTH WALES**: Store Creek, between Orange and Wellington, Sep. 1950, *P.Althofer* (NSW); Warrumbungles, Nov. 1982, *R.Bates 2808* (AD); Ungarie, 6 Oct. 1987, *R.Bates 10459* (AD); Ebor, 22 Nov. 1987, *R.Bates 12861* (AD); Cooma, 29 Nov. 1987, *R.Bates* (AD); Peak Hill, Oct. 1906, *J.L.Boorman* (NSW); Rylstone, 4 Nov. 1962, *W.Brinsley* (CANB); Tooloom, 9 Sep. 1911, *R.H.Cambage* (NSW); Bumberry, 2 Oct. 1916, *H.Cleland* (AD); 10 km S of Ardlethan, 29 Sep. 1985, *M.A.Clements 3786* (CANB); Mt Jerrabomberra, 14 Oct. 1985, *M.A.Clements 3874* (CANB); 200 m N of Moonbi Lookout, 9 Oct. 2004, *L.M.Copeland 3807* (CANB); 1.25 km S of Mt Jerrabomberra, 24 Oct. 1997, *I.Crawford 4511* (CANB); Moonbi Range, 1 Oct. 1984, *M.D.Crisp 7399a & I.R.Telford* (CANB); Abercrombie Caves, 2 Oct. 1955, *H.Curnow & A.W.Dockrill* (AD); Mudgee, Oct. 1881, *H.Deane* (NSW); 8 km E of Ardlethan, 10 Sep. 1988, *D.L.Jones 2796 & M.A.Clements* (CANB); Narranderra Range, 10 Sep. 1988, *D.L.Jones 2809* (CANB); Sims Gap, 20 Sep. 1990, *D.L.Jones 6579 & C.H.Broers* (CANB); 9.2 km E of Weethalle, 20 Sep. 1990, *D.L.Jones 6584 & C.H.Broers* (CANB); *ca.* 32.8 km W of West Wyalong, 22 Oct. 1992, *D.L.Jones 10448 & C.H.Broers* (CANB); Buckinbong State Forest, 26 Sep. 2000, *D.L.Jones 17522 & K.J.FitzGerald* (CANB); Quarry, 8 km N of Rankin Springs, 28 Sep. 2000, *D.L.Jones 17560 & K.J.FitzGerald* (CANB); 9.1 km E of Weethalle towards West Wyalong, 28 Sep. 2000, *D.L.Jones 17570 & K.J.FitzGerald* (CANB); Bookham, 16 Oct. 1992, *D.L.Jones* 17877 (CANB); Yarranjerry State Forest, 18 Sep. 2005, *D.L.Jones 19248 & B.E.Jones* (CANB); Wahgunyah State Forest, 29 Sep. 2005, *D.L.Jones 19282 & M.A.Clements* (CANB); Rifle Range, East Goulbourn, Oct. 1906, *J.Lumsden* (NSW); Thredbo River (in fruit), Jan. 1899, *J.H.Maiden & W.Forsyth* (NSW); Tea-tree Creek, Bundarra, Oct. 1968, *I.G.Matthias* (CANB); Ginninderra Falls, 15 Oct. 1960, *H.S.McKee 7449* (CANB); 8 km SW of Dubbo, 13 Sep. 1973, *T.B.Muir 5122* (CANB); Gulpa Forest, 25 km S of Deniliquin, 9 Oct. 1978, *W.E.Mulham* (NSW); Koorawatha Falls, 5 Oct. 2002, *R.W.Purdie 5585* (CANB); Alum Mountain, Bulahdelah, July 1924, *H.M.R.Rupp* (NSW); Escort Rock, 5 Oct. 1963, *B.Whitehead* (CANB); Crackerjack Mountain, 26 Oct. 1963, *B.Whitehead* (CANB); Kangarooby, 26 Sep. 1964, *B.Whitehead* (CANB). **AUSTRALIAN CAPITAL TERRITORY**: Upper Orroral Valley, 4 Nov. 1960, *N.T.Burbidge 6670* (CANB); Rendezvous Creek, Gudgenby Road, 1 Nov. 1961, *N.T.Burbidge 7226* (CANB); Canberra Airport, 26 Oct. 1995, *I.Crawford 3258* (CANB); Kambah, 20 Sep. 1983, *F.Davies 69 & I.R.Telford* (CANB); Black Mountain, 16 Oct. 1964, *M.Gray 5556* (CANB); Gungahlin Hill Nature Reserve, 24 Oct. 1995, *D.L.Jones 14559 & B.E.Jones* (CANB); Majura Firing Range, 19 Oct. 1998, *D.L.Jones 15887, M.A.Clements & P.Downey* (CANB); track to Nursery Swamp, 8 Nov. 1999, *D.L.Jones 17018 & M.Garratt* (CANB); Naas River Valley Fire Trail, 8 Dec. 1998, *D.L.Jones 16263 & M.Garratt* (CANB, MEL, NSW); 6 km S of Tharwa, 8 Nov. 1999, *D.L.Jones 17031 & M.Garratt* (CANB); SW side of Black Mountain, 29 Oct. 2005, *D.L.Jones 19334* (CANB); between O'Malley and Mt Mugga, 20 Oct. 1991, *D.Mallinson 148* (CANB); 1 km E of Vanitys Crossing, 2 Nov. 1992, *D.Mallinson 274* (CANB); W slope of Black Mountain, 28 Oct. 1962, *H.S.McKee 9644* (CANB); Belconnen Naval Radio Station, Lawson, 15 Oct. 1998, *M.E.Nightingale (ORG 1624)* (CANB). **VICTORIA**: Mordialloc, 2 Aug. 1900, *W.R.Baker* (MEL); Barrabool Flora and Fauna Reserve, 17 Oct. 1986, *A.C.Beauglehole 82717* (MEL); Boyeo Flora Reserve, 12 Sep. 1986, *A.C.Beauglehole 84240* (MEL); West Wail Flora and Fauna Reserve, 15 Oct. 1986, *A.C.Beauglehole 86187* (MEL); Dandenong Ranges, Nov. 1925, *A.B.Braine* (CANB); near Corryong, 31 Oct. 2004, *P.G.Branwhite* 253 (CANB); Healesville, 28 Sep. 1921, *D.Coleman* (AD); Mt Piper, 6 Oct. 1912, *C.French jr.*

(AD); Lyndhurst South, Dec. 1920, *A.C.Gates* (MEL); Deddick, Oct. 1941, *W.Hunter* (NSW); Stawell Rifle Range Reserve, 18 Sep. 1990, *D.L.Jones 6527 & C.H.Broers* (CANB); Kanga, Sep. 1941, *J.Leppitt 670* (AD); Greensborough, Sep. 1941, *J.Leppitt 702* (AD); Greensborough, Sep. 1925, *W.H.Nicholls* (NSW); Ringwood, 9 Sep. 1915, *E.E.Pescott* (AD); Sale, Oct. 1899, no collector (NSW).

ILLUSTRATIONS: Page 550, Jones (2021); page 345, Copeland & Backhouse (2022); page 240, Backhouse (2023), both as *Pterostylis cycnocephala*.

4. ***Hymenochilus cymbellus*** D.L.Jones, ***sp. nov***. (Fig. 7–8).

TYPE: Australia. South Australia: 1.4 km along track E of Mangalo-Cowell road towards “Pootitnee” property, 6 Sep. 2000, *D.L.Jones 17348 & M.Garratt* (holotype, CANB 622384; isotypes: AD, MEL–2371227A).

DIAGNOSIS: With an affinity to *H. cycnocephalus,* but it differs by its sparser basal rosette with narrower rosette leaves (to 10 mm wide *cf.* 15 mm wide in *H. cycnocephalus*), thinner scapes (0.5–1.5 mm wide *cf.* 2–3 mm wide in *H. cycnocephalus*), flowers with distinct darker green stripes (faintly striped flowers in *H. cycnocephalus*) and shallowly saccate lateral sepals that narrow inwards to a distinctly pointed apex (deeply saccate lateral sepals with subacute apex in *H. cycnocephalus*).

Leaves 3–10; *lamina* ovate to elliptical, 7–25 mm long, 4–10 mm wide, green, thin-textured, dull, margins entire, apex acute to acuminate or apiculate. *Scape* 2–12 cm tall, 0.5–1.5 mm across, 1–8-flowered. *Sterile bracts* 2–4, closely sheathing to spreading, elliptic when flattened, 3–8 mm long, 1.5–4 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 2–4 mm long, straight, slender. *Ovaries* oblong to elliptic, 2–4 mm long, *ca.* 1.5 mm wide. *Flowers* porrect, relatively crowded to well-spaced, 6–9 mm long, 3–4 mm wide, green with conspicuous narrow darker green stripes. *Dorsal sepal* 7–8 mm long, 4–5 mm wide, slightly gibbous at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, shallowly saccate, dorsally gibbous, the apex pointed, when flattened 4–5 mm long, 4–5 mm wide, points subacute, 2–3 mm apart. *Petals* asymmetrical, more or less ovate, 5.0–5.5 mm long, 3.0–3.5 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, a dorsal gibbosity above the middle, ventral margin smooth or weakly irregular. *Labellum claw* irritable, ligulate, *ca.* 1.3 mm long, *ca.*1 mm wide. *Labellum lamina* elliptic–obovate, 2.2–2.5 mm long, 1.8–2.2 mm wide, whitish green with a dark green basal appendage, membranous, apex emarginate. *Basal appendage* recurved at right angles, oblong, *ca.* 1.5 mm long, *ca.* 1 mm wide, margins dark green, thickened, central ridge narrow, raised above the margins, dark green, ending in a broad, blunt beak 0.8–1.0 mm long. *Callus* a thickened tapered medial ridge. *Column* obliquely erect, 7–8 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2 mm long, *ca.*1 mm wide, basal lobe deltate; inner margins strongly incurved, sparsely ciliate; barrier cilia *ca.* 0.4 mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 2.5 mm long, *ca.* 1.3 mm wide, raised. *Capsules* 6–8 mm long, 3–4 mm wide, on pedicels to 10 mm long.

DISTRIBUTION AND ECOLOGY: Known from the Eyre Peninsula in South Australia, between 50–350 m elevation. However, its exact range is uncertain. It may also occur in the Gawler Ranges. Grows on and around the margins of acidic rock outcrops; also, in shrubland, especially with broombush, in red–brown loam developed on acid schistose rocks, and among *Triodia* R.Br. clumps in relatively open sites.

FLOWERING: July to September.

RECOGNITION: *Hymenochilus cymbellus* is characterised by small, sparse rosettes with narrow leaves, thin scapes, relatively crowded to well-spaced, narrow, conspicuously striped flowers, shallowly saccate lateral sepals that narrow inwards to a distinctly pointed apex, ovate petals, elliptic-obovate labellum, and labellum basal appendage with a broad, blunt beak.

SIMILAR SPECIES: *Hymenochilus cycnocephalus* has more numerous and generally larger rosette leaves than *H. cymbellus*, darker green flowers with inconspicuous stripes, deeply saccate lateral sepals ending in a broad, blunt apex and an elliptical labellum with a broader beak on the basal appendage. Compared to *H. cymbellus, H. nemoralis* has relatively large rosette leaves, thicker scapes with more numerous relatively crowded to well-

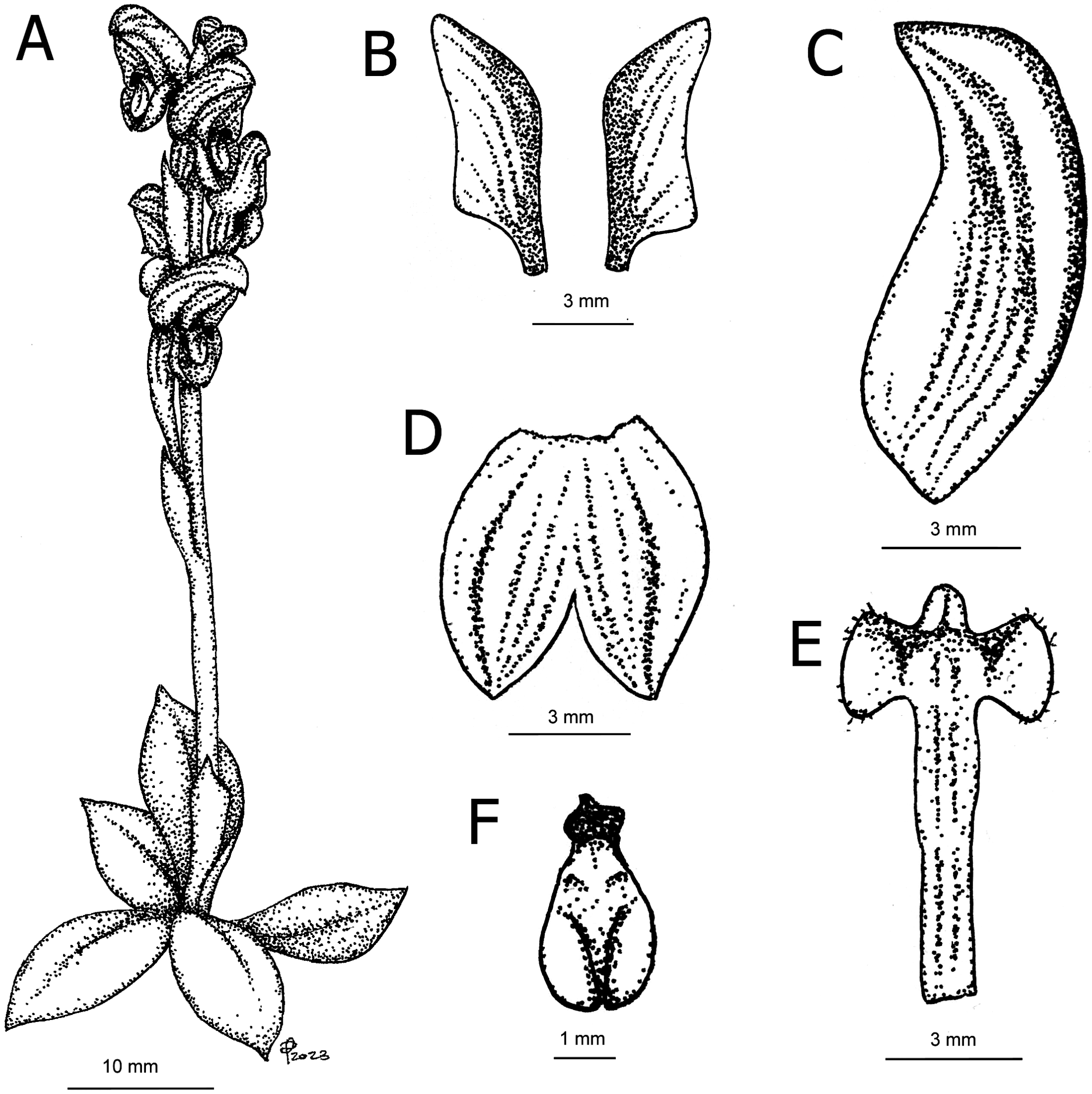


FIGURE 7. *Hymenochilus cymbellus* D.L.Jones. **A**. Habit. **B**. Petals. **C**. Flower from side. **D**. Synsepalum. **E**. Column from front. **F**. Labellum flattened, from above. Illustration by Z. Groeneveld. Carapee Rock SA, *DLJ 17379*, 6 Sep. 2000.

spaced flowers, deeply pouched blunt lateral sepals and an oblong labellum lamina with a short labellum appendage and narrow beak-like structure. *Hymenochilus pachylus* has larger crowded, fleshier rosette leaves than *H. cymbellus*, thicker scape, well-spaced flowers, and broadly obovate labellum with a short broad appendage. *Hymenochilus longipes* has larger rosette leaves than *H. cymbellus*, slender scape and broader, less prominently striped flowers with a longer stalk on the labellum appendage. *Hymenochilus crassicaulis* is more robust than *H. cymbellus* with greyish rosette leaves, thicker scapes, and larger crowded bluish-green and white flowers with a large beak on the labellum appendage. *Hymenochilus anemophilus*, *H. calcicola*, *H. pratensis* and *H. spissus* can all be distinguished from *H. cymbellus* by their densely crowded flowers.

Notes: The leaves of this species can either be extant or withered at flowering time.

Conservation status: A preliminary extinction risk assessment, based known occurrences of these species, yields an estimated extent of occurrence of 11,800 km^2. The species is at risk of continuing decline as a result of climate change, particularly the effect increased frequency and severity of drought, and increased temperatures on this species habitat. This indicates that the species may be eligible for listing as Vulnerable (B1+2ab).

Etymology: From the Latin *cymbella*, small boat, in reference to the shape of the lateral sepals.

Specimens examined: **SOUTH AUSTRALIA**: Curtinye Hill, NE of Kimba, 28 Aug. 1983, *R.Bates 3309* (AD); Stamford Hill, 18 July 1994, *R.Bates 37129* (CANB); E of Coolanie Hall, 5 Sep. 2000, *D.L.Jones 17329 & M.Garratt* (AD, CANB, MEL); Carrapee Hill, 6 Sep. 2000, *D.L.Jones 17379 & M.Garratt* (CANB); Carrapee Hill, 14 Sep. 1974, *F.A.Mason 296* (AD); Hincks Natl. Park, 7 Oct. 1968, *R.C.A.Nash* (AD); Hincks Natl. Park, 7 Oct. 1968, *J.R.Wheeler 776* (AD).

Illustrations: Page 550, Jones (2021); page 240, Niejalke (2022).

5. *Hymenochilus longipes* D.L.Jones, *sp. nov*. (Fig. 9–10).

TYPE: Australia. Queensland: “Nabwood”, Stanthorpe, Inglewood Road (private property), 18 Sep. 1996, *R.Crane 1624* (holotype, CBG-9708281).

Diagnosis: With affinity to *H. cycnocephalus,* but it differs by its thin-textured rosette leaves (thicker and fleshier in *H. cycnocephalus*), widely spaced darker green flowers with darker green veins (flowers translucent with faint veins in *H. cycnocephalus*), elliptic to obovate labellum lamina (oblong to elliptic in *H. cycnocephalus*) and a longer labellum basal appendage which protrudes prominently from the flower in side view (labellum basal appendage does not protrude prominently in *H. cycnocephalus*).

Leaves 5–8; *lamina* elliptical, 10–25 mm long, 5–12 mm wide, green, thin-textured, margins entire, apex acute to apiculate. *Scape* 10–28 cm tall, 1.5–2.5 mm across, 5–12-flowered. *Sterile bracts* 4–6, closely sheathing, oblong to elliptic when flattened, 5–15 mm long, 4–6 mm wide, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels ca.* 4 mm long, straight, slender. *Ovaries* oblong to elliptic, 3–4 mm long, *ca.*1.5 mm wide. *Flowers* porrect, widely spaced, 8–9 mm long, *ca.* 3–4 mm wide, green with darker green veins. *Dorsal sepal* 7–9 mm long, 4–6 mm wide, slightly gibbous at the base, nearly straight or shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, deeply saccate, dorsally gibbous, when flattened 4.0–5.5 mm long, 4.0–4.5 mm wide, points subacute, *ca.* 3 mm apart. *Petals* asymmetrical, more or less ovate–oblong, 6–7 mm long, 2.5–3.0 mm wide, green with darker green veins, dorsal margin strongly thickened, dark green, with a dorsal gibbosity just above the middle, ventral margin irregular. *Labellum claw* irritable, ligulate, *ca.*1 mm long, *ca.* 0.6 mm wide. *Labellum lamina* elliptic to obovate, 2.0–2.3 mm long, 1.8–2.0 mm wide, whitish green with a dark green appendage, membranous, apex emarginate. *Basal*

Figure 8. *Hymenochilus cymbellus* D.L.Jones. Eyre Peninsula, SA. Photo by J. Niejalke.

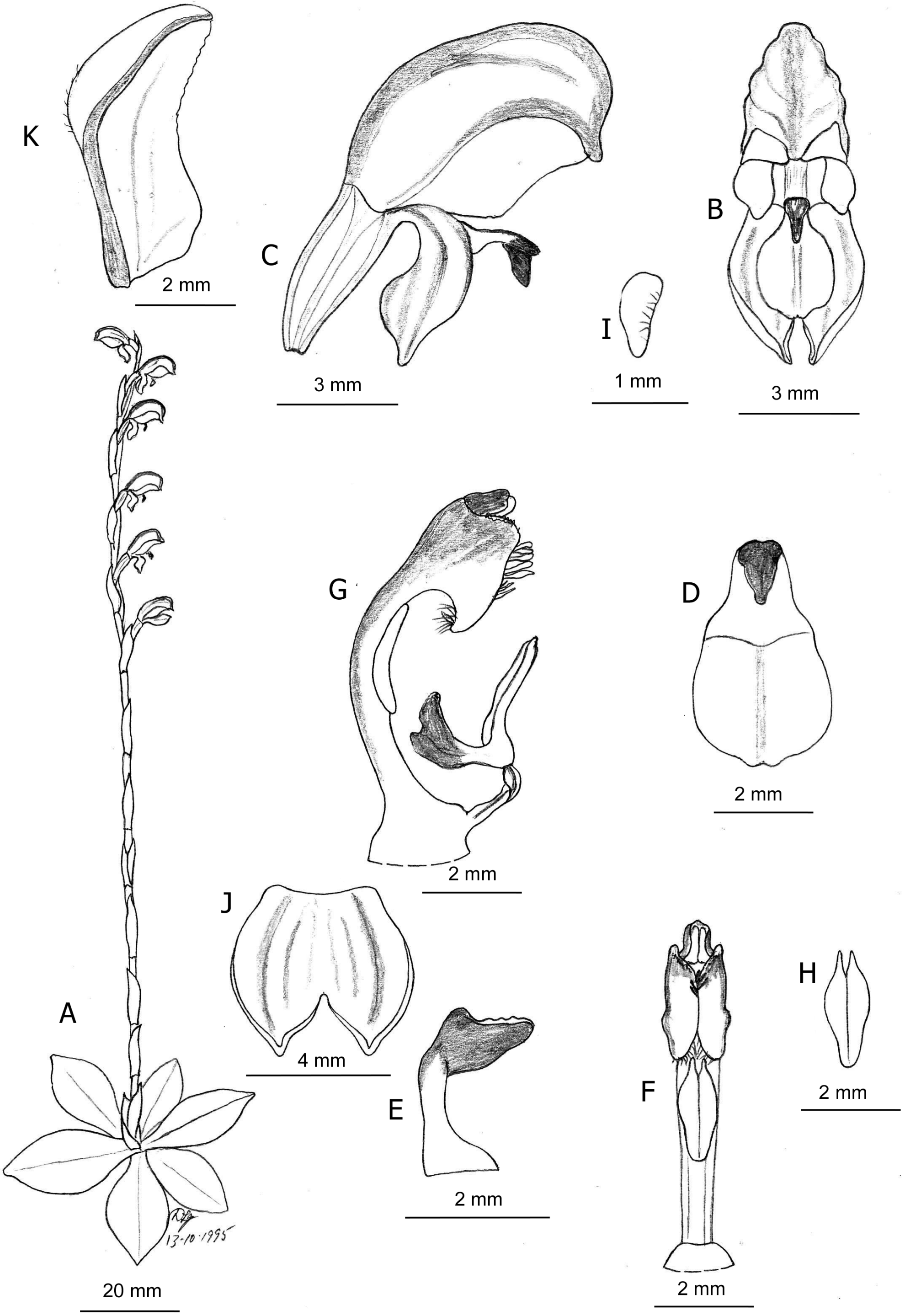


Figure 9. *Hymenochilus longipes* D.L.Jones. **A**. Habit. **B**. Flower from front. **C**. Flower from side. **D**. Labellum flattened, from above. **E**. Labellum appendage from side. **F**. Column from front. **G**. Column and labellum from side. **H**. Stigma. **I**. Pollinium. **J**. Synsepalum. **K**. Petal. Illustration by D. Jones. Texas Qld, *R. Crane1439*, 13 Oct. 1995.

appendage sharply recurved, on a long stalk and protruding from the flower in sideview, narrowly oblong, 1.5–2 mm long, *ca.* 0.8 mm wide, margins dark green, thickened, central ridge narrow, raised above the margins, dark green, ending in a broad, bluntish blunt beak 0.8–1 mm long. *Callus* a thickened, darker green, tapered medial ridge. *Column* obliquely erect, 6–8 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2 mm long, *ca.*1 mm wide, basal lobe deltate, inner margins sparsely ciliate; barrier cilia *ca.* 0.2 mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, scutiform, *ca.* 2 mm long, *ca.*1.2 mm wide, raised. *Capsules* obovoid, 5–6 mm long, *ca.* 3 mm wide, green to brown, on pedicels to 5 mm long.

Distribution and ecology: Occurs in the Darling Downs district of southern Queensland and Northern Tablelands of New South Wales, between 200–400 m in elevation. Grows in open woodland among granite rocks and in *Callitris* Vent. woodland, in well-drained brown to yellowish sand.

Flowering: Late August to November.

Recognition: *Hymenochilus longipes* is characterised by relatively small, green, thin-textured rosette leaves; thin scape; widely spaced, narrow green flowers with darker green veins; relatively small, deeply saccate lateral sepals; ovate-oblong petals; elliptic-obovate labellum lamina and, a long-stalked narrow labellum appendage protruding well out from the flower in sideview with a short, broad bluntish terminal beak.

Similar species: *Hymenochilus cycnocephalus* has larger fleshy rosette leaves, broader paler, faintly striped flowers than *H. longipes,* and a shortly stalked labellum appendage held all or mostly within the flower and with a longer, narrower pointed terminal beak. *Hymenochilus pachylus* has thicker-textured rosette leaves than *H. longipes*, broader flowers and a shorter stalk on the labellum appendage. *Hymenochilus nemoralis* has larger rosette leaves than *H. longipes* and larger, boldly striped flowers. *Hymenochilus cymbellus* has smaller, sparser rosette leaves than *H. longipes*, slender scape and narrower, prominently striped flowers with a broad beak on the labellum appendage. *Hymenochilus crassicaulis* is more robust than *H. longipes* with greyish rosette leaves, thicker scapes and larger, crowded bluish-green and white flowers with a large beak on the labellum appendage. *Hymenochilus anemophilus*, *H. calcicola*, *H. pratensis* and *H. spissus* can all be distinguished from *H. longipes* by their densely crowded flowers.

Figure 10. *Hymenochilus longipes* D.L.Jones. Warrabah, NSW. Photo by L. Copeland.

Notes: The leaves of this species are usually withered at flowering time.

Conservation status: This species has a widespread distribution, including within protected areas, with estimated extent of occurrence 46,000 km^2 a population size estimated to be >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Etymology: From the Latin *longus*, long, *pes, pedis*, foot, in reference to the long appendage on the labellum that projects conspicuously out from the lateral sepals in the set position.

Specimens examined: Hill 2 km E of Acland, 14 Sep. 1992, *R.Crane 836* (CANB); "Nabwood", Stanthorpe, Inglewood Road (private property), 22 Sep. 1995, *R.Crane 1439* (CANB); *ibid*, 18 Sep. 1996, *R.Crane 1622* (CANB); *ibid*, 18 Sep. 1996, *R.Crane 1624* (CANB); Murphys Creek, Glen Aplin, 20 Oct. 1996, *R.Crane 1743* (CANB); Girraween National Park, 11 Nov. 1996, *R.Crane 1763* (CANB).

Illustrations: Page 551, Jones (2021).

6. *Hymenochilus muticus* (R.Br.) D.L.Jones & M.A.Clem., *Austral. Orch. Res*. 4: 74 (2002); *Pterostylis mutica* R.Br., *Prodr*. 328 (1810). (Fig. 11–12).

TYPE: Australia. New South Wales: Port Jackson, raceground, Sep.–Oct. 1803, *R. Brown s.n.* (first-step lectotypification: BM, *fide* George (1971); second-step lectotypification: BM [BM000048248], specimen (a), *fide* Clements 1989, photo!; isolectotypes, BM [BM-000990303] specimen (a)!, K[K 00061957] specimen (c)!).

Leaves 5–12; *lamina* ovate to elliptical, 10–45 mm long, 5–18 mm wide, green, fleshy, dull, margins entire or slightly wavy, apex acute to apiculate. *Scape* 12–35 cm tall, 2–4 mm across, 3–22-flowered. *Sterile bracts* 3–5, closely sheathing, ovate to elliptic when flattened, 5–16 mm long, 3–6 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 3–5 mm long, straight, slender. *Ovaries* oblong to elliptic, 3–5 mm long, *ca.*1.5 mm wide. *Flowers* porrect, widely spaced, 10–14 mm long, 3–4.5 mm wide, translucent green with faint darker green stripes. *Dorsal sepal* 9–12 mm long, 5–7 mm wide, porrect from the ovary at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* obliquely deflexed to deflexed, deeply saccate, dorsally curved, when flattened 6–7 mm long, 7–9 mm wide, points subacute, 5–7 mm apart. *Petals* asymmetrical, more or less ovate–elliptic to rhomboid, 7.0–9.5 mm long, 3.5–4.5 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, a dorsal gibbosity above the middle, ventral margin with beaded siliceous cells. *Labellum claw* irritable, ligulate, *ca.* 2 mm long, *ca.*1 mm wide. *Labellum lamina* oblong to elliptic, 2.5–3.0 mm long, 2.5–3 mm wide, whitish green with a dark green basal appendage, membranous, apex emarginate. *Basal appendage* recurved nearly at right angles to lamina, oblong to oblong–tapered, *ca.* 2.2 mm long, *ca.*1.3 mm wide, margins green, thickened, central ridge narrow, raised above the margins, dark green, ending below the apex of the appendage. *Callus* a thickened, tapered, channelled medial ridge. *Column* obliquely erect, 6.5–7.0 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 3 mm long, *ca.*1.5 mm wide, basal lobe ovate to deltate, inner margins incurved, sparsely ciliate; barrier cilia *ca.* 0.4 mm long, linear-clavate. *Anther ca.*1.2 mm long, obtuse. *Pollinia* clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 3.5 mm long, *ca.*1.2 mm wide, raised. *Capsules* 5–8 mm long, 3–4 mm wide, on pedicels to 10 mm long.

Distribution and ecology: This species occurs in Queensland (Mt Moffat, Canarvon Range to Stanthorpe, coast near Noosa), New South Wales (widespread inland, Tenterfield to Narranderra, Albury, inland to Brewarrina) Australian Capital Territory, and Victoria (east to west, mainly inland areas), between 10–900 m in elevation. Although the type collection was made from Port Jackson, its main occurrence is in areas well inland from the coast. It grows in open forest, woodland, especially *Callitris* woodland, rocky slopes, rock outcrops and grassland in shallow well-drained to moisture-retentive clay loam and sandy loam.

Flowering: August to November.

Recognition: *Hymenochilus muticus* is characterised by relatively large, fleshy rosette leaves (to 45 × 18 mm); tall, sturdy scape (to *ca.* 35 × 0.4 cm); widely spaced translucent green flowers, to 14.0 × 4.5 mm, with faint darker green stripes; deeply saccate lateral sepals; relatively broad ovate-elliptic to rhomboid petals; oblong to elliptical labellum lamina to 3 × 3 mm; and labellum basal appendage with a short, protruding central ridge ending well below the top of the appendage.

Similar species: *Hymenochilus pagophilus* has a slightly thicker scape than *H. muticus*, moderately crowded to crowded, broader, shinier flowers, and a rectangular-obovate labellum. *Hymenochilus pisinnus* has fewer and smaller rosette leaves than *H. muticus*, thinner flower stem and smaller flowers with shallowly saccate lateral sepals and a smaller obovate labellum.

Hymenochilus confertus D.L.Jones*, H. rubenachii* (D.L.Jones) D.L.Jones & M.A.Clements and *H. wapstrarum* (D.L.Jones) D.L.Jones & M.A.Clements can all be distinguished from *H. muticus* by their densely crowded flowers.

Notes: *Hymenochilus muticus* is commonest in inland localities and is generally uncommon to rare in coastal and near-coastal sites. The type collection was made from the raceground at Port Jackson (possibly the modern suburb of Randwick) which is not far from the coast. The type specimens are not as robust as plants from inland areas, but they are in the early stage of flowering and features of the labellum are consistent with those in other parts of New South Wales.

We are uncertain whether *H. muticus sens. strict*. extends to Tasmania. We have examined several collections from that state that may be this species, however they are all either in such poor condition and therefore difficult to identify with any accuracy, or are without specific locality, as in some of Gunn's collections. A number of specimens have crowded flowers atypical of *H. muticus* and may be better placed in *H. rubenachii* or *H. wapstrarum*, however, a few have widely spaced flowers. The presence of *H. muticus* in Tasmania can only be resolved by the examination of fresh specimens. Details of specimens examined to date from Tasmania are included in the specimen list.

Conservation status: This species has a widespread distribution, including in three national parks, with estimated extent of occurrence 1,155,000 km^2, and a population size estimated to be >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Specimens examined: **QUEENSLAND**: Durong, Kingaroy Line, Aug. 1949, *W.W.Abell* (NSW); Brigooda, 12 Sep. 1949, *W.W.Abell* (NSW); Wandai, 27 July 1952, *W.W.Abell* (NSW); Texas, 22 Sep. 1992, *R.Crane 842, 852 & 857* (CANB); Nabwood, off Stanthorpe-Inglewood Road, 18 Aug. 1997, *R.Crane 1437* (CANB); Texas State Forest, 19 Sep. 1996, *R.Crane 1629* (CANB); Proston, Aug. 1949, *W.Power* (NSW). NEW SOUTH WALES: Coonamble, Oct. 1987, *R.Bates* (AD); Girilambone, near Cobar, Oct. 1987, *R.Bates* (AD); Gulargambone, Oct. 1987, *R.Bates 10636* (AD); Bobadah, Oct. 1987, *R.Bates* (AD); 15 km W of Mt Kaputar, 14 Oct. 1987, *R.Bates 10649* (AD); Warrambungles, 12 Oct. 1987, *R.Bates 10714* (AD); 20 km SSW of Cowra, 20 Oct. 1987, *R.Bates 11111* (AD); 10 km N of Parkes, 10 Oct. 1987, *R.Bates 11292* (AD); Bingara, Sep. 1907, *J.L.Boorman* (NSW); Forked Mountain, Coonabarabran, Sep. 1908, *J.L.Boorman* (NSW); Warialda, Sep. 1914, *J.L.Boorman* (NSW); 20 km E of Goolgowi, 22 Sep. 1974, *B.G.Briggs 5404* (NSW); Dubbo Arboretum, 1 Sep. 1961, *W.Brinsley* (PERTH); Mullion Creek, 7 Dec*a.* 1960, *N.T.Burbidge 6895* (CANB); Eugowra, 2 Oct. 1978, *M.A,Clements 1589* (CANB); Kangarooby, 16 Oct. 1984, *M.A.Clements 3514* (CANB); *ca.* 12 km W of Canowindra, 8 Sep. 1985, *M.A.Clements 3724* (CANB); *ca.* 35 km S of Dubbo, 22 Sep. 1985, *M.A.Clements 3747* (CANB); Coonabarabran, 7 Oct. 1985, *M.A.Clements 3844* (CANB); Mt Jerrabomberra, 14 Oct. 1985, *D.L.Jones 3873* (CANB); Narranderra Range, 30 Sep. 1989, *M.A.Clements 5051* (CANB); Marayong, 3 Sep. 1966, *R.Coveny* (NSW); Howell, 5 Oct. 1969, *R.Coveny 2285* (NSW); Warrumbungle Range, 11 Oct. 1978, *M.D.Crisp 4381* (CANB); 32 km from Nymagee on Bobadah Road, 11 Aug. 1973, *G.Cunningham & P.Milthorpe 878* (NSW); along gas pipeline, Kilparney, Mt Hope, 31 Aug. 1974, *G.Cunningham & P.Milthorpe 3201* (NSW); 8 miles S of Nymagee, 5 Oct. 1974, *G.Cunningham & P.Milthorpe 3204* (NSW); NE corner of Manna State Forest, Condobolin, 20 Sep. 1975, *G.Cunningham & P.Milthorpe 3812* (NSW); Kingsdale, 17 Oct. 1967, *H.Doing* (CANB); West Wyalong, 3 Oct. 1969, *H.Goldsack* (AD); Greenbah Creek, Coonabarabran-Mendooran Road, 10 Oct. 1989, *K.M.Groeneveld 115* (CANB); *ca.* 1.5 km SE of Gungal, 10 Sep. 2001, *W.Holzinger 107* (CANB); Oxley Park, Tamworth, 11 Sep. 1993, *J.R.Hosking 782a & P.Syrett* (CANB, MEL, NSW); Carlisles Gully, New England Tableland, 17 Nov. 1953, *R.W.Jessup & M.Gray 2277* (CANB); Rimbanda Road, New England Tableland, 17 Nov. 1953, *R.W.Jessup & M.Gray 2287* (CANB); 1 km S of Coonabarabran, 13 Sep. 1985, *D.L.Jones 1845 & B.E.Jones* (CANB); 12 km S of Ardlethan, 10 Sep. 1988, *D.L.Jones 2801 & M.A.Clements* (CANB); Mt Caley, 11 Sep. 1988, *D.L.Jones 2832 & M.A.Clements* (CANB); 43.5 km from Forbes towards Grenfell, 29 Sep. 1989, *D.L.Jones 5147* (CANB, NSW); Bullawa Sate Forest, 30 Sep. 1989, *D.L.Jones 5169* (CANB); halfway up track to Mt Kaputar, 30 Sep. 1989, *D.L.Jones 5179* (BRI, CANB, NSW); Deriah State Forest, 2 Sep. 1990, *D.L.Jones 6364 & B.E.Jones* (CANB); 9 km S of Narrabri, 2 Sep. 1990, *D.L.Jones 6368 & B.E.Jones* (CANB); Quarry Road, *ca.* 16 km N of Griffith, 20 Sep. 1990, *D.L.Jones 6571 & C.H.Broers* (CANB); *ca.* 1 km S of Peel, 24 Sep. 1990, *D.L.Jones 6599 & C.H.Broers* (CANB); Blue Biddy Mountain, 24 Sep. 1990, *D.L.Jones 6613 & C.H.Broers* (CANB); Tuckland State Forest, NW of Gulgong, 24 Sep. 1990, *D.L.Jones 6629 & C.H.Broers* (CANB); 22 km N of Grenfell towards Forbes, 25 Sep. 1990, *D.L.Jones 6653 & C.H.Broers* (CANB); 2.7 km W of Elong Elong, 25 Sep. 1990, *D.L.Jones 6641 & C.H.Broers* (CANB); 54 km W of Dubbo, 25 Sep.

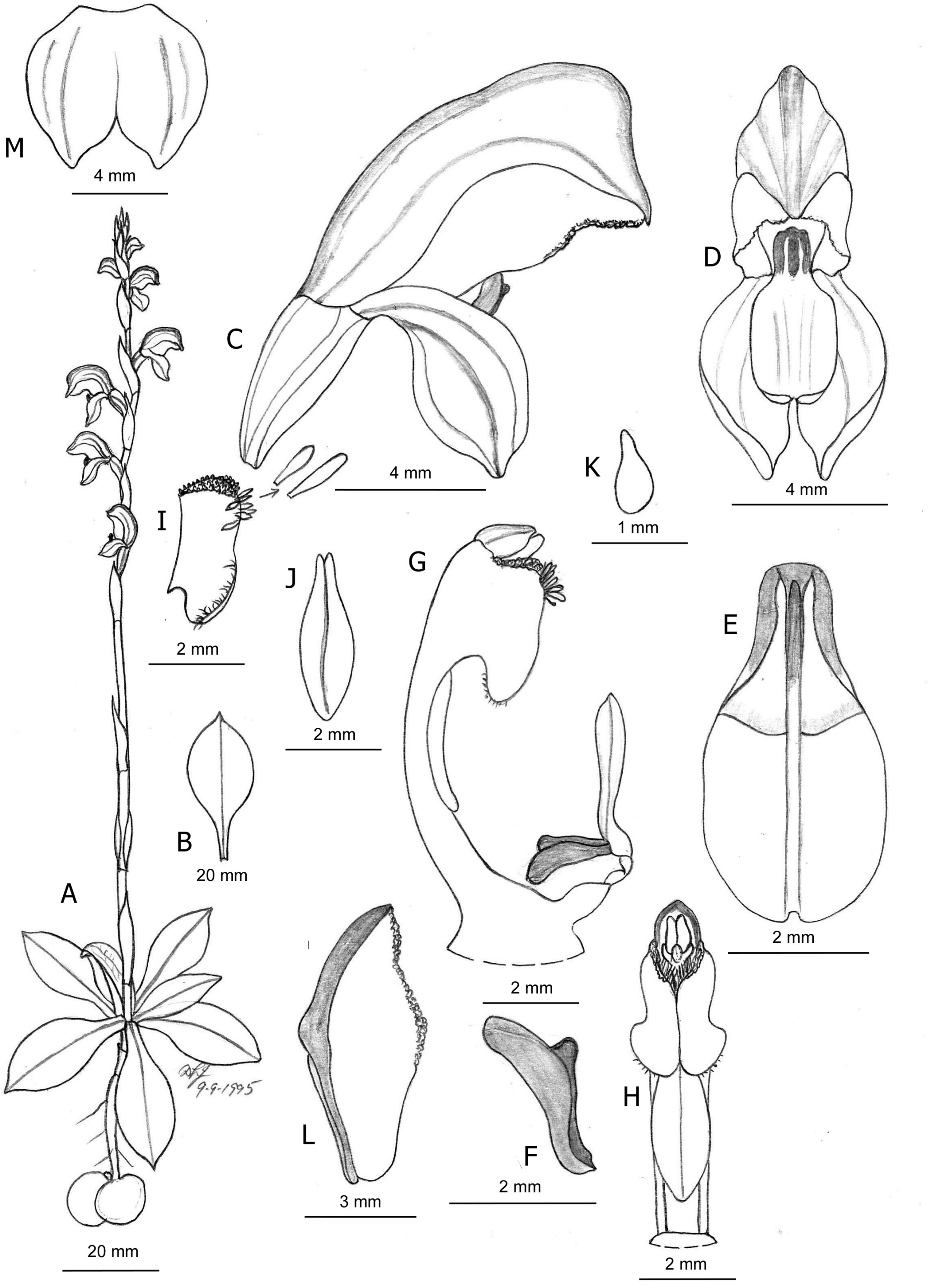


FIGURE 11. *Hymenochilus muticus* (R.Br.) D.L.Jones & M.A.Clem. **A**. Habit. **B**. Rosette leaf. **C**. Flower, side view. **D**. Flower, front view. **E**. Labellum flattened, from above. **F**. Labellum appendage, side view. **G**. Column and labellum, side view. **H**. Column, front view. **I**. Internal view of column wing and barrier trichomes. **J**. Stigma. **K**. Pollinium. **L**. Petal. **M**. Synsepal. Illustration by D. Jones. Mt Currumbenya NSW, *D.L. Jones s.n.*, 9 Sep. 1995.

1990, *D.L.Jones 6646 & C.H.Broers* (CANB); Fairfield, near Broken Hill, Aug. 1923, *T.Harris* (AD); Reefton State Forest, 22 Oct. 1992, *D.L.Jones 10441 & C.H.Broers* (CANB); 31 km N of Griffith, 28 Sep. 2000, *D.L.Jones 17552* (CANB); 9.1 km E of Weethalle, 28 Sep. 2000, *D.L.Jones 17569* (CANB); 8 km W of Barmedman, 28 Sep. 2000, *D.L.Jones 17574* (CANB); Sims Gap, 28 Sep. 2000, *D.L.Jones 17557* (CANB); Yarranjerry State Forest, 18 Sep. 2005, *D.L.Jones 19244 & B.E.Jones* (CANB); Wahgunyah State Forest, 29 Sep. 2005, *D.L.Jones 19281 & M.A.Clements* (CANB); Tea-tree Creek, Bundarra Road, Oct. 1968, *I.G.Matthias* (CANB); Coonabarabran, 18 Sep. 1975, *P.Metcalfe* (NSW); Waabalong, Hillston, 4 Aug. 1973, *P.Milthorpe 1281* (NSW); 2 km S of Shepherds Hill, Euabalong West, 2 Sep. 1974, *P.Milthorpe & G.Cunningham 2764* (NSW); Broken Range, Hyandra, Mt Hope, 31 Aug. 1974, *P.Milthorpe & G.Cunningham 2998* (NSW); Bulga Range, 10 km E of Narromine, 6 Sep. 1973, *N.Perry 10* (NSW); Cocoparra Natl. Park, 1 Sep. 1990, *J.Roberts* (CANB); Paterson, Sep. 1924, *H.M.R.Rupp* (NSW); Martins Creek, 29 Aug. 1926, *G.V.Scammell* (NSW); Griffith, 29 Aug. 1927, *G.V.Scammell* (NSW); Escort Rock, Eugowra, 5 Oct. 1963, *B.Whitehead* (CANB); Warraderry, 21 Sep. 1963, *B.Whitehead* (CANB); Gunning Gap, 17 Sep. 1966, *B.Whitehead* (CANB). **AUSTRALIAN CAPITAL TERRITORY**: Upper Cotter Road, 13 Oct. 1963, *L.Adams 722* (CANB); Tidbinbilla Range, 27 Oct. 1963, *L.Adams 752* (CANB); Bendora Dam Road, 30 Oct. 1963, *L.Adams 758* (CANB); Molonglo Gorge, 6 Nov. 1966, *L.Adams 1607* (CANB); Towards Bendora Dam, 5 Nov. 1964, *L.Adams & M.Gray 5573* (CANB); Majura Firing Range, 3 Nov. 1994, *I.Crawford 2785* (CANB); *ibid*, 30 Oct. 1998, *P.Downey 344* (CANB); Bruce Ridge, 20 Oct. 1999, *M.Garratt (ORG 2776)* (CANB); Gibralter Falls, 14 Nov. 1962, *M.Gray 5293* (CANB); Bulls Head to Bendora Dam Road, 13 Oct. 1963, *M.Gray 5345* (CANB); Majura Firing Range, 19 Oct. 1998, *D.L.Jones 15888, M.A.Clements & P.Downey* (CANB); Gungahlin Hill Nature Reserve, 20 Oct. 1998, *D.L.Jones 15895* (CANB); 3.6 km S of Glendale Crossing, Namadgi Natl. Park, 3 Dec. 1998, *D.L.Jones 16234 & M.Garratt* (CANB); *ca.* 300 m S of Birrigai Camp, Tidbinbilla Road, 21 Oct. 1991, *D.Mallinson 156* (CANB); 1 km E of Vanitys Crossing, 2 Nov. 1992, *D.Mallinson 275* (CANB); Five Crossings, 8 Nov. 1962, *H.S.McKee 9656* (CANB); Black Mountain, 17 Nov. 1969, *P.Macnicol & CA.Appleby* (CANB). **VICTORIA**: Diamond Creek, 30 Sep. 1904, *W.R.Baker* (CANB); Yea, Oct. 1904, *W.R.Baker* (MEL); Bendigo, 14–16 Sep. 1905–1907, *W.R.Baker* (MEL); Mt Meg Flora and Fauna Reserve, 13 Sep. 1985, *A.C.Beauglehole 80407* (CANB); Warby Ranges State Park, 23 Sep. 1985, *A.C.Beauglehole 80796* (CANB); Wallaby Hill Education Area, 24 Sep. 1985, *A.C.Beauglehole 80859* (MEL); Knocker Track near Omeo, 17 Nov. 1989, *P.Branwhite (D.L.Jones 5390)* (CANB); 17.7 km from Wangaratta towards Thoona, 26 Oct. 1967, *E.Canning* (CANB); Havelock–Timor State Forest, 3 Oct. 1981, *E.Courtney* (MEL); Chiltern Forest, Oct. 1964, *M.R.Pocock* (AD); (?)TASMANIA. Penstock, Dec. 1929, *A.V.Giblin* (CANB); Glen Leith, New Norfolk, 24 Oct. 1840, *R.Gunn* (CANB); “Wetmore”, Midlands, Nov. 2005, *K.Johnson & M.Appleby* (CANB); Knocklofty-Mt Stewart, 22 Oct. 1951, *Scott* (HO 87743).

Figure 12. *Hymenochilus muticus* (R.Br.) D.L.Jones & M.A.Clem. Sandy Hollow, NSW. Photo by L. Copeland.

Illustrations: Page 546, Jones (2021), as *H. muticus*; page 343, Copeland & Backhouse (2022); page 236, Backhouse (2023), both as *Pterostylis mutica*.

7. ***Hymenochilus nemoralis*** D.L.Jones, ***sp. nov***. (Fig. 13–14).

TYPE: Australia. South Australia: Alligator Gorge National Park, Circle Track, 5.9 km from Ranger Station, 5 Sep. 1999, *D.L.Jones 16701 & M.Garratt* (holotype, CANB-607292).

Diagnosis: With affinity to *H. cycnocephalus* but it dif-

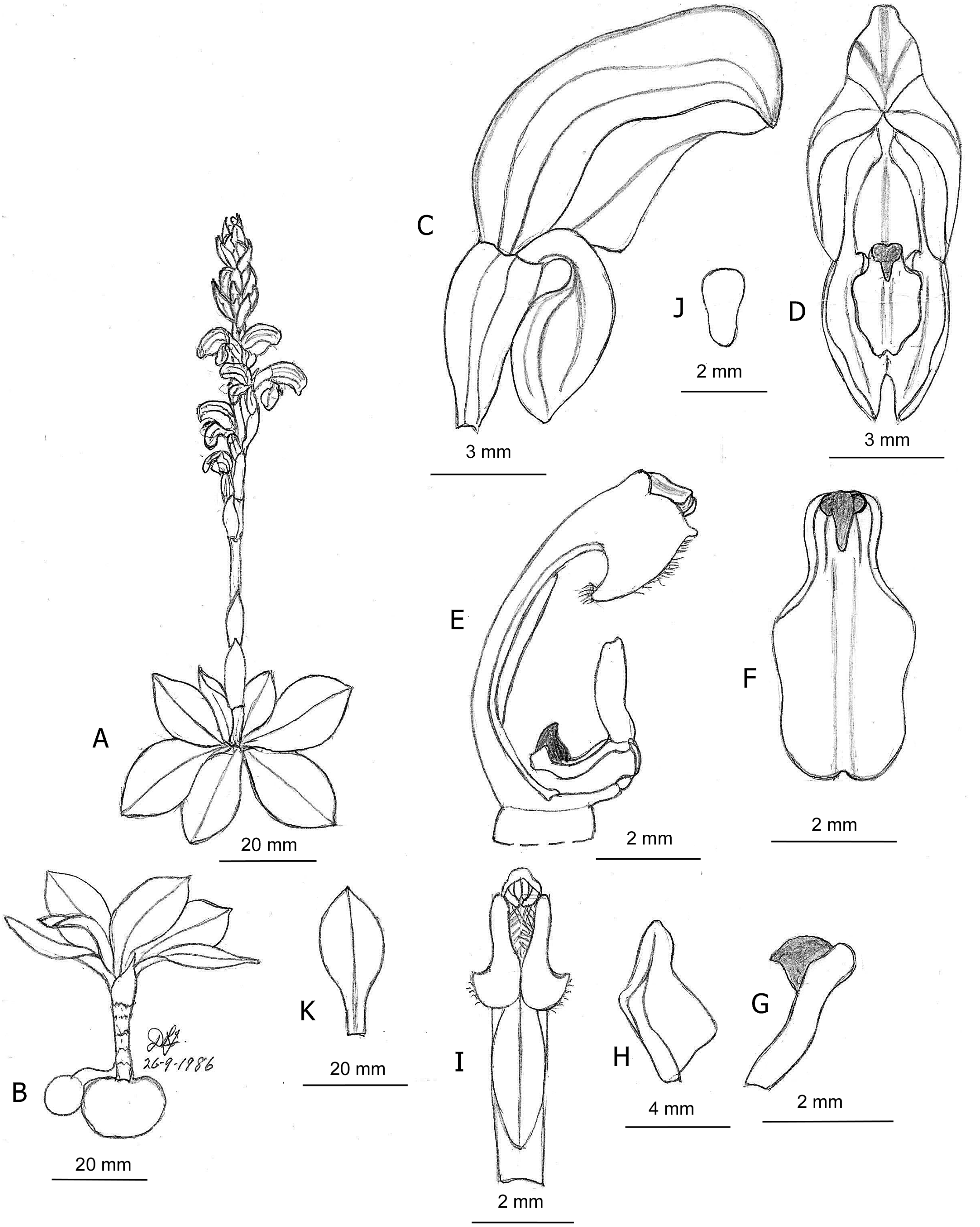


Figure 13. *Hymenochilus nemoralis* D.L.Jones. **A**. Habit. **B**. Rosette. **C**. Flower, side view. **D**. Flower, front view. **E**. Column and labellum, side view. **F**. Labellum flattened, from above. **G**. Labellum appendage, side view. **H**. Petal. **I**. Column, front view. **J**. Pollinium. **K**. Rosette leaf. Illustration by D. Jones. Tailem Bend SA, *M.A. Clements s.n.*, 26 Sep. 1986.

fers by its longer rosette leaves (to 40 mm long *cf.* to 25 mm long in H. *cycnocephalus*), thicker scape (3–4 mm wide *cf.* 2–3 mm in *H. cycnocephalus*) and darker green flowers with prominent narrow dark green stripes (translucent green, faintly striped flowers in *H. cycnocephalus*.

Leaves 5–11; *lamina* thickish, ovate to elliptical, 10–40 mm long, 5–15 mm wide, green to greyish–green, thin-textured, dull, margins entire, apex acute to acuminate. *Scape* 5–25 cm tall, 3–4 mm across, 5–18-flowered. *Sterile bracts* 3–6, closely sheathing to spreading, elliptic when flattened, 5–16 mm long, 4–8 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 3–5 mm long, straight, slender. *Ovaries* oblong to elliptic, 3–5 mm long, *ca.* 1.5 mm wide. *Flowers* porrect, relatively crowded to well-spaced, 10–12 mm long, 3–4 mm wide, light green with narrow darker green stripes. *Dorsal sepal* 8–9.5 mm long, 4–5 mm wide, slightly gibbous at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, deeply saccate, dorsally gibbous, when flattened 4–5 mm long, 4–5 mm wide, points subacute, 2–3 mm apart. *Petals* asymmetrical, more or less ovate, 6–7 mm long, 3–3.5 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, a dorsal gibbosity above the middle, ventral margin smooth or irregular. *Labellum claw* irritable, ligulate, *ca.* 1.6 mm long, *ca.*1.3 mm wide. *Labellum lamina* oblong, 2.2–2.5mm long, 1.8–2mm wide, whitish green with a dark green appendage, membranous, apex emarginate. *Basal appendage* recurved at right angles, oblong, *ca.*1.5 mm long, *ca.*1 mm wide, *ca.* 0.5 mm thick, margins dark green, thickened, central ridge narrow, raised above the margins, dark green, ending in a narrow, pointed beak 0.8–1 mm long. *Callus* a thickened tapered medial ridge. *Column* obliquely erect, 7–8 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2.5 mm long, *ca.*1.5 mm wide, basal lobe deltate, inner margins strongly incurved, sparsely ciliate; barrier cilia *ca.* 0.4 mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* clavate, *ca.* 0.8 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 3 mm long, *ca.*1.3 mm wide, raised. *Capsules* 6–8 mm long, 3–4 mm wide, on pedicels to 9 mm long.

Figure 14. *Hymenochilus nemoralis* D.L.Jones. Kangaroo Flat, SA. Photo by J. Niejalke.

Distribution and ecology: Widespread in South Australia extending at least from the Mount Lofty Ranges north to the Flinders Ranges and possibly also in the Gawler Ranges and upper parts of the South-eastern District, between 50–800 m in elevation. It apparently also occurs in western Victoria, where known from the vicinity of Tallageira and Rocklands (text and illustration on page 241 Backhouse 2023). I did not see any specimens from that region. It often grows in treed habitats such as open forest and woodland, but is also found in shrubland, mallee-broombush association and on rock outcrops in well-drained loamy soils developed on acidic rocks such as schists, granite, and porphyry.

Flowering: August to October.

Recognition: Compared to *Hymenochilus cycnocephalus, H. nemoralis* is characterised by large thickish rosette leaves; thick scape; relatively crowded to widely spaced green flowers with prominent narrow

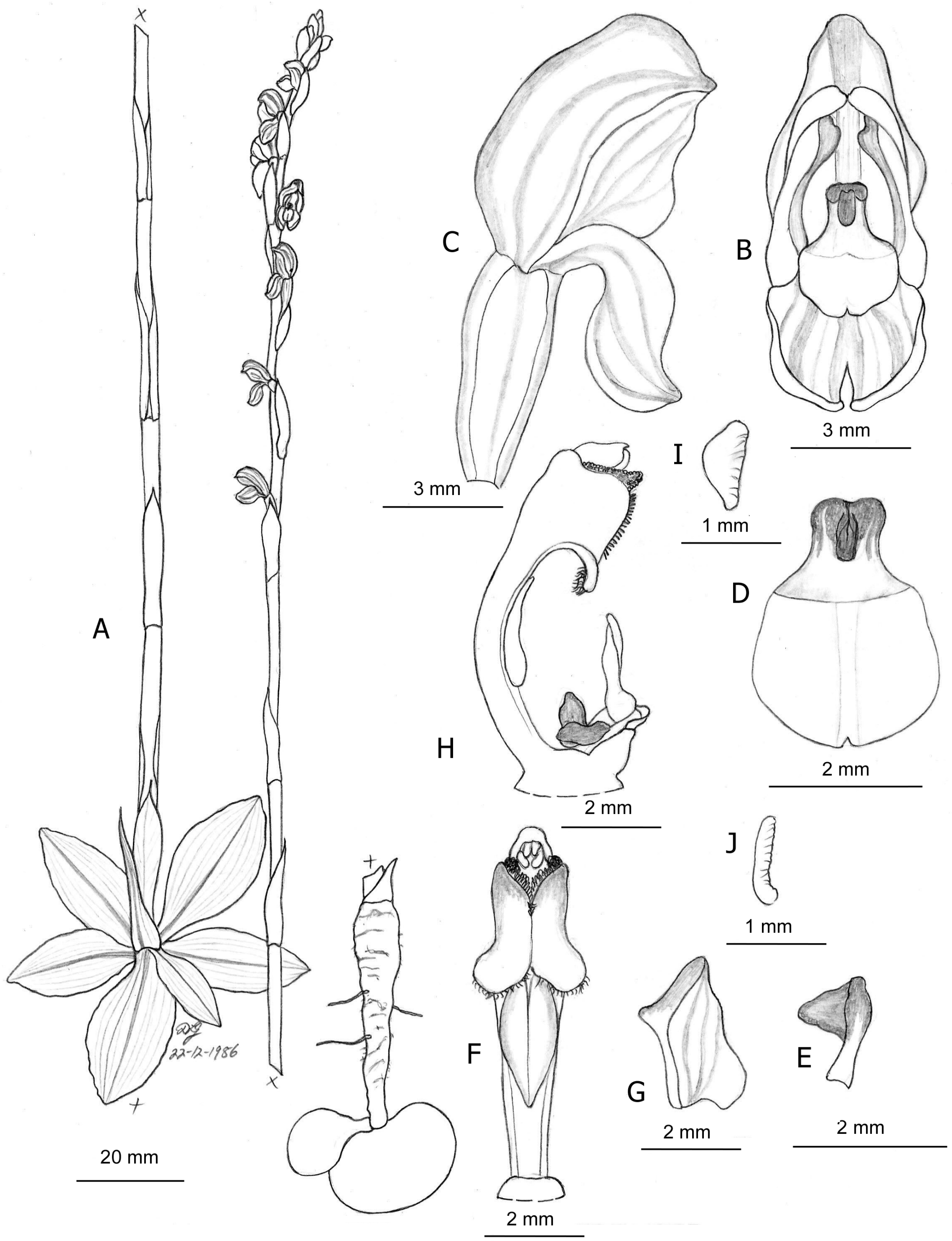


FIGURE 15. *Hymenochilus pachylus* D.L.Jones. **A**. Habit. **B**. Flower, front view. **C**. Flower, side view. **D**. Labellum flattened, from above. **E**. Labellum appendage, side view. **F**. Column, front view. **G**. Petal. **H**. Column and labellum, side view. **I–J**. Pollinia from different anther cells. Illustration by D. Jones. Barrington Tops NSW, *R.G. Tunstall s.n.*, 22 Dec. 1986.

dark green stripes; deeply saccate lateral sepals; ovate petals; oblong labellum lamina and, a short labellum appendage with a narrow, pointed beak.

Similar species: *Hymenochilus cycnocephalus* has smaller thinner rosette leaves, paler green flowers with inconspicuous stripes and an oblong to elliptical labellum with a broader beak on the labellum appendage. *Hymenochilus cymbellus*, which may occur in areas close to where *H. nemoralis* grows, has smaller, sparse rosette leaves, thin scapes, narrower flowers and shallowly saccate lateral sepals that narrow inwards to a distinctly pointed apex. *Hymenochilus longipes* also has thinner-textured rosette leaves than *H. nemoralis*, narrower flowers and a longer stalk on the labellum appendage. *Hymenochilus pachylus* has large, fleshy rosette leaves similar to *H. nemoralis*, but with widely spaced flowers and an obovate labellum with a thick blunt beak on the basal appendage. *Hymenochilus crassicaulis* is more robust than *H. nemoralis* with greyish rosette leaves, thicker scapes, and larger crowded bluish-green and white flowers with a large beak on the labellum appendage. *Hymenochilus anemophilus, H. calcicola, H. pratensis* and *H. spissus* can all be distinguished from *H. nemoralis* by their densely crowded flowers.

Notes: The leaves of this species are generally extant at flowering time. It is the most robust South Australian species within the *H. cycnocephalus* group.

Conservation status: This species has a widespread distribution, including in protected areas, with estimated extent of occurrence 119,000 km^2 and a population size of >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Etymology: From the Latin *nemoralis*, pertaining to forests, woods and groves, in reference to the forested habitats that this species prefers.

Specimens examined: **SOUTH AUSTRALIA**: near Tarlee, July 1979, *R.Bates 487* (AD); Alligator Gorge, 16 Sep. 1974, *R.Bates 774* (AD); Mt Lofty Ranges, Oct. 1943, *M.R.Hone 7372* (AD); 3 km S along Wirrabarra Forest Road towards Wirrabarra Forest, 4 Sep. 1999, *D.L.Jones 16684 & M.Garratt* (CANB).

Figure 16. *Hymenochilus pachylus* D.L.Jones. Barrington Tops, NSW. Photo by L. Copeland.

Illustrations: Page 551, Jones (2021); page 241, Niejalke (2022); page 241, Backhouse (2023), as *Pterostylis nemoralis*.

8. *Hymenochilus pachylus* D.L.Jones, ***sp. nov***. (Fig. 15–16).

TYPE: Australia. New South Wales: Barrington Tops, Pol Blue Creek, 19 Jan. 1985, *D.L.Jones 1766* (holotype, CBG-8506250; isotype, BRI).

Diagnosis: With affinity to *H. cycnocephalus* but it differs by its thicker rosette leaves, taller, thicker scape (to 28 mm tall, 3–4 mm wide cf. to 20 mm tall, 2–3 mm wide in *H. cycnocephalus*), flowers prominently striped (faintly striped in *H. cycnocephalus*), elliptic to obovate labellum lamina (oblong to elliptic in *H. cycnocephalus*) and labellum appendage with a short thick beak (narrow in *H. cycnocephalus*).

Leaves 5–8; *lamina* elliptical, 10–25 mm long, 5–12 mm wide, green, fleshy, margins entire, apex acute to apiculate. *Scape* 10–28 cm tall, 3–4 mm across, 5–12-flowered. *Sterile bracts* 4–6, closely sheathing, oblong to elliptic when flattened, 5–15 mm long, 4–6 mm wide, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels ca.* 4 mm long, straight, slender. *Ovaries* oblong to elliptic, 3–4 mm long, *ca.*1.5 mm wide. *Flowers* porrect, well-spaced, 8–9 mm long, 3–4 mm wide, translucent green with darker green veins. *Dorsal sepal* 7–9 mm long, 4–6 mm wide, slightly gibbous at the base, nearly straight or shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* deflexed, deeply saccate, dorsally gibbous, when flattened 4.0–5.5 mm long, 4.0–4.5 mm wide, points subacute, *ca.* 3 mm apart. *Petals* asymmetrical, more or less ovate–oblong, 6–7 mm long, 2.5–3.0 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, with a dorsal gibbosity just above the middle, ventral margin irregular. *Labellum claw* irritable, ligulate, *ca.* 1 mm long, c. 0.6 mm wide. *Labellum lamina* elliptic to obovate, 2.0–2.3 mm long, 1.8–2.0 mm wide, whitish green with a dark green appendage, membranous, apex emarginate. *Basal appendage* sharply recurved, narrowly oblong, 1.5–2.0 mm long, *ca.* 0.8 mm wide, margins dark green, thickened, central ridge narrow, raised above the margins, dark green, ending in a blunt beak 0.8–1.0 mm long. *Callus* a thickened, darker green, tapered medial ridge. *Column* obliquely erect, 6–8 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2 mm long, *ca.*1 mm wide, basal lobe deltate, inner margins sparsely ciliate; barrier cilia *ca.* 0.2 mm long, clavate. *Anther ca.*1 mm long, obtuse. *Pollinia* clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, scutiform, *ca.* 2 mm long, *ca.*1.2 mm wide, raised. *Capsules* obovoid, 5–6 mm long, *ca.* 3 mm wide, green to brown, on pedicels to 5 mm long.

Distribution and ecology: Relatively common on Barrington Tops in northern New South Wales; also occurring on the New England Tableland (Thungutti area of New England National Park, Tamworth) and in Mt Kaputar National Park, between 200–400 m in elevation. Grows in moist grassy areas on slopes above streams and on flats near swamps in dark brown to blackish well-structured loam.

Flowering period: Late November to February.

Recognition: *Hymenochilus pachylus* is characterised by relatively large, green, fleshy rosette leaves; tall, thickish scape; well-spaced green flowers with darker green veins; deeply saccate lateral sepals; ovate-oblong petals; broadly obovate labellum lamina and, a short, broad labellum appendage with a thick beak.

Similar species: *Hymenochilus cycnocephalus* has thinner-textured rosette leaves than *H. pachylus*, thinner scapes and a narrower oblong to elliptic labellum with a narrower labellum appendage and narrower terminal beak. *Hymenochilus longipes* also has thinner-textured rosette leaves than *H. pachylus*, narrower flowers and a longer stalk on the labellum appendage. *Hymenochilus nemoralis* has larger rosette leaves than *H. pachylus*, thicker scapes, and larger flowers that are more boldly striped. *Hymenochilus cymbellus* has smaller sparser rosette leaves than *H. pachylus*, slender scape and narrower, prominently striped flowers with a broad beak on the labellum appendage. *Hymenochilus crassicaulis* is more robust than *H. pachylus* with greyish rosette leaves, thicker scapes and larger crowded bluish-green and white flowers with a large beak on the labellum appendage. *Hymenochilus anemophilus*, *H. calcicola*, *H. pratensis* and *H. spissus* can all be distinguished from *H. pagophilus* by their densely crowded flowers.

Notes: The rosette leaves are usually withered at flowering time.

Conservation status: This species has a widespread distribution, including in three national parks, with estimated extent of occurrence as 21,000 km^2 and a population size estimated to be >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Etymology: From the Greek *pachylos*, thickish, in reference to the relatively thick peduncle, leaves and labellum appendage when compared with *H. cycnocephalus*.

Specimens examined: **NEW SOUTH WALES**: Pol Blue Creek, Barrington Tops, 8 Jan. 1989, *P.Branwhite (D.L.Jones 5617)* (CANB); Barrington Tops, Pol Blue, 5 Jan. 1985, *M.A.Clements 3624* (CANB); Euglah Spring Fire Trail, Mt Kaputar Natl. Park, 20 Sep. 1976, *R.Coveny 8866 & S.K.Roy* (NSW); Barrington Tops, 26 Nov. 1983, *G. D'Aubert (ORG 3475)* (CANB); Barrington Tops, 3 Jan.

1984, *G. D'Aubert (ORG 3480)* (CANB); Barrington Tops, 26 Feb. 1953, *A.W.Dockrill* (NSW); private property near Stewarts Brook State Forest, 3 De*ca.* 1998, *W.M.Dowling (ORG 2002)* (CANB); Nolands Swamp, Barrington Tops, 3 Feb. 2000, *W.M.Dowling 121* (CANB); *ibid*, 7 Jan. 1934, *L.Fraser & J.Vickery* (NSW); Barrington Tops, Jan. 1993, *D.Herd, G.Hillman, J.Riley & R.G.Tunstall* (CANB); Barrington Tops, Mt Royal Range, 28 Dec. 1947, *M.W.Nichols* (NSW); Pol Blue Creek, Barrington Tops, 27 Jan. 1990, *J.Riley (D.L.Jones 5634)* (CANB); Barrington Tops, Jan. 1928, *H.M.R.Rupp* (AD, NSW); Little Murray Creek, 11 Feb. 1971, *I.R.Telford 2701* (CANB).

Illustrations: Page 551, Jones (2021); page 346, Copeland & Backhouse (2022), as *Pterostylis pachyla* ms.

9. *Hymenochilus pagophilus* D.L.Jones, ***sp. nov***. (Fig. 17–18).

TYPE: Australia. South Australia: Near camping ground, Wilpena Pound, 31 July 1995, *D.L.Jones 14091 & B.E.Jones* (holotype, CANB-664129; isotype, AD).

Diagnosis: With affinity to *H. muticus* but it differs by its moderately crowded to crowded flowers (widely spaced in *H. muticus*), broader, shinier flowers (to 6 mm wide in *H. pagophilus cf.* to 4.5 mm wide in *H. muticus* and rectangular-obovate labellum (oblong to elliptic in *H. muticus*).

Leaves 5–12; *lamina* elliptical to ovate, 15–40 mm long, 5–14 mm wide, green, dull, margins entire, apex acute, acuminate or apiculate. *Scape* 5–35 cm tall, 3–4 mm wide, 3–30-flowered. *Sterile bracts* 3–5, closely sheathing, ovate to elliptic when flattened, 5–18 mm long, 4–6 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 3–10 mm long, straight, very slender. *Ovaries* oblong to elliptic, 3–5 mm long, 1–1.5 mm wide. *Flowers* porrect, shiny, moderately crowded to crowded, 8.5–12.0 mm long, 4–6 mm wide, green with faint darker green stripes. *Dorsal sepal* 8–10 mm long, 4–5 mm wide, porrect from the ovary at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* obliquely deflexed to deflexed, deeply saccate, dorsally curved, when flattened 6.5–8 mm long, 7–9 mm wide, points subacute, 4–6 mm apart. *Petals* asymmetrical, rhomboid, 8–9 mm long, 3.5–4.0 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, a dorsal gibbosity above the middle, ventral margin with beaded siliceous cells. *Labellum claw* irritable, ligulate, *ca.*1.8 mm long, *ca.*1.3 mm wide. *Labellum lamina* rectangular–obovate, 2.5–3.0 mm long, 2.5–3.0 mm wide, pale green with a light green to dark green basal appendage, membranous, apex truncate, emarginate. *Basal appendage* recurved at right angles or less, oblong, *ca.* 2 mm long, *ca.*1.3 mm wide, margins light green to dark green, thickened, central ridge narrow, slightly raised above the margins, green, ending below the apex of the appendage in a very short blunt beak. *Callus* a thickened, tapered, channelled medial ridge. *Column* obliquely erect, 7–8 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2.5 mm long, *ca.*1.4 mm wide, basal lobe ovate-deltate, inner margins incurved, sparsely ciliate; barrier cilia *ca.* 0.4 mm long, linear-clavate. *Anther ca.* 1 mm long, obtuse. *Pollinia* clavate to deltate, *ca.*1 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 3 mm long, *ca.*1 mm wide, raised. *Capsules* obovoid, 7–9 mm long, 3–4 mm wide, on pedicels to 14 mm long.

Distribution and ecology: Endemic in South Australia, where it occurs between 500 and 1000 m in elevation. The species is frequent in the northern Lofty Ranges and Flinders Ranges, extending to the northern parts of these ranges and into the Gammon Ranges (one record) and Emu Bluff in the Gairdner-Torrens Basin (one record); also in the Mongalata Hills in the Murray District and a single record from North Corunna Hill on the Eyre Peninsula. Grows in the wetter parts of the state on slopes and ridges under trees and shrubs, often among rocks or tussocks in shallow skeletal soils over acidic rocks such as quartzite and granite; also occasional on inland ranges and hills growing on the upper slopes and sheltered cliffs and bluffs where rainfall is concentrated.

Flowering: July to September.

Recognition: *Hymenochilus pagophilus* is characterised by large rosette leaves (to 40 × 14 mm); short to tall, thick scape (to 35 × 0.4 cm); moderately crowded to crowded, shiny flowers to 12 × 6 mm; deeply saccate lateral sepals; ovate petals with beaded siliceous marginal cells; rectangular-obovate labellum to 3.0 × 2.8 mm; and, recurved oblong appendage with a narrow central ridge slightly raised above the margins.

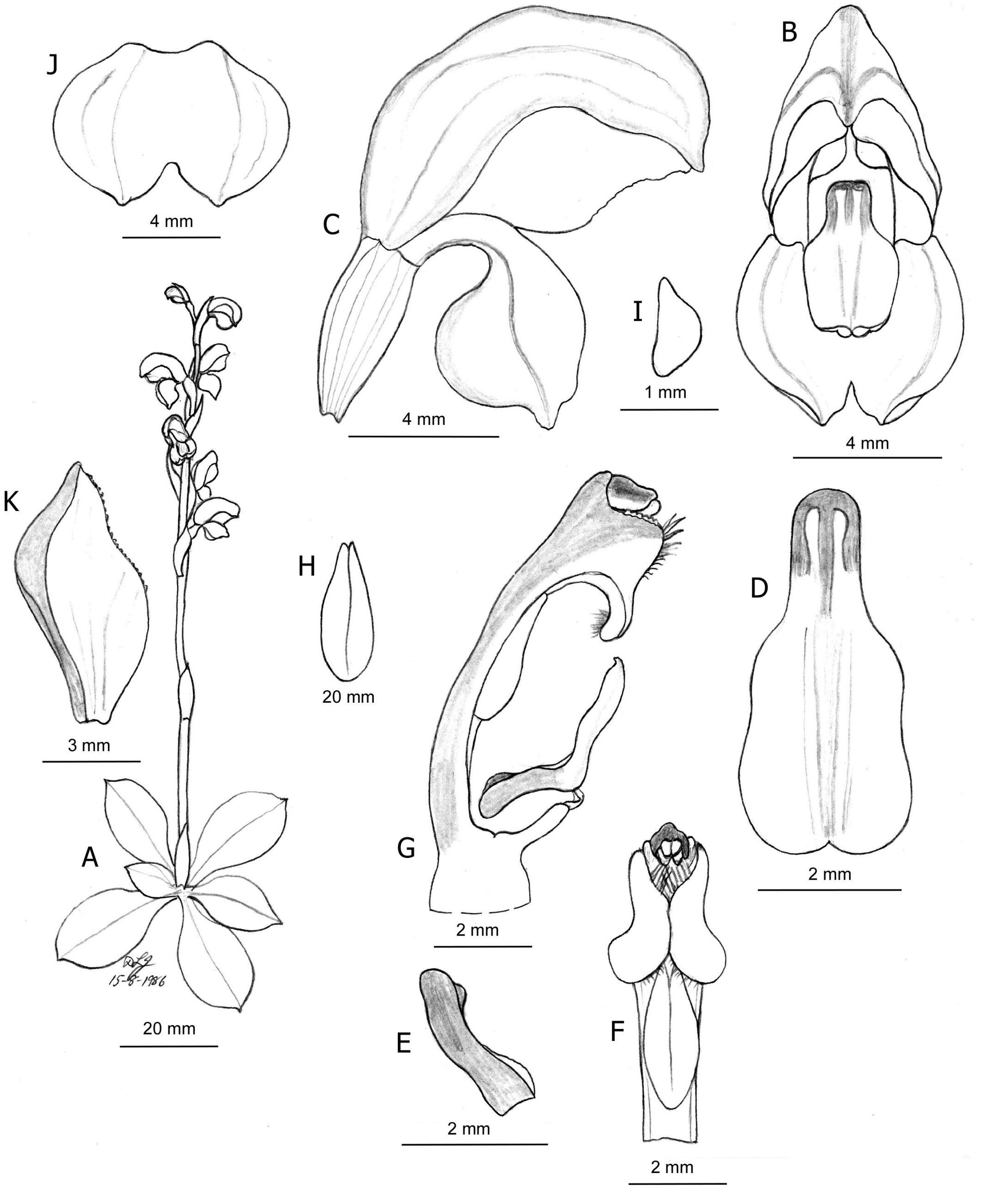


Figure 17. *Hymenochilus pagophilus* D.L.Jones. **A**. Habit. **B**. Flower, front view. **C**. Flower, side view. **D**. Labellum flattened, from above. **E**. Labellum appendage, side view. **F**. Column, front view. **G**. Column and labellum, side view. **H**. Stigma. **I**. Pollinium. **J**. Synsepal. **K**. Petal. Illustration by D. Jones. Flinders Ra. SA, cult H. Richards, 15 Aug. 1996.

Similar species: *Hymenochilus muticus* has a slightly thinner scape than *H. pagophilus*, well-spaced narrower flowers, and an oblong to elliptic labellum with a broader recurved appendage in which the central ridge ends in a short, slightly protruding, blunt beak situated well below the top of the appendage. *Hymenochilus pisinnus* has fewer and smaller rosette leaves than *H. pagophilus*, thinner flower stem and smaller flowers with shallowly saccate lateral sepals and an obovate labellum. *Hymenochilus confertus, H. rubenachii* and *H. wapstrarum* can all be distinguished from *H. pagophilus* by their densely crowded flowers.

Notes: The rosette leaves are usually green at anthesis.

Conservation status: This species has a widespread distribution, including in three national parks, with estimated extent of occurrence 116,000 km^2 and a population size of estimated to be >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Etymology: From the Greek *pagos*, hill and *philos*, loving, in reference to its habit of growing in mountainous and hilly districts.

Specimens examined: **SOUTH AUSTRALIA**: Emu Bluff, E of Lake Everard, 30 Aug. 1978, *R.Bates* (AD); Bibliando, 6 Aug. 2000, *R.Bates 57150* (CANB); Mongalata Hills, 25 Aug. 2000, *R.Bates 57249* (AD, CANB); Wilpena Pound, Flinders Ranges, Oct. 1924, *B.Beck* (AD); North Corunna Hill, Eyre Peninsula, 7 Sep. 1974, *R.J.Chinnock 1928 & B.Copley* (AD); Gammon Ranges, Arcoona Bluff Range, N of Arcoona Pound, 15 Sep. 1956, *Hj. Eichler 12606* (AD); 7.3 km SW of Blinman, towards Parachlina, 2 Aug. 1995, *D.L.Jones 14097A* (CANB); Aroona Valley, 5 Aug. 1995, *D.L.Jones 14099 & B.E.Jones* (CANB); Dutchmans Stern Conservation Park, 7 Sep. 1999, *D.L.Jones 16732 & M.Garratt* (CANB); 6 km along Heysen Trail from Dutchmans Stern entry gate, 10 Sep. 2000, *D.L.Jones 17473 & M.Garratt* (CANB); near Chalet, Wilpena Pound, 26 Aug. 1974, *T.B.Muir 5303* (CANB, MEL); Yourambulla Range, 7 km NW of Hawker, 31 Aug. 2003, *D.E.Murfet 4404* (CANB); near track to St Marys Peak, Wilpena Pound, 19 Oct. 2003, *D.E.Murfet 4456* (CANB); Wilpena Pound, 17 Sep. 1973, *P.Ollerenshaw 187* (CANB); Yarrah Vale Gorge, 16 km NE of Quorn, 21 Sep. 1973, *A.J.Sikkes 608 & P.Ollerenshaw* (CANB); 1 km SW of St Marys Peak, Wilpena Pound, 22 Sep. 1973, *A.J.Sikkes 752 & P.Ollerenshaw* (CANB); lower slopes, Mt John, Wilpena, 4 Sep. 1961, *D.E.Symon* (AD); upper slopes, Mt John, 14 Sep. 1960, *D.E.Symon 594* (AD, CANB); Wilpena Pound, Flinders Ranges, 1 Sep. 1967, *J.Warcup 167a* (AD).

Illustrations: Page 546, Jones (2021); page 242, Niejalke (2022).

10. ***Hymenochilus pisinnus*** D.L.Jones, ***sp. nov***. (Fig. 19–20).

Figure 18. *Hymenochilus pagophilus* D.L.Jones. Flinders Ra. SA. Photo by J. Niejalke.

TYPE: Australia. Western Australia: About 8 miles [*ca.* 12.8 km] S of Salmon Gums, 12 Sep. 1971, *A.S.George 11022* (holotype, PERTH-7535422).

Diagnosis: With affinity to *H. muticus* but it differs by its smaller rosette (3–7 leaves *cf.* 5–12 in *H. muticus*) with smaller, narrower leaves (to 35 × 12 mm *cf.* to 45 × 18 mm in *H. muticus*) , thinner scape (0.5–1.5 mm *cf.* 2–4 mm wide in *H. muticus*), smaller flowers (to 9 × 4 mm *cf.* to 14.0 × 4.5 mm in *H. muticus*) that are often on long pedicels (to 20 mm long *cf.* to 5 mm long in *H. muticus*), shorter, shallowly saccate lateral sepals (deeply saccate in *H. muticus*), smaller rhomboid petals and, smaller obovate labellum (to 2.5 × 2.0 mm *cf.* oblong to elliptic labellum to 3 × 3 mm in *H. muticus*).

Leaves 3–7; *lamina* narrowly elliptical to narrowly ovate, 10–35 mm long, 3–12 mm wide, green, dull, margins entire, apex acute, acuminate or apiculate. *Scape* 5–18 cm tall, 0.5–1.5 mm wide, 1–16-flowered. *Sterile bracts* 3–5, closely sheathing, ovate to elliptic when flattened, 5–10 mm long, 2–4 mm wide, thin-textured, acuminate. *Fertile bracts* similar, closely sheathing. *Pedicels* 3–20 mm long (longest on lower flowers), straight, very slender. *Ovaries* oblong to elliptic, 3–5 mm long, 1.0–1.5 mm wide. *Flowers* porrect, widely spaced, 7.5–9 mm long, 3–4 mm wide, translucent green with faint darker green stripes. *Dorsal sepal* 7–9 mm long, 4–5 mm wide, porrect from the ovary at the base, shallowly curved for most of its length, abruptly decurved near the apex. *Lateral sepals* obliquely deflexed to deflexed, shallowly saccate, dorsally curved, when flattened 4.5–6.0 mm long, 6–7 mm wide, points subacute, 3–4 mm apart. *Petals* asymmetrical, rhomboid, 4.5–6.5 mm long, 3–4 mm wide, translucent green with darker veins, dorsal margin strongly thickened, dark green, a dorsal gibbosity above the middle, ventral margin with beaded siliceous cells. *Labellum claw* irritable, ligulate, *ca.*1.4 mm long, *ca.*1 mm wide. *Labellum lamina* obovate, often widening evenly from the base, 2.0–2.5 mm long, 1.5–2.0 mm wide, whitish green with a light green to dark green basal appendage, membranous, apex emarginate. *Basal appendage* recurved at right angles or more, oblong, *ca.*1.6 mm long, *ca.*1 mm wide, margins light green to dark green, thickened, central ridge narrow, hardly raised above the margins, dark green, ending below the apex of the appendage in a very short blunt beak. *Callus* a thickened, tapered, channelled medial ridge. *Column* obliquely erect, 6–7 mm long, shallowly curved, green with darker areas on the wings. *Column wings* more or less rectangular, *ca.* 2.3 mm long, *ca.*1 mm wide; basal lobe ovate to deltate, inner margins incurved, sparsely ciliate; barrier cilia *ca.* 0.3 mm long, linear to clavate. *Anther ca.* 0.8 mm long, obtuse. *Pollinia* oblong–clavate, *ca.*1 mm long, yellow, mealy. *Stigma* central, elliptical, *ca.* 2.5 mm long, *ca.*1 mm wide, raised. *Capsules* 5–8 mm long, 3–4 mm wide, on pedicels to 10 mm long. (Fig. 8).

Distribution and ecology: Widely distributed in Western Australia (Wongan Hills to Eyre) and South Australia, including the Nullarbor region, also in parts of north-western Victoria. The species has an elevational range of 10–350 m. It grows in a wide range of habitats but is most prominent in vegetation with a short sparse understorey such as shrubland, mallee communities, *Callitris* woodland, mallee-broombush association and saltbush. It is frequently, but not always, found in areas with limestone in the soil profile, either as subterranean pavements or as outcrops, concretions, and rubble. The soils are mostly infertile sands, crustose loams and terra rossa.

Flowering: July to October.

Recognition: *Hymenochilus pisinnus* is characterised by relatively small and often narrow rosette leaves (to 25 × 15 mm); thin scape (to *ca.* 18 cm tall but only 0.5–1.5 mm wide); small widely spaced flowers (to 9 × 4 mm) that are often on long pedicels (to 20 mm long on lower flowers); short, shallowly saccate lateral sepals; small, rhomboid petals; obovate labellum to 2.5 × 2.0 mm; labellum appendage recurved, with the central ridge immersed or slightly protruding and ending well below the apex.

Similar species: *Hymenochilus muticus* shares the elongated scape and well-spaced flowers with *H. pisinnus* but is much more robust with more, larger, fleshier rosette leaves, taller, thicker scape, larger, broader flowers, larger ovate–elliptic to rhomboid petals, deeply saccate lateral sepals and a larger oblong to elliptical labellum with a broad labellum appendage in which the central ridge, although short and blunt, protrudes noticeably. In large populations of *H. muticus* it is often possible to find plants with the slender stature of *H. pisinnus*, however, these can be distinguished by the larger flowers and oblong to elliptic labellum with a broad appendage. Even robust plants of *H. pisinnus* never attain the dimensions of large specimens of *H. muticus*. *Hymenochilus pagophilus* is also more robust than *H. pisinnus* with larger rosette leaves, thicker flower stems and larger flowers with deeply saccate lateral sepals and a more or less rectangular labellum. *Hymenochilus confertus, H. rubenachii* and *H. wapstrarum* can all be distinguished from *H. pisinnus* by their densely crowded flowers.

Notes: This orchid, the only member of the *H. muticus* group to occur in Western Australia, is quite probably Australia's most drought-tolerant orchid.

Etymology: From the Latin *pisinnus*, small, little, in reference to the usual puny nature of the plants, especially relative to *H. muticus*.

Conservation status: This species has a widespread distribution, including in three national parks, with estimated extent of occurrence 788,000 km^2 and a population size estimated to be >10,000. There is no known evidence of continuing decline. A preliminary extinction risk assessment based on known occurrences of, and threats to, results in a classification of this species as least concern.

Specimens examined: **VICTORIA**: Murrawong North Roadside Reserve, 8 Sep. 1986, *A.C.Beauglehole 83936* (MEL); Ellam Flora Reserve, 18 Sep. 1986, *A.C.Beauglehole 84700* (MEL); *ca.* 32 km S of Bambill, 6 Sep. 1986, *J.H.Browne 361* (MEL); Red Bluff Wildlife Reserve, 7 Sep. 1986, *R.Fomes* (MEL); Sea Lake district, Sep. 1912, *J.C.A.Goudie* (AD); *ca.* 20.4 km W of Ouyen towards Walpeup, 29 Aug. 1999, *D.L.Jones 16529 & M.Garratt* (CANB); Broken Bucket, 12 Sep. 2000, *D.L.Jones 17488 & M.Garratt* (CANB). **SOUTH AUSTRALIA**: Chaunceys Line, Sep. 1939, *A.Ashby* (AD); Nullarbor Region, 50 km E of WA border, 4 Sep. 1981, *R.Bates 989b* (AD); Alford Town Reserve, 14 Sep. 1987, *R.Bates 10480* (AD); Woodchester area, 3 Sep. 1989, *R.Bates 20421* (CANB); S of Telowie Gorge, 10 Sep. 1989, *R.Bates 20452* (CANB); Owen Common, 10 Sep. 1989, *R.Bates 20480* (CANB); Clements Gap Conservation Park, 27 Aug. 1996, *R.Bates 43726* (CANB); Brinkley, 6 Aug. 2000, *R.Bates 57149* (CANB); Kulpara, 4 Sep. 1966, *B.J.Blaylock 132* (AD); Curramulka, 27 Aug. 1967, *B.J.Blaylock 565* (AD); 6 km SSE of Moonta, 30 Sep. 1967, *B.J.Blaylock* (AD); Ferries MacDonald Conservation Park, 8 Aug. 1990, *P.Branwhite (D.L.Jones 6192)* (CANB); Mt Sturt, 31 Sep. 1986, *K.Brewer* (AD); 800 m from Pygery towards Port Kenny, 2 Sep. 1983, *J.D.Briggs 1113* (CANB); *ca.* 34 miles from Kimba towards Whyalla, 29 Aug. 1968, *E.Canning* (CANB); *ca.* 21 km S of Kimba, 25 Sep. 1986, *M.A.Clements 4185* (AD); Mona Railway Yard, *ca.* 5 km W of Bute, 11 Aug. 1966, *B.Copley 484* (AD); Wauraultee Scrub, SW of Maitland, 22 Aug. 1978, *B.Copley 5254* (AD); Voigts Road, W of Stansbury, 19 Sep. 1973, *B.Copley 4119* (AD); Clinton North, Aug. 1912, *A.Edguist* (AD); Poochera, 26 Aug. 1955, *F.M.Hilton* (AD); Glenhill Station, Tintinara, 9 Oct. 1979, *P.Hornsby* (AD); Hundred of Senior, 8 Sep. 1962, *D.Hunt 1113* (AD); near Coonalpyn, 26 Aug. 1966, *D.Hunt 2684* (AD); 1.8 km W of Parilla towards Tailem Bend, 30 Aug. 1999, *D.L.Jones 16537 & M.Garratt* (CANB); 9.1 km W of Lameroo towards Peake, 30 Aug. 1999, *D.L.Jones 16540 & M.Garratt* (CANB); 3.5 km W of Peake towards Sherlock, 30 Aug. 1999, *D.L.Jones 16545 & M.Garratt* (CANB); Sherlock, 30 Aug. 1999, *D.L.Jones 16549 & M.Garratt* (CANB); Ferries McDonald Conservation Park, 30 Aug. 1999, *D.L.Jones 16556 & M.Garratt* (CANB); Moonta Town Reserve, 1 Sep. 1999, *D.L.Jones 16602 & M.Garratt* (CANB); Muloowurtie Conservation Reserve, 2 Sep. 1999, *D.L.Jones 16610 & M.Garratt* (CANB); Curramulka Scrubs, 2 Sep. 1999, *D.L.Jones 16624 & M.Garratt* (CANB); 8.8 km E of Minlaton towards Stansbury, 2 Sep. 1999, *D.L.Jones 16653 & M.Garratt* (CANB); 4 km SW of Muloowurtie Point towards Minlaton, 3 Sep. 2000, *D.L.Jones 17268 & M.Garratt* (CANB); 64 km S of Whyalla towards Cowell, 5 Sep. 2000, *D.L.Jones 17297 & M.Garratt* (CANB); 7.7 km SW along road to Mt Geharty from Whyalla-Cowell road, 6 Sep. 2000, *D.L.Jones 17299 & M.Garratt* (CANB); Mt Geharty, 6 Sep. 2000, *D.L.Jones 17305 & M.Garratt* (CANB); S end of Mt Olympus, 5 Sep. 2000, *D.L.Jones 17332 & M.Garratt* (CANB); 21 km from Cleve towards Rudall, 6 Sep. 2000, *D.L.Jones 17364 & M.Garratt* (CANB); lower NE slope of Darke Peak, 6 Sep. 2000, *D.L.Jones 17371 & M.Garratt* (CANB); Mt Granite, 9 Sep. 2000, *D.L.Jones 17458 & M.Garratt* (CANB); Dublin Scrub, 27 Aug. 1962, *D.Kraehenbuehl 601* (AD); Sevenhill, 8 Oct. 1957, *B.B.Lowery* (NSW); Mt Bosanquet, 16 Sep. 1972, *F.A.Mason 1* (AD); W of Gawler, Aug. 1954, *R.Nash* (CANB); Monarto South, 9 Sep. 1967, *M.R.Pocock 16* (AD); Ardrossan, 1901-06, *R.S.Rogers* (AD); Maitland, 19 Aug. 1905, *R.S.Rogers* (AD); Monarto South, 5 Sep. 1912, *R.S.Rogers* (AD); *ibid*, 20 Sep. 1913, *R.S.Rogers* (NSW); Dingo Ranges, 32 km NW of Pinnaroo, 31 Aug. 1961, *M.C.A.Sharrad 1149* (AD); 65 km N of Bordertown, 29 Aug. 1961, *P.G.Wilson 2087* (AD). **WESTERN AUSTRALIA**: Border Village, 4 Sep. 1981, *R.Bates 989d* (AD); Eucla, Sep. 1981, *R.Bates 990a* (AD); 10 km E of Madura, Sep. 1981, *R.Bates 990c* (AD); 20 km E of Balladonia, Sep. 1981, *R.Bates 990d* (AD); Twilight Cove, near Cocklebiddy, 2 Sep. 1981, *R.Bates 990e* (AD); 20 km NW of Wongan Hills, 4 Sep. 1984, *R.Bates 4218* (AD); Ravensthorpe, 9 Sep. 1967, *V.M.Bennett* (PERTH); 5 km SW of Mt Beaumont, 9 Aug. 1980, *A.Brown* (PERTH); 39.5 km SSE of Peak Eleanora, 25 Sep. 1984, *M.A.Burgman 3571b* (PERTH); Junana Rock, 10 Aug. 1980, *M.A.Clements 2025* (CANB); Bremer Range, 29 Aug. 1999, *K.J.Fitzgerald 127* (CANB); 20.9 km S of Caiguna, 24 Aug. 1983, *M.J.Fitzgerald* (PERTH); Lake King, 24 Aug. 1957, *A.S.George* (PERTH);17.8 miles E of Newdegate, 12 Sep. 1959, *A.S.George 285* (PERTH); 18 miles E of Newdegate, 30 Aug. 1963, *A.S.George 5686* (PERTH): 0.5 miles N of Hopetoun, 31 Aug. 1963, *A.S.George 5751* (PERTH); Parker Range, 30 July 1969, *A.S.George 9432* (PERTH); 10 miles ESE of Tambellup, 30 Sep. 1971, *A.S.George 11077* (PERTH); 26 km E of Madura, 10 July 1974, *A.S.George 11823* (PERTH); Twilight Cove, 11 July 1974, *A.S.George 11867* (PERTH); Painted Cliffs, 50 km E of Lake Cronin, 5 Aug. 1980, *A.S.George 15824* (PERTH); 2 km NW of Mt Heywood, 8 Aug. 1980, *A.S.George 15886* (PERTH); SW of Mt Ney, 9 Aug. 1980, *A.S.George 15902* (PERTH); NW of Mt Ney, 11 Aug. 1980, *A.S.George 15962* (PERTH); 5 km E of Grass Patch, 12 Aug. 1980, *A.S.George 15975* (PERTH); Israelite Bay, 14 Aug. 1980, *A.S.George 16004* (PERTH); 7 km W of Israelite Bay, 14 Aug. 1980, *A.S.George 16019* (PERTH); Sheoak Hill, SE of Mt Ragged, 14 Aug. 1980, *A.S.George 16038* (PERTH); below S side of Mt Ragged, 15 Aug. 1980,

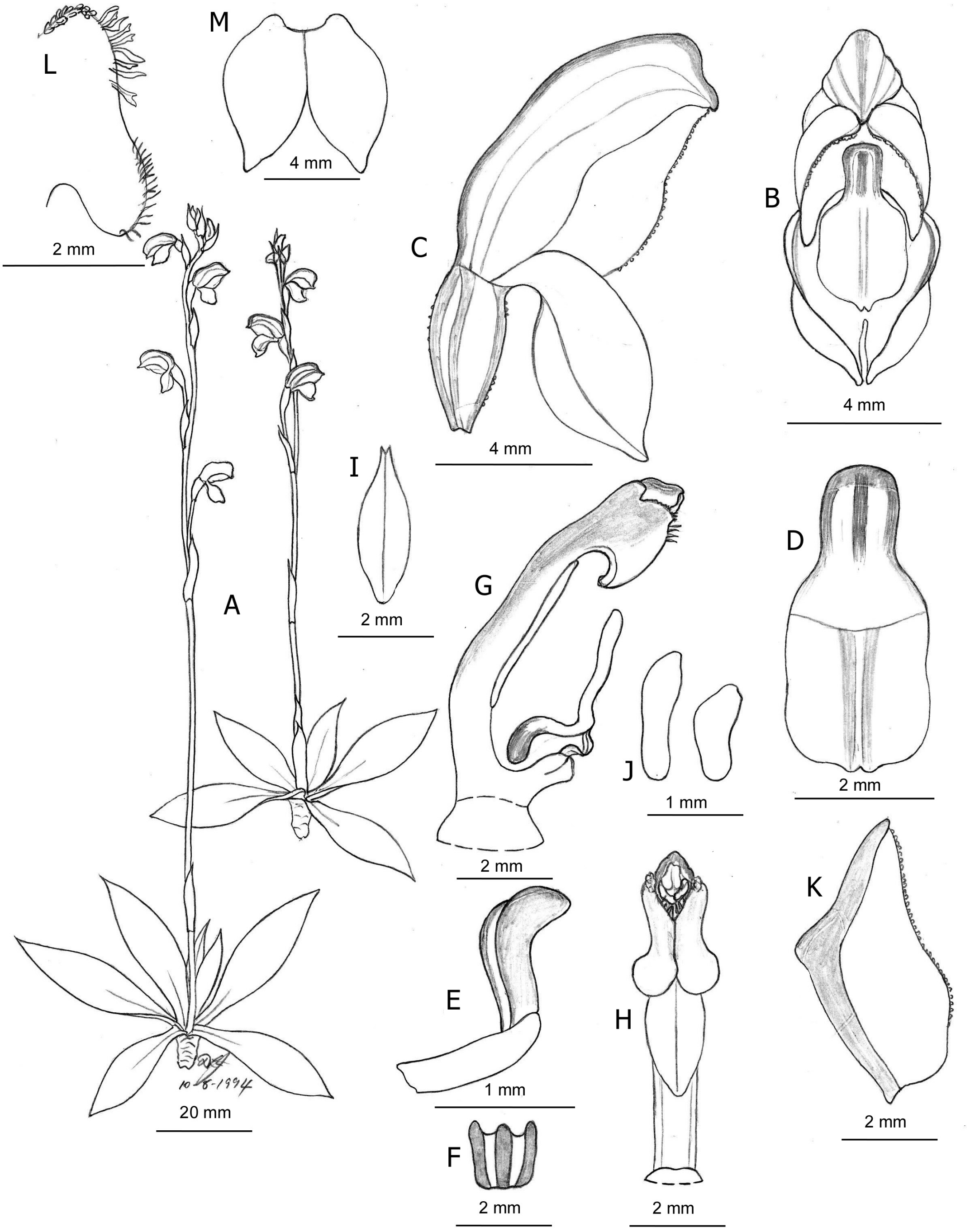


FIGURE 19. *Hymenochilus pisinnus* D.L.Jones. **A**. Habit. **B**. Flower, front view. **C**. Flower, side view. **D**. Labellum flattened, from above. **E**. Labellum appendage, side view. **F**. Labellum appendage grooves. **G**. Column and labellum, side view. **H**. Column, front view. **I**. Stigma. **J**. Pollinia from different anther cells. **K**. Petal. **L**. Internal view of column wing. **M**. Synsepal. Illustration by D. Jones. Lake Grace WA, C.J. French, 10 Aug. 1994.

A.S.George 16080 (PERTH); S side of Junara Rocks, 16 Aug. 1980, *A.S.George 16080* (PERTH); Pine Hill, 16 Aug. 1980, *A.S.George 16101* (PERTH); Juranda Rock Hole, 16 Aug. 1980, *A.S.George 16113* (PERTH); SW of Mt Ragged, 17 Aug. 1980, *A.S.George 16144* (PERTH); 17 km NE of Boyatup Hill, 17 Aug. 1980, *A.S.George 16153* (PERTH); near Salmon Gums, 24 Aug. 1937, *Mrs Horbury* (AD); Kumarl, Sep. 1937, *L.A.Horbury* (NSW, PERTH); 2.4 km S of Hyden-Norseman Road, N of Middle Ironcap, 14 Oct. 1993, *D.L.Jones 12354* (CANB); E edge of Wongan Hills, 31 Aug. 1980, *K.F.Kenneally* 7422 (PERTH); 5 miles W of Dowak, 12 Aug. 1978, *F.Magagannoti* (PERTH); 11 miles E of Southern Cross, 12 Aug. 1961, *A.R.Main* (PERTH); E of Hyden, 7 Sep. 1973, *C.A.Nelson* (CANB); 5 km NW of Ongerup, 29 Aug. 1973, *K.Newbey 3733* (PERTH); 4 km SE of Hatters Hill, 10 Aug. 1979, *K.Newbey 5499* (PERTH); Boingaring Rock, 11 Sep. 1980, *K.Newbey 7281* (PERTH); 5 miles N of Norseman, 8 Aug. 1951, *R.D.Royce 499* (PERTH); Kondinin, 6 Sep. 1945, *R.D.Royce 511* (PERTH); Lake King district, Sep. 1930, *Mr Steedman* (PERTH): Dowak, July–Aug., *D.Voigt 15* (PERTH); 3 km N of old Eucla, 14 Sep. 1960, *D.J.Whibley 631* (AD); 100 km S of Balladonia, 10 Sep. 1964, *P.Wilson 2882* (AD); Salmon Gums, 12 Sep. 1964, *P.Wilson 3064* (AD); *ca.* 20 km S of Lake King, 10 Aug. 1968, *P.Wilson 6978* (PERTH).

ILLUSTRATIONS: Page 547, Jones (2021); page 243, Niejalke (2022); page 407, Hoffman *et al*. (2019), as *Pterostylis mutica*; page 141, Brown (2022), as *Pterostylis mutica*; page 237, Backhouse (2023), as *Pterostylis pisinna*.

FIGURE 20. *Hymenochilus pisinnus* D.L.Jones. Ngarkat Conservation Park, SA. Photo by J. Niejalke.

ACKNOWLEDGEMENTS. We thank Emma Toms, Marion Garratt, and Karina Richards for technical assistance. Many people helped with specimens and information including Gary Backhouse, Robert Bates, Garry Brockman, Lachlan Copeland, Christopher French, Helen Richards, Hans and Annie Wapstra. We thank Zoe Groeneveld for the illustrations of *H. anemophilus* and *H. cymbellus*. For permission to use their photos we thank Gary Backhouse, Lachlan Copeland, June Niejalke and Robert Bates. Thanks also to the directors of AD, BRI, CANB, HO, MEL, NSW, QVM for providing access to specimens. Special thanks to Barbara Jones for support at home and in the field. Plant material collected with permission of the Australian Capital Territory Government, PL201543 and PL201573; Government of South Australia's Department of Environment, Water and Natural Resources, Y26092-1, K14673, W14679; the New South Wales National Parks and Wildlife Service, Scientific Licence, SL 100750; New South Wales State Forests, XX51121, HC 53443; Tasmanian Department of Parks, Wildlife and Heritage, 91/7, FL95073; Tasmanian Department of Primary Industry, Water and Environment, FL03121; the Victorian Government's Department of Conservation Forests and Lands, 1/70/89/0021, 4154 878/47; Victorian Government's Department of Environment, Land, Water and Planning, Flora and Fauna Guarantee Act 1988 and National Parks Act 1975, 10006307; Government of Western Australia Department of Environment and Conservation (previously the Department of Conservation and Land Management), CE000160, CE000418, NE000515, NE000890, NE001714, NE002573, NE002538, , SW001959, SW001960, SW001963, SW004596, and SW015074; the Queensland Government's Queensland Parks and Wildlife Service, 996, 1333, 1427, 1678, 1696, FO/000878/96/SAA, F1/000056/97/SAA, FO/000889/96/SAA, F1/00232/99/SAA, 1685 and F1/000172/01/SAA; and Queensland Government's Department of Environment and Heritage Protection WITK11258712 and WISP11258812.

Literature cited

Backhouse, G.N. (2023). *Guide to native orchids of Victoria*. Melbourne: CSIRO Publishing.

Brown, R. (1810). *Prodromus floræ Novæ Hollandiæ et Insulæ Van–Diemen*. London: J. Johnson and Co.

Brown, A. (2022). *The complete orchids of Western Australia*. Perth WA: self-published.

Copeland, L. M. & Backhouse, G. N. (2022). *Guide to native orchids of NSW and ACT*. Melbourne: CSIRO Publishing.

Fitzgerald, R.D. (1876). *Australian Orchids*. Sydney, Australia: Richards.

George, A. S. (1971). A check list of the Orchidaceae of Western Australia. *Nuytsia*, 1(2), 190.

Hoffman, N., Brown A. & Brown, J. (2019). *Orchids of south-west Australia, Fourth Ed*. Nedlands, WA: University of Western Australia Press.

IUCN Standards and Petitions Committee (2022). Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1. Prepared by the Standards and Petitions Committee. Retrieved from https://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Jones, D. L. (2008). Two new species of *Hymenochilus* (Orchidaceae) from south-eastern Australia. *The Orchadian*, 15(11), 492–497.

Jones, D. L. (2009). Five threatened new species of *Hymenochilus* (Orchidaceae) from southern Australia. *The Orchadian*, 16(4), 176–187.

Jones, D. L. (2021). *A complete guide to the native orchids of Australia*, Third edition. Sydney: Reed New Holland.

Jones, D. L. & Clements, M. A. (2002). A review of *Pterostylis* (Orchidaceae). *Australian Orchid Research*, 4, 3–152.

Niejalke, J. (2022). *Native Orchids of South Australia a Field Guide*. Pinnaroo SA: self-published.

LANKESTERIANA 24(1): 33–38. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.58649

DENDROBIUM DERRYI (EPIDENDROIDEAE: MALAXIDEAE): AN ADDITION TO THE FLORA OF INDIA

Khyanjeet Gogoi

The Orchid Society of Eastern Himalaya (TOSEHIM), Regional Orchids Germplasm Conservation & Propagation Centre (Assam Circle), Daisa Bordoloi Nagar, Talap, Tinsukia 786 156, Assam, India.
khyanjeet.gogoi@gmail.com

Abstract. *Dendrobium derryi*, a new addition to the orchid flora of India, has been discovered in Karbi Anglong district of Assam. This article provides an updated description of the species, accompanied by detailed photos and line drawings based on material collected within the country.

Keywords / Palabras clave: *Dendrobium* sect. *Calcarifera*, *Dendrobium* species, especie de *Dendrobium*, Hamren, Karbi Anglong, new record, nuevo registro

Introduction. *Dendrobium* Sw. is one of the largest genera within the Orchidaceae, comprising approximately 1450 species (Schuiteman 2014). It is also one of the most important in commercial horticulture. The genus was established by O. Swartz in *Nova Acta Regiae Societatis Scientiarum Upsaliensis* in 1799 (Chen *et al*. 2009). *Dendrobium* is widely distributed throughout India, across to Japan, south to Malaysia and Indonesia, and east to Australia, New Guinea, and the Pacific Islands (Chen *et al*. 2009, Garay & Sweet 1974, Pearce & Cribb 2002, Seidenfaden 1985, Tsi 1999, Wood 2006).

In India, the genus is widely distributed in the Eastern Himalayas, Western Himalayas, Western Peninsular, Andaman and Nicobar Islands (Misra 2019). As many as 32 species have been recorded from Sikkim Himalaya (King & Pantling 1898), 15 species from the North-West Himalaya (Deva & Naithani 1986), 47 species from Arunachal Pradesh (Chowdhery 1998), 45 species from Sikkim and the North East Himalaya (Lucksom 2007), 82 species from Northeast India (Lokho 2013), and 12 species from Odisha (Misra 2014). Hooker (1888–1890) recorded 158 species from British India, while Pradhan (1979) reported 66 species from India in his work 'Indian Orchids Guide to Identification and Culture, Vol-II'. Bose *et al*. (1999) reported 91 Species from India. According to a recent report, the genus is represented by 124 species (Deori *et al*. 2019), and according to Misra (2019), it is 137 species, out of which 97 species are from the northeast region (Deori *et al*. 2019) and nearly 57 species in Assam (Gogoi 2018, 2019).

The *Dendrobium* sect. *Calcarifera* was first published by J. J. Smith in 1908 and later revisited by Comber (1983). While *D. derryi* is known in regions like Sumatra, Borneo, and peninsular Malaysia (POWO 2023), it has never been documented in India. This manuscript records this species for the first time in India providing a comprehensive description, illustrations, and information on its habitat and distribution.

Materials and methods. Fresh plant material in its vegetative condition was collected during a botanical excursion on March 16, 2012, in Hamren, located in the Karbi Anglong district of Assam, India. This material was subsequently planted at the Regional Orchids Germplasm Conservation and Propagation Centre (Assam Circle). Measurements and species descriptions of both vegetative and reproductive characters were conducted after flowering, using living plants, and followed the terminology for morphological descriptions as outlined by Beentje (2012). All photographs were taken using a Canon 6D Mark-II camera fitted with an EF 100 mm f/2.8L Macro USM lens. A voucher specimen has been deposited at TOSEHIM (Herbarium of The Orchid Society of Eastern Himalaya), Regional Orchid Germplasm Conservation and Propagation Centre (Assam Circle), Assam.

ORCID of the Author: KG
Received 5 October 2023; accepted for publication 20 November 2023.

Taxonomic treatment

Dendrobium derryi Ridl. in Mat. Fl. Malay. Penins. 1: 52. 1907. (Fig. 1, 2, 3).

TYPE: Peninsular Malaysia. Larul Hills, Derry sn. (holotype: SING).

Plant epiphytic. *Stems* erect when young, pendant when old, 35–80 cm long; internodes 1–4 cm long, 0.5–0.8 cm in diameter, subterete. *Leaves* many, deciduous, 6–10 × 1.5–3.5 cm, oblong to narrowly elliptic, apex sub oblique, acute, shiny ash-grey or pearl-grey above, dark violet below, sheathed; sheath 3–3.5 cm long, tubular, apex truncate, dingy green suffused violet, with greenish violate nerves. *Inflorescence* borne on nodes of leafless stems, 1–2 flowered, sessile, pendent; rachis 0.3 cm long, olive-green, or dirty violet; floral bracts 0.2–0.3 cm long, triangular, acute, pale green or purplish. *Flowers* 2–3 cm long, 2–2.5 cm across; pedicel with ovary pinkish mauve, sepals, and petals greenish white or pale yellowish, lip white with base pale yellow, column white with orange apical stelidia, anther cap white. *Pedicel* with ovary 1.4–1.6 cm long. *Dorsal sepals* 1.1–1.5 × 0.5–0.8 cm, oblong, obtuse; lateral sepals 1.8–2.0 × 0.6–0.8 cm, obliquely triangular-oblong, obtuse, minutely apiculate. *Petals* 1.4–1.5 × 0.6–0.7 cm, oblong or spathulate, rounded, obtuse, often minutely erose, reflexed. Mentum 1.2–1.5 cm long, 0.4–0.5 cm wide, sub-cylindrical, obtuse, sightly laterally compressed, spur-like, gently decurved. *Lip* 2.3–2.5 cm long, blade 1.3–1.4 × 1.0–1.2 cm, spathulate to broadly rounded or rarely almost orbicular, retuse to bilobulate, with a minute mucro in the sinus, recurved, strongly convex, margin undulate; disc of blade with 2 longitudinal low, raised central keels separated by a groove. *Column* 0.4–0.5 × 0.3–0.4 cm; stelidia 0.1 cm, obliquely quadrangular, distally slightly recurved and hooked, clasping anther cap, obtuse; foot 1.2–1.4 cm long, canaliculate; anther cap 2.0 × 2.0–2.1 mm, quadrangular, cucullate.

Specimen examined: India. Assam: Karbi Anglong, Hamren, 16 March 2012, fl. 20 May 2023 in the Orchids Germplasm Conservation and Propagation Centre (Assam Circle), *Gogoi* 01147 (TOSEHIM!).

Flowering: From March to August.

Habitat: Epiphytic in evergreen forests at 400 m in Hamren of Karbi Anglong district, Assam.

General distribution: Peninsular Malaysia, Sumatra, Borneo, and now India (Assam).

Conservation status: The species was previously known from a single locality. The degradation of its habitat due to shifting cultivation and illegal logging may pose a threat to the species in the near future.

Note: The species *D. derryi* was initially reported from Borneo, Malaya, and Sumatra. In this correspondence, this species is reported from Karbi Anglong district of Assam, an easternmost state of India. This transition of *D derryi* is very interesting from a geographical point of view. At the same time, the current finding also depicts that present-day South East Asia was a single landmass and drifted to different landmasses in due course of time, hence the relatives of the taxon still existed in different pockets.

Discussion. This species belongs to *Dendrobium* sect. *Calcarifera*, characterized by verrucose-papillose roots, fleshy or pseudobulbs, often-pendulous stems with semi-deciduous leaves arranged in two ranks (Smith 1908). The stems typically produce multiple growths each year, both producing racemose inflorescences, short and pendent, on newer and older leafless stems, with the pedicel attached at a right angle to the long, spur-like mentum. Additionally, the lip has a distinct claw, often bearing a projection or tooth on its upper side near the base, abruptly broadening above with or without side lobes and a retuse and bilobed apex.

In India, there are three species in Sect. *Calcarifera*: *Dendrobium cumulatum* Lindl. (1855), *D. parcum* Rchb.f. (1866), and *D. rhodocentrum* Rchb.f. (1872). With the recent discovery of *D. derryi* in Assam, the total number of species in this section has increased to four. *Dendrobium derryi* shares morphological similarities with *D. cumulatum* Lindl. but can be distinguished by its inflorescences with a 0.3 cm long rachis and 1–2 flowers, white or pale yellowish flowers, and a lip that is white, spathulate to broadly rounded or orbicular, retuse to bilobulate, with a small mucro in the sinus. The blade's disc

Figure 1. *Dendrobium derryi*. Close-up of the flowers in its natural habitat.

possesses two longitudinal low, raised central keels separated by a groove.

Conclusions. Karbi Anglong district in Assam, Northeast India, boasts agroclimatic conditions ideal for the establishment of a diverse range of orchid species in their native environments. To date, 106 orchid species have been identified in Karbi Anglong, including 12 *Dendrobium* species (Gogoi & Yonzone 2013). While there have been studies on the orchids of Karbi Anglong, efforts toward their preservation and propagation remain insufficient. The entire orchid family is under significant threat due to ongoing habitat destruction from deforestation, shifting cultivation, industrial activities, soil erosion, overgrazing, and particularly the unregulated collection for the floral trade. Such activities have jeopardized the native orchid populations, with a looming risk of extinction if their habitats are not safeguarded. It is imperative to prioritize habitat conservation in this region to ensure the continued existence of this rich orchid diversity for future generations.

Key to the species of *Dendrobium* sect. *Calcarifera* from India

1. Inflorescence corymbose or sub- corymbose 2
    2. Mentum short, column with tuft of hairs .... ***D. rhodocentrum***
    2b. Mentum long, column not hairy 3
        3. Inflorescence 1–2-flowered .... ***D. derryi***
        3b. Inflorescence 2–7-flowered .... ***D. cumulatum***
1b. Inflorescence terminal or axillary .... ***D. parcum***

Acknowledgements. I extend my gratitude to the Department of Forest in Karbi Anglong District, Assam, for their continuous supervision and valuable suggestions during this study. I also thank Ba Vuong Truong of Vietnam for their assistance and valuable suggestions in identifying the species.

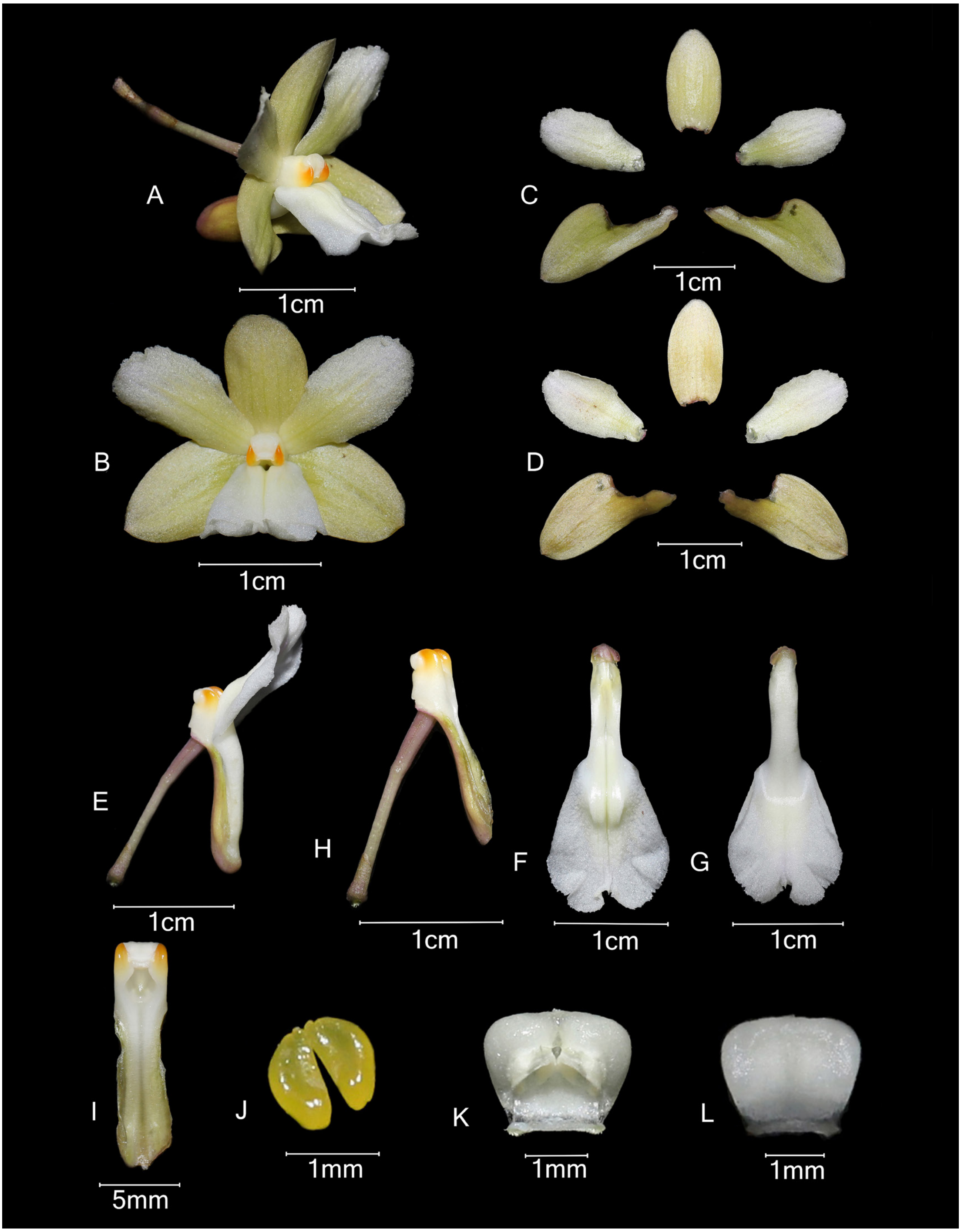


FIGURE 2. *Dendrobium derryi*. **A**. Side view of flowers. **B**. Ventral view of flower. **C**. Ventral view of perianth. **D**. Dorsal view of perianth. **E**. Lip with ovary & column. **F**. Dorsal view of lip. **G**. Ventral view of lip. **H**. Ovary with pedicel and column. **I**. Front view of Column. **J**. Ventral view of pollinarium. **K**. Anther cap dorsal view. **L**. Anther cap ventral view. Photos by K.Gogoi.

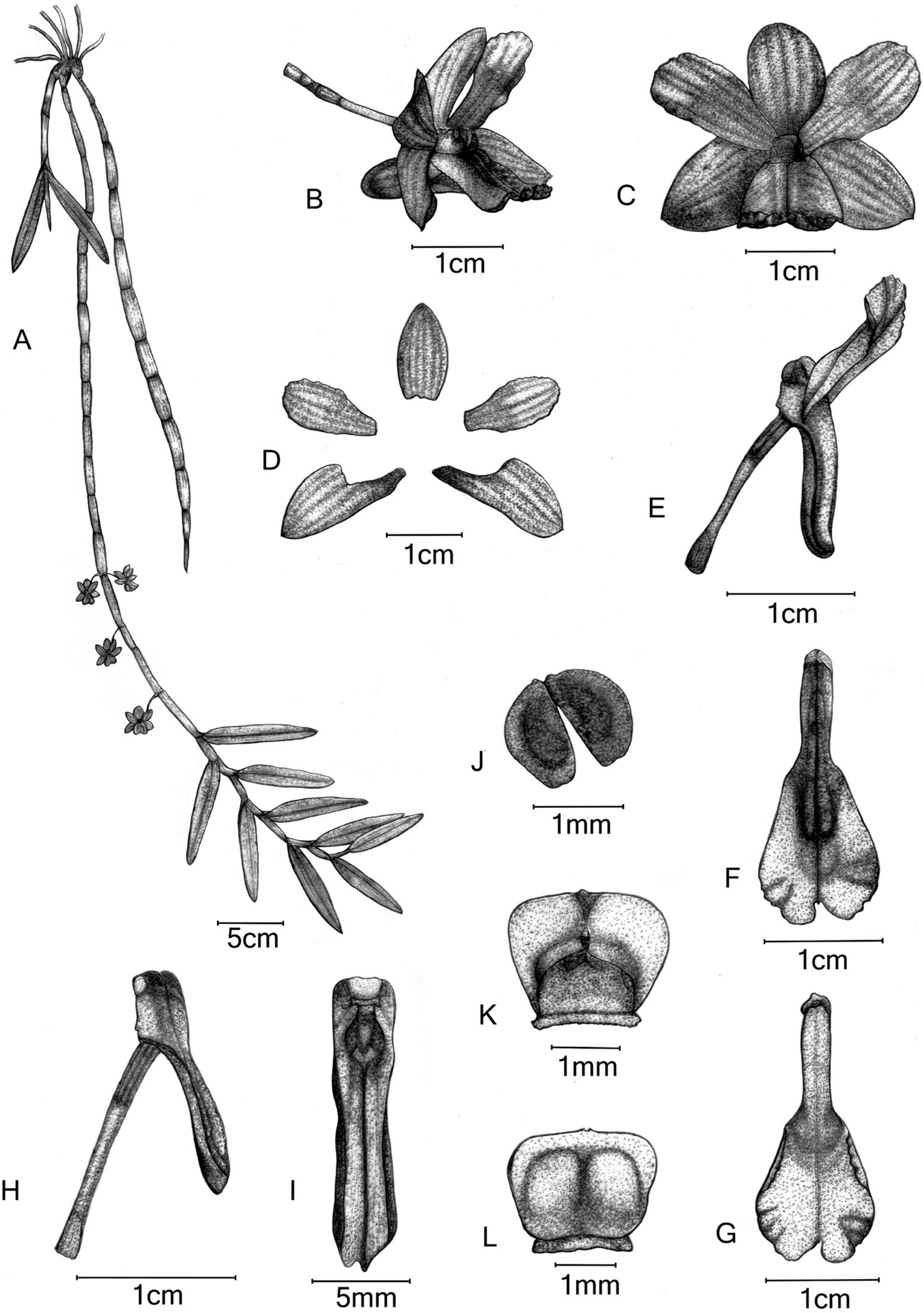


FIGURE 3. *Dendrobium derryi*. **A**. Habit. **B**. Side view of flower. **C**. Ventral view of flower. **D**. Ventral view of perianth. **E**. Lip with ovary & column. **F**. Dorsal view of lip. **G**. Ventral view of lip. **H**. Ovary and column with the foot. **I**. Front view of Column. **J**. Ventral view of pollinarium. **K**. Anther cap dorsal view. **L**. Anther cap ventral view. Drawing by K.Gogoi.

Literature cited

Beentje, H. (2012). *The Kew Plant Glossary, an illustrated dictionary of plant terms* (revised edition). Kew: Royal Botanic Gardens, Kew Publishing. 170 p.

Bose, T. K., Bhattacharjee, S. K., Das, P. & Basak, U.C. (1999). *Orchids of India*. Calcutta, India: Naya Prokash.

Chen, S. C., Liu, Z., Zhu, G., Lang, K. Y., Tsi, Z. H., Luo, Y., Jin, X., Cribb, P. J., Wood, J. J., Gale, S. W., Ormerod, P., Vermeulen, J. J., Wood, H. P., Clayton, D. & Bell, A. (2009). Orchidaceae. In: Z. Wu, P. H. Raven & D. Hong (eds), *Flora of China,* vol. 25. Science Press, Beijing, China and Missouri Botanical Garden Press, St. Louis, USA. 570 p.

Chowdhery, H. J. (1998). *Orchid Flora of Arunachal Pradesh.* Dehra Dun, India: Bishen Singh Mahendra Pal Singh. 824 p.

Comber, J.B. (1983). The section *Calcarifera* of the genus *Dendrobium* in Java Orchids. Orchid Digest, 47(5), 191–196.

Deori, C., Sarma, S. K. & Hynniewta, T. M. (2019). *Dendrobium Orchids of Northeast India.* Guwahati, Assam: Purbayon Publication. 404 p.

Deva, S. & Naithani, H. B. (1986). *The Orchid Flora of North West Himalayas*. New Delhi: Print and Media Associate.

Garay, L. A. & Sweet, H. R. (1974). *Orchids of Southern Ryukyu Islands*. Massachusetts, U.S.A.: Harvard University Cambridge. 180 p.

Gogoi, K. (2018). *Wild Orchids of Assam - A Pictorial Guide*. Guwahati, Assam: Assam State Biodiversity Board. 473 p.

Gogoi, K. (2019). *Orchids of Assam - A Pictorial Guide.* Dibrugarh, Assam: Dibrugarh University. 588 p.

Gogoi, K. & Yonzone, R. (2013). Orchids of The Karbi Anglong District of Assam, India (Part-I) in *The McAllen International Orchid Society Journal*, 14(4), 11–20.

Hooker, J. D. (1888−1890). *Flora of British India.* Vols 5 & 6. London: L. Reeve and Co.

King, G. & Pantling, R. (1898). *The orchids of the Sikkim Himalayas. Annals of the Royal Botanical Garden Calcutta*, 8, 1–342, tt. 1–448.

Lindley, J. (1855). *Dendrobium cumulatum* Lindl. *The Gardeners' chronicle,* 756.

Lokho, A. (2013). Diversity of Dendrobiums sw. Its distributional patterns and present status in the northeast india. *International Journal of Scientific and Research Publications,* 3(5), 1−8.

Lucksom, S. Z. (2007). *The Orchids of Sikkim and North East Himalaya.* Gangtok, East Sikkim, India: Development Area, Jiwan Thing Marg. 984 p.

Misra, S. (2014). *Orchids of Odisha, A Handbook.* Dehra Dun, India: Bishen Singh Mahendra Pal Singh. 424 p.

Misra, S. (2019). *Orchids of India- a hand book.* Dehra Dun, India: Bishen Singh Mahendra Pal Singh. 652 p.

Pearce, N. R. & Cribb, P. J. (2002). *Orchids of Bhutan: Flora of Bhutan.* Vol. 3, No. 3. Edinburg: Royal Botanical Garden. 643 p.

POWO. (2023). Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Retrieved from https://powo.science.kew.org/. Accessed 22 July 2023.

Pradhan, U. C. (1979). *Indian Orchids Guide to Identification and Culture,* Vol II. (pp. 190–747). Faridabad, India: Thomson Press.

Reichenbach f., H. G. (1866). *Dendrobium parcum* Rchb.f. in *The Gardeners' chronicle,* 1042.

Reichenbach f., H. G. (1872). *Dendrobium rhodocentrum* Rchb.f. in *The Gardeners' chronicle,* 426.

Ridley, H. N. (1907). *Materials for a flora of the Malayan peninsula*. Singapore: Printed at the Methodist publishing house.

Schuiteman, A. (2014). *Dendrobium.* In: A. M. Pridgeon, P. J. Cribb & M. W. Chase (Eds.), *Genera Orchidacearum*, 6, 51–73. Oxford, U.K.: Oxford University Press.

Seidenfaden, G. (1985). Orchid genera in Thailand XII. Dendrobium Sw. *Opera Botanica*, 83,1−295.

Smith, J. J. (1908). *Die Orchideen von Java* – Figuren Atlas. Leiden: E. J. Brill.

Swartz, O. (1799) Dianome Epidendri generis Linn*, Nova Acta Regiae Societatis Scientiarum Upsaliensis,* Edman, Upsala, 6: 61–88.

Tsi, Z. H. (1999). *Flora Reipublicae Popularis Sinicae Tomus*, Vol. 19. Beijing: Science Press. pp. 339–420.

Wood, H. P. (2006). Dendrobium sections: northern clade, northern (Asian) group. In R. Schettler (ed.), *Dendrobiums*. Ruggell: A.R.G. Gantner Verlag K.G.

LANKESTERIANA 24(1): 39–47. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.57030

A NEW SPECIES OF *EPIDENDRUM* (LAELIINAE) OF THE INCOMPTUM GROUP FROM THE NORTH OF ANTIOQUIA, COLOMBIA

Milton Rincón-González[1,2], Elizabeth Santiago Ayala[3], Eric Hágsater[3]
& Sebastián Vieira-Uribe[1,4,5]

[1]Grupo de Investigación Schultes, Fundación Ecotonos, Carrera 72 # 13A-56, Cali, Colombia.

[2] Herbario JBB, Subdirección Científica, Jardín Botánico de Bogotá José Celestino Mutis, Bogotá D.C., Colombia.

[3]Herbario AMO, Montañas Calizas 490, Lomas de Chapultepec, Miguel Hidalgo, 11000, Ciudad de México, México.

[4]Grupo de Investigación en Biodiversidad Tropical - GIBIOT, Jardín Botánico de Medellín, Calle 73 # 51D-14. Medellín, Colombia.

[5]Author for correspondence: utricseb@gmail.com

Abstract. A new species of *Epidendrum* of the Incomptum group is described and illustrated, thus far found only at the type locality. Information is provided to separate the species belonging to the Arbuscula and Incomptum groups. Additionally, the new taxon described herein, *Epidendrum pembertonii*, is thoroughly compared with the four most morphologically similar species (*E. brenesii*, *E. bisulcatum*, *E. foldatsii*, *E. sotoanum*), revealing notable differences in the number and shape of leaves, inflorescence length, flower color, venation of sepals, as well as the shape and ornamentation of the lip and column.

Resumen. Se describe e ilustra una especie nueva de *Epidendrum* del grupo Incomptum, hasta ahora encontrada solamente de la localidad tipo. Se proporciona información para separar las especies pertenecientes a los grupos Arbuscula e Incomptum. Además, el nuevo taxón descrito aquí, *Epidendrum pembertonii*, se compara minuciosamente con las cuatro especies morfológicamente más similares (*E. brenesii*, *E. bisulcatum*, *E. foldatsii*, *E. sotoanum*), mostrando diferencias notables en la cantidad y forma de las hojas, longitud de la inflorescencia, color de las flores, venación de los sépalos, forma y ornamentación del labelo y columna.

Keywords / Palabras clave: Alto de Ventanas, Arbuscula group, *Epidendrum brenesii*, *Epidendrum pembertonii*, Yarumal

Introduction. *Epidendrum* L. (Linnaeus 1763) is a neotropical genus that exhibits an extensive distribution range from South Carolina in the United States to Argentina (Hágsater & Soto 2005). With an estimated 2400 species, *Epidendrum* showcases remarkable variability in both vegetative and floral characteristics (Hágsater *et al.* 2016, Karremans 2021, Rincón-González *et al.* 2022). Hágsater (1985) introduced a classification system that organizes Epidendrum species into informal groups and subgroups to unravel the complexities of studying this genus. This system primarily relies on morphological features, with a strong emphasis on vegetative structures, particularly the architecture of the plant, simple or branching stems, the presence or lack of spathes at the base of the inflorescences, and these, racemose or paniculate, and flowering only once or repeatedly over several years. This approach has been widely adopted for taxonomic studies of the genus (Hágsater & Salazar 1993, Hágsater *et al.* 1999, Hágsater & Sánchez-Saldaña 2001, 2004, 2006, 2007, 2008, 2009, 2010, 2013, 2015, 2016, Hágsater & Santiago 2018a, b, 2019, 2020a, b, 2021, 2022a, b, 2023, Hágsater *et al.* 2016, Rincón-González *et al.* 2022).

Initially, Hágsater (1985) proposed to recognize the Arbuscula group, consisting of species that produce the new growth from one of the middle internodes of the previous growth, typically without branching and sometimes producing aerial roots. This group is further treated as the Arbuscula subgroup (Hágsater &

ORCID of the Author: MRG, ESA, EH, SVU
Received 11 October 2023; accepted for publication 28 January 2024. First published online: 13 February 2024.

FIGURE 1. Comparison between *Epidendrum incomptum* Rchb.f. (Incomptum group) (A, B) and *Epidendrum arbusculum* Lindl. (Arbuscula group) (C, D). Photographs by Adam Karremans (A–B) and Rolando Jiménez (C–D).

Table 1. Characteristics of the Arbuscula and Incomptum groups.

Group/Character	Arbuscula	Incomptum
Inflorescence	Racemose, lax, > 12.5 cm long	Racemose, compact, < 12 cm long
Floral bract	4–30 mm long	3–7 mm long
Flower texture	Membranaceous	Fleshy
Number of flowers	> 20	< 15 (except in *E. molinae* > 40)
Ovary (length)	0.9–6.0 cm	1.0–2.0 cm

Sánchez-Saldaña 2006: pl. 808), characterized by a racemose, nutant inflorescence, membranaceous, colorful flowers, with long ovary, and a bicallose lip. Conversely, the Incomptum subgroup (Hágsater & Sánchez-Saldaña 2004: pl. 710) is characterized by a racemose, nutant inflorescence, fleshy flowers with the perianth green, green-violet, purple, with entire to 3-lobed lip, extended to convex, orbicular, reniform to obreniform, bicallose, and a short ovary (Fig. 1). Subsequently, Hágsater & Santiago (2018a) published five species of *Epidendrum* classified within the "Incomptum group", indicating a clear distinction between the Arbuscula and Incomptum groups, considering them as distinct lineages. Comparative morphological details of each group are shown in Table 1. Additionally, there is a geographical association with these groups, as the Arbuscula group is exclusive to Mexico and northern Mesoamerica, while the Incomptum group has a broader distribution, encompassing Mexico, Central America, the Caribbean, and South America (Hágsater *et al.* unpubl. data).

Here, we propose a new species of *Epidendrum* from Colombia belonging to the Incomptum group. We provide a detailed description, illustrations, discuss its morphological similarities with other species, and offer information regarding its distribution, ecology and conservation status.

Materials and methods. During recent expeditions in 2018-2022, several field trips were made to the forests in Alto de Ventanas in Yarumal, Antioquia, within natural reserves owned and managed by Corporación Salvamontes, Colombia. We collected plant material that was deposited in the JAUM herbarium. The Colombian herbaria CAUP, COL, FMB, HUA, JAUM, JBB, MEDEL, PSO, and TOLI were also reviewed in search of more specimens of this species, and the virtual collections (digital photographs) of A, BHBC, F, HBG, K, MBM, NY, RB, and U. We followed the morphological species concept (De Queiroz 2007). Photographs with scale were taken for study and description; we measured the organs with a digital caliper and observed the specimens under a stereomicroscope Motic SMZ 168. The information derived from the review of the specimens was verified at the AMO-DATA base (2021), and was searched for possible duplicates or other unidentified specimens of the Incomptum group from the same general geographic area. A Lankester Digital Composite Plate (LCDP) was prepared from the photographic material available, and a botanical description, and the new species was compared with the most similar species in the Incomptum group.

Taxonomic treatment

Epidendrum pembertonii Rinc-González, E.Santiago & S.Vieira-Uribe, ***sp. nov.*** (Fig. 2–3A).

TYPE: Colombia. Antioquia: Municipio de Yarumal, Vereda Tobón, Finca Guasimal, 2080 m. 25 Julio 2022. *Sebastian Vieira et al. #382* (holotype: JAUM).

Diagnosis: *Epidendrum pembertonii* is similar to *E. brenesii* Schltr. (Schlechter 1923) but easily distinguished by having two, elliptic (*vs*. 3–5, oblong) larger leaves (5.2–6.0 × 2.5–2.7 *vs*. 2–8 × 1.3–2.5 cm), longest inflorescence (7.2 *vs*. 2–4 cm), tepals greenish yellow with a brown tinge (*vs*. light green with purple tinge to deep purple), red lip with yellow to red calli (*vs*. purple tinge to deep purple lip with yellow-greenish calli), greenish yellow column (*vs*. green), the dorsal sepal narrowly obovate, 5-veined (*vs*. obovate-elliptic, 3-veined), the lateral sepals obliquely elliptic, 5-veined

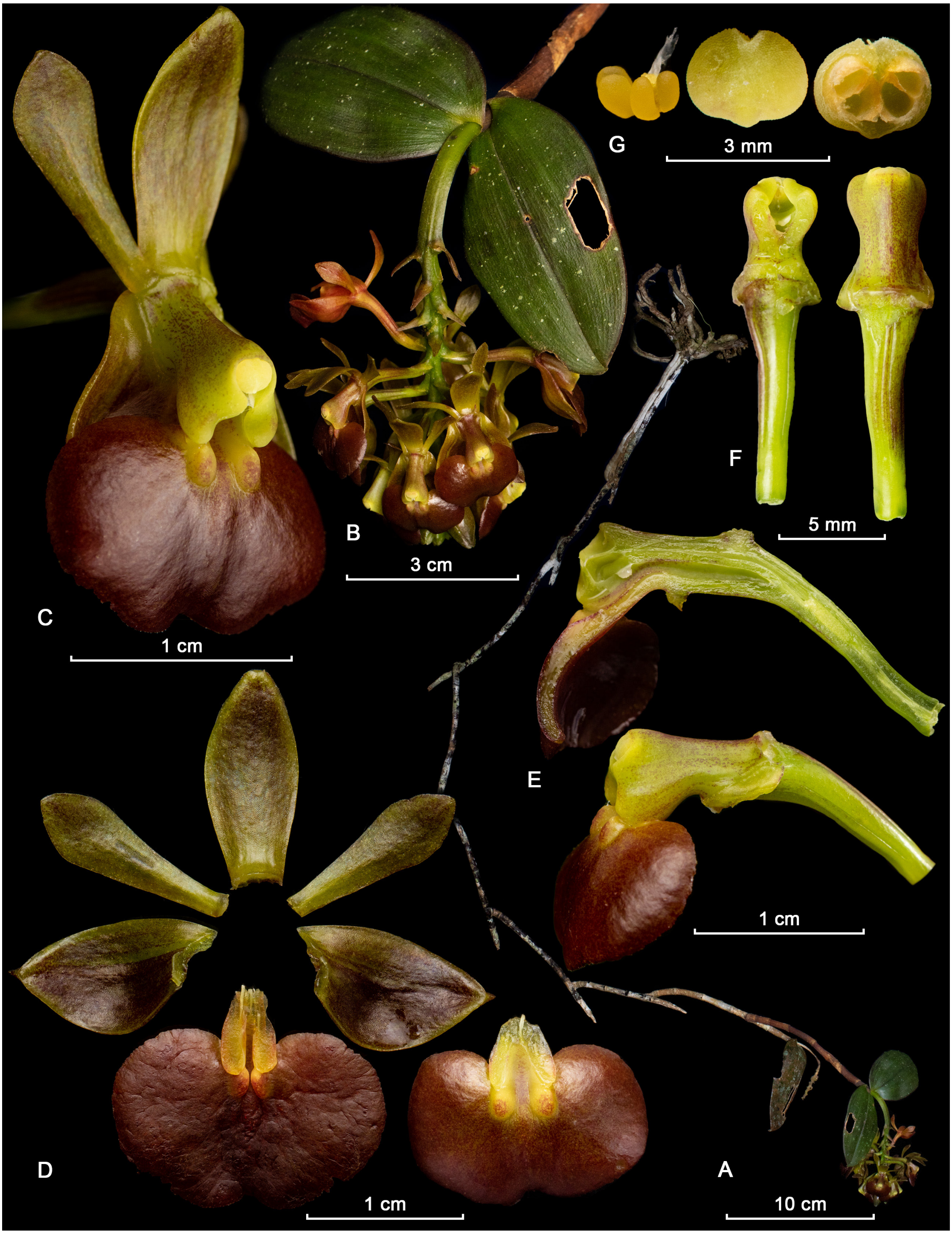


Figure 2. LCDP of *Epidendrum pembertonii* Rinc-González, E.Santiago & S.Vieira-Uribe. **A**. Habit. **B**. Inflorescence. **C**. Flower. **D**. Dissected perianth. **E**. Column and lip, side view. **F**. Column, ventral and dorsal views. **G**. Pollinarium and anther cap, dorsal and ventral views. LCDP prepared by S. Vieira-Uribe, based on *Vieira et al. #382*.

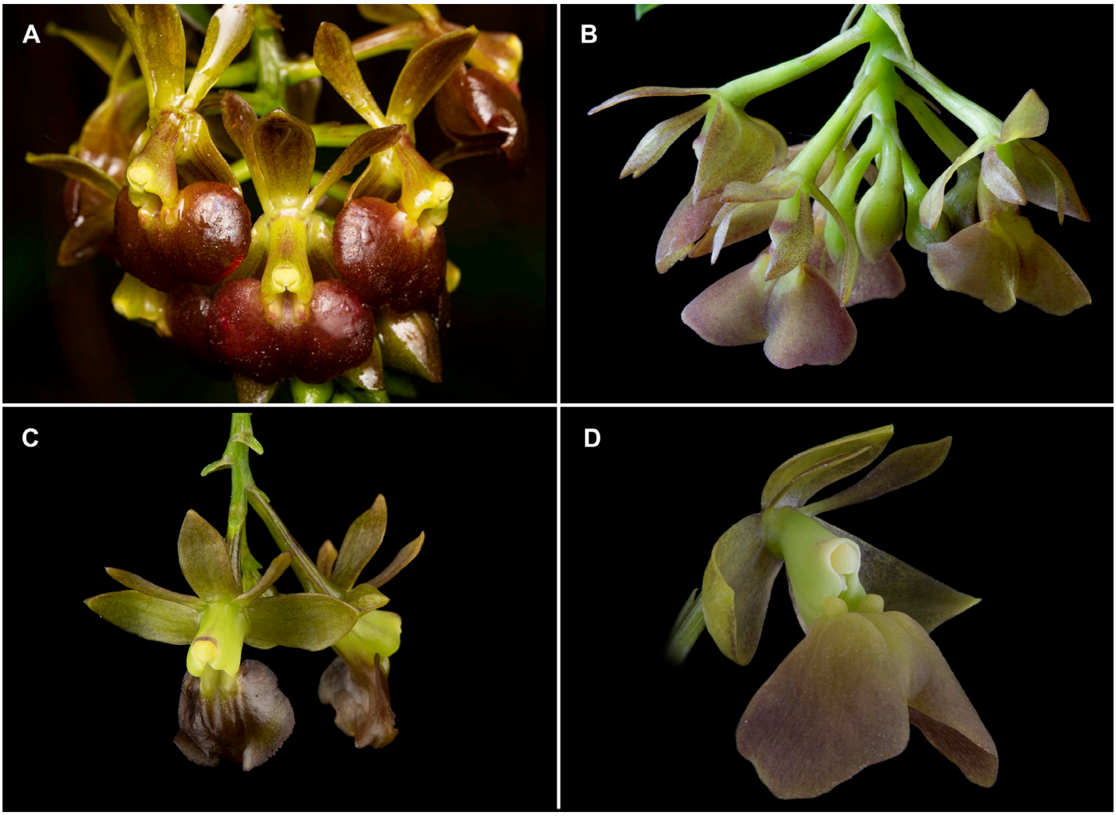


Figure 3. Comparison of *Epidendrum pembertonii* Rinc-González, E.Santiago & S.Vieira-Uribe and most similar species. **A**. *Epidendrum pembertonii.* **B**. *Epidendrum brenesii* Schltr. **C**. *Epidendrum bisulcatum* Ames. **D**. *Epidendrum sotoanum* Karremans & Hágsater. Photographs by S. Vieira-Uribe (A), Adam Karremans (B–C) and Melissa Díaz (D).

(*vs*. obovate-elliptic, 3-veined), the lip smooth, apex apiculate, (*vs*. velutinous, short setose, apex sometimes slightly 4-lobed) and the longer column (9–10 *vs*. 7–8 mm), straight, apex arching upwards (*vs*. arching downwards).

Epiphytic, sympodial, erect to pendulous *herb* 78 cm tall, new stems produced from a sub-apical internode of previous stem. *Roots* fleshy, from base of primary stem. *Stems* 8–13 × 0.3–0.5 cm, cane-like, terete, erect to pendulous when weight in old plants makes them hang from the roots, simple. *Leaves* 2, aggregate towards the apex of the stem, spreading, alternate; sheaths 0.32–0.65 × 0.3–0.5 cm, tubular, striated, reddish-brown; blades 5.2–6.0 × 2.5–2.7 cm, elliptic, obtuse, coriaceous, green, concolor. *Spathe* lacking. *Inflorescence* 7.2 cm long, apical, from the mature stem, racemose, arcuate; peduncle 2.2 × 0.43 cm, laterally compressed, green; rachis 5 cm long, arching-nutant. *Floral bracts* 5–6 mm long, much shorter than ovary, decreasing in size towards apex of the rachis, triangular, acute, embracing. *Flowers ca*. 18, opening in succession, until most open at the same time, resupinate, greenish yellow tinged with brown, lip red with calli yellow to red, column greenish yellow, slightly tinged reddish brown, anther yellow; fragrance none detected. *Ovary* 12–15 × 2.2–2.8 mm, slightly inflated behind the perianth, terete, furrowed, somewhat arcuate. *Sepals* free, fleshy, 5-veined, margins entire; dorsal sepal 13.5 × 6.0 mm, spreading, narrowly obovate, sub-rounded, minutely apiculate; lateral sepals 13.1 × 7.5 mm, partly spreading, obliquely elliptic, obtuse, apiculate. *Petals* 13.5 × 4.2 mm, free, spreading, oblanceolate, apex obtuse, 3-veined, margin entire. *Lip* 9–12 × 15.2–17.0 mm, united to column, fleshy, convex, smooth, wider than long, reniform, base cordate, apex emarginate, margin entire, spreading; bicallose, calli globose, slightly separate, disc with a thick, low rib running at the apex, reaching apical sinus of lip. *Column* 9–10 mm long, somewhat thick towards the apex, truncate, straight, apex arching upwards. *Clinandrium-hood* reduced, margin entire. *Anther* 1.9 × 2.3 mm, sub-globose, apex minutely apiculate, apical surface minutely papillose, 4-celled. *Pollinia* 0.87 × 0.66 mm, ovoid; caudicles granulose, shorter than pollinia; viscarium semi-liquid. *Rostellum* apical, slit. *Lateral lobes of stigma* about half length of stigmatic cavity. *Cuniculus* shallow, slightly penetrating ovary, narrow, smooth. *Capsule* not seen.

Eponymy: We dedicate this species to Robert W. Pemberton, an entomologist and botanist, as well as a generous donor who contributed to the expansion of the Los Magnolios Natural Reserve, which protects the habitat of the new species.

Habitat and ecology: Known only from Colombia, specifically from the north slope of the Cordillera Central in Antioquia. It grows as an epiphyte at 2080 m of elevation in premontane wet forest. A single plant has been found, thriving near an open pasture on the main trunk of a medium sized tree located along a small creek at approximately 2 m above the ground and in partial shade. It grows together with several other orchid species, including *Maxillariella lawrenceana* (Rolfe) M.A.Blanco & Carnevali (Blanco *et al.* 2007) and *Restrepia pelyx* Luer & R.Escobar (Luer & Escobar 1982). The plant has been observed flowering during every month of the year, with a single inflorescence lasting 2-3 months.

Conservation status: DD. Deficient Data. This species is pparently endemic to the Alto de Ventanas region of Yarumal-Antioquia, located in the north of the central Andes. Thus far, it has been exclusively found in the Los Magnolios Natural Reserve, owned and managed by Corporación Salvamontes. The reserve protects 770 hectares of habitat in the Alto de Ventanas area. However, this region has experienced significant deforestation, with approximately 70% of its forests lost due to the expansion of pastures for dairy farming (CORANTIOQUIA 2020)

Morphological affinities: *Epidendrum pembertonii* belongs to the Incomptum Group which is characterized by the successive lateral growths produced from the middle of the previous growth, the few leaves aggregate towards the apex of the stems, a short apical, racemose, nutant inflorescence, with fleshy, green, yellow, yellow-greenish, violet-green, to black flowers, short ovaries, and the lip entire to 3-lobed. The species is recognized by having 2 elliptic leaves, inflorescence of 7.2 cm long, the combination of color in the flowers, sepals 5-veined, petals oblanceolate, lip reniform, 9–12 × 15.2–17.0 mm and column somewhat thick towards the apex, straight, apex arching upwards, 9–10 mm long. *Epidendrum brenesii* is the most similar species, differing in having 3–5 oblong leaves (*vs*. 2, elliptic), shorter inflorescence (2–4 *vs*. 7.2 cm), 3-veined sepals (*vs*. 5-veined), Column arched downwards, 7–8 mm long (*vs*. straight, apex arched upwards, 9–10 mm). *Epidendrum bisulcatum* Ames (Ames 1923) differs in having oblong leaves (*vs*. elliptic), inflorescence 3.8 cm long (*vs*. 7.2 cm), dorsal sepal oblong, 3-nerved (*vs*. narrowly obovate, 5-nerved), lip suborbicular, retuse to rounded apex (*vs*. reniform, emarginate, apiculate). *Epidendrum foldatsii* Hágsater & Carnevali (Hágsater & Salazar 1993) is characterized by an inflorescence 2 cm long (*vs*. 7.2 cm), ovary 5–7 mm long (*vs*. 12–15 mm), sepals 3-veined (*vs*. 5-veined), petals 1-veined (*vs*. 3-veined), lip obreniform (*vs*. reniform) and column slightly sigmoid, 3 mm long (*vs*. straight, apex arched upwards, 9–10 mm). *Epidendrum sotoanum* Karremans & Hágsater (Karremans & Hágsater 2009) is characterized by an inflorescence 2 cm long (*vs*. 7.2 cm), cuniculus short, without penetrating the ovary (*vs*. shallow, slightly penetrating ovary), sepals 3-4 veined (*vs*. 5-veined), petals narrowly-obovate (*vs*. oblanceolate), lip superficially glabrous but with low rounded papilla, 10–17 × 20–30 mm (*vs*. smooth, 9–12 × 15.2–17 mm). The mentioned differences with the most similar species are expanded and illustrated in Table 2 and Figure 3.

Acknowledgments. The authors wish to thank Libardo Cuartas and Luz Dary Echavarría, the forest guards work- ing in Los Magnolios Natural Reserve, for discovering and photographing this species for the first time; Corporación Salvamontes and the Orchid Conservation Alliance for the protection of the habitat of the new species, the staff at the herbarium Jardín Botánico Joaquín Antonio Uribe (JAUM) for their support, and finally Robert Pemberton for his support to the expansion and management of the natural reserve where the new species was found. We would also like to thank the anonymous reviewers for all their suggestions and comments for the improvement of this manuscript.

Table 2. Distribution and morphological comparison between the closest species to *Epidendrum pembertonii*.

	E. bisulcatum	***E. brenesii***	***E. foldatsii***	***E. pembertonii***	***E. sotoanum***
Country	Costa Rica Panama	Costa Rica	Venezuela	Colombia	Costa Rica
Leaves number, shape, measures)	2–4, oblong, 6.0–9.0 × 1.4–2.2 cm	3–5, oblong, 2–8 × 1.3–2.5 cm	2–4, obovate-elliptic, 2.0–4.5 × 1.1–1.7 cm	2, elliptic, 5.2–6.0 × 2.5–2.7 cm	3, obovate-elliptic, 5–10 × 1.3–2.5 cm
Inflorescence (length)	3.8 cm	2–4 cm	2 cm	7.2 cm	2 cm
Tepals (color)	Live-green	Light green with purple tinge to deep purple	Unregistered	Yellow-greenish tinge brown	Greenish brown or yellow
Lip (color)	Lighter with a purple cast over it	Light green with purple tinge to deep purple	Unregistered	Red with the calli yellow to red	Greenish brown or yellow
Column (color)	Yellow-greenish	Green	Unregistered	Yellow-greenish, slightly tinge reddish brown, anther yellow	Green, darker at the base
Ovary (length)	10–11 mm	8–13 mm	5–7 mm	12–15 mm	12–20 mm
Cuniculus nectary	Shallow, slightly penetrating ovary, narrow, smooth	Penetrating somewhat the ovary, smooth	Unregistered	Shallow, slightly penetrating ovary, narrow, smooth	Short, without penetrating the ovary, smooth
Dorsal sepal (shape, length, number of veins)	Oblong, 12–15 × 6.0–6.5 mm, 3-veined	Obovate-elliptic, 12–13 × 6.0–6.5 mm, 3–veined	Elliptic, 4.5–5.0 × 2.5 mm, 3-veined	Narrowly obovate, sub-rounded, 13.5 × 6.0 mm, 5–veined	Obovate-elliptic, 12–16 × 4.0–7.5 mm, 3–4 veined
Lateral sepals (shape, length, number of veins)	Oblong, 12–15 × 6.0–6.5 mm, 5-veined apparently	Obovate-elliptic, 14.5–15.0 × 7.5 mm, 3-veined	Obliquely ovate, 5 × 2.8 mm, 3-veined	Obliquely elliptic, 13.1 × 7.5 mm, 5–veined	Obovate-elliptic, 13–18 × 7–9 mm, 3–4 veined
Petals (shape, length, number of veins)	Linear-spathulate, 11–12 × 2.5 mm, 3-veined	Linear-oblanceolate, 12 × 2.5–3 mm, 3-veined	Linear-oblanceolate, 4.5 × 1 mm, 1-veined	Oblanceolate, 13.5 × 4.2 mm, 3-veined	Narrowly-obovate, spreading, 11–15 × 2-4 mm, 3-veined
Lip (shape, surface, measures)	Suborbicular, surface unregistered 9.0-10 × 11.0–12.5 mm	Reniform, velutinous, short setose, densely covered by short, pointed trichomes. 8–12 × 15–19 mm	Obreniform, surface unregistered, 4 × 7.5 mm	Reniform, smooth, 9-12 × 15.2–17.0 mm	Widely reniform, superficially glabrous in appearance but with low rounded papilla. 10–17 × 20–30 mm
Callus and keels	Bicallose, callus laminar, short, with 3 low keels in front, the central keel running to the apex of the lip, the lateral ones short	Bicallose, callus formed by a pair of short, laterally compressed thickenings; disc with a low, wide keel that reaches the apical sinus	Bicallose, callus divergent in front of the column, with a fleshy, rounded keel running down the middle without reaching the apical sinus	Bicallose, callus globose, slightly separate; disc with a thick, low rib running at apex, reaching apical sinus of lip	Bicallose, callus thickened at the base and ending in a pair of low keels
Lip apex (shape)	Retuse to rounded	Emarginate, the apex sometimes slightly 4-lobed	Deeply emarginate	Emarginate, apiculate	Deeply emarginate
Column (shape, length)	Slightly arched upward, 7.0–8.0 mm long	Arching downwards, 7-8 mm long	Slightly sigmoid, 3 mm long	Straight, apex arching upwards, 9–10 mm long	Somewhat arching downwards, 7–8 mm long

LITERATURE CITED

Ames, O. (1923). *Epidendrum bisulcatum*. In *Schedulae Orchidianae*, 5, 24–27, fig. 5.

AMO-DATA. (2021). The databank for collection notes, images, and herbarium specimens of the Herbario AMO, including images of the most important specimens housed in major herbaria of Europe and the Americas. Retrieved from https://revistas.ucr.ac.cr/index.php/lankesteriana/article/view/22999

Blanco, M. A., Carnevali, G., Witten, W. M., Singer, R. B., Koehler, S., Williams, N. H., Ojeda, I., Neubig, K. M. & Endara, L. (2007). Generic realignments in Maxillariinae (Orchidaceae). *Lankesteriana*, 7(3), 515–537. Doi: https://doi.org/10.15517/lank.v0i0.7935

Corporación Autónoma Regional del Centro de Antioquia (CORANTIOQUIA) (2020). Plan de manejo 2020–2025, Distrito Regional de Manejo Integrado DRMI Alto de Ventanas. 279 Pp.

De Queiroz, K. (2007). Species concepts and species delimitation. *Systematic Biology*, 56, 879–886. Doi: https://doi.org/10.1080/10635150701701083

Hágsater, E. (1985). Towards an understanding of the genus *Epidendrum*. In *Proceedings of the Eleventh World Orchid Conference* (pp. 195–201). Miami, Florida: American Orchid Society.

Hágsater, E. & Salazar, G. A. (Eds.). (1993). The genus *Epidendrum*. Part 1. "A century of new species in *Epidendrum.". Icones Orchidacearum*, 2, pl. 101–200.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2001). The genus *Epidendrum*. Part 3. "A third century of new species in *Epidendrum.". Icones Orchidacearum*, 4, pl. 401–500.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2004). The genus *Epidendrum*. Part 4. "A fourth century of new species in *Epidendrum.". Icones Orchidacearum,* 7, pl. 701–800.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2006). The genus *Epidendrum.* Part 5. "Species new & old in *Epidendrum.". Icones Orchidacearum,* 8, pl. 801–900.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2007). The genus *Epidendrum*. Part 6. "Species new & old in *Epidendrum.". Icones Orchidacearum,* 9, pl. 901–1000.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2008). The genus *Epidendrum*. Part 7. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 11, pl. 1101–1200.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2009). The genus *Epidendrum.* Part 8. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 12: pl. 1201–1300.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2010). The genus *Epidendrum*. Part 9. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 13, pl. 1301–1400.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2013). The genus *Epidendrum*. Part 10. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 14, pl. 1401–1500.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2015). The genus *Epidendrum*. Part 11. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 15(1), pl. 1501–1568.

Hágsater, E. & Sánchez-Saldaña, L. (Eds.). (2016). The genus *Epidendrum*. Part 11. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 15(2), pl. 1569–1600.

Hágsater, E. & Santiago, E. (Eds.). (2018a). The genus *Epidendrum*. Part 12. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 16(1), pl. 1601–1667.

Hágsater, E. & Santiago, E. (Eds.). (2018b). The genus *Epidendrum.* Part 12. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 16(2), pl. 1668–1700.

Hágsater, E. & Santiago, E. (Eds.). (2019). The genus *Epidendrum*. Part 13. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 17(1), pl. 1701–1756.

Hágsater, E. & Santiago, E. (Eds.). (2020a). The genus *Epidendrum.* Part 13. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 17(2), pl. 1757–1800.

Hágsater, E. & Santiago, E. (Eds.). (2020b). The genus *Epidendrum.* Part 14. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 18(1), pl. 1801–1848.

Hágsater, E. & Santiago, E. (Eds.). (2021). The genus *Epidendrum.* Part 14. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 18(2), pl. 1849–1900.

Hágsater, E. & Santiago, E. (Eds.). (2022a). The genus *Epidendrum.* Part 15. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 19(1), pl. 1901–1949.

Hágsater, E. & Santiago, E. (Eds.). (2022b). The genus *Epidendrum.* Part 15. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 19(2), pl. 1950–1962.

Hágsater, E. & Santiago, E. (Eds.). (2023). The genus *Epidendrum.* Part 15. "Species new & old in *Epidendrum*.". *Icones Orchidacearum,* 19(3), pl. 1963–2000.

Hágsater, E., Sánchez-Saldaña, L. & García-Cruz, J. (Eds.). (1999). The genus *Epidendrum*. Part 2. "A second century of new species in *Epidendrum*." *Icones Orchidacearum,* 3, pl. 301–400.

Hágsater, E., Santiago, E. & Rodríguez-Martínez, L. (2016). *Epidendrum lasiostachyum* (Orchidaceae): a new Colombian species of the *Epidendrum* macrostachyum group. *Lankesteriana,* 16, 27–37. Doi: http://dx.doi.org/10.15517/lank.v16i1.23621

Hágsater, E. & Soto, M. A. (2005). *Epidendrum* In: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. N. Rasmussen (Eds). *Genera Orchidacearum* 4: *Epidendroideae, part one*. Oxford University Press, Cambridge, 236–251.

Karremans, A. P. (2021). With Great Biodiversity Comes Great Responsibility: The Underestimated Diversity of

Epidendrum (Orchidaceae). *Harvard Papers in Botany*, 26(2), 299–369. Doi: https://doi.org/10.3100/hpib.v26iss2.2021.n1

Karremans, A. P. & Hágsater, E. (2009). Confusion in *Epidendrum brenesii* Schltr., and a new Costa Rican species: *Epidendrum sotoanum* (Orchidaceae). *Lankesteriana*, 9(3), 403–409. Doi: https://doi.org/10.15517/lank.v0i0.12076

Linnaeus, C. (1763). *Epidendrum*. In: *Species Plantarum: exhibentes plantas rite cognitas, ad genera relatas, cum differentiis specificis, nominibus trivialibus, synonymis selectis, locis natalibus, secundum systema sexuale digestas*, ed. 2(2), 785–1684.

Luer, C. A. & Escobar R. (1982). New species and combinations in *Dracula* and *Masdevallia* (Orchidaceae) from Colombia and Venezuela. *Selbyana*, *7*(1), 64–78.

Rincón-González, M., Santiago Ayala, E. & Hágsater, E. (2022). A new species of *Epidendrum* (Orchidaceae) from The Central Andes of Antioquia, Colombia. *Lankesteriana*, 22(2), 145–153. Doi: https://doi.org/10.15517/lank.v22i2.52169

Schlechter, R. (1923). *Epidendrum brenesii.* In: *Repertorium Specierum Novarum Regni Vegetabilis, Beihefte,* 19, 209–210.

LANKESTERIANA 24(1): 49–60. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.57040

TWO NEW SPECIES OF PLEUROTHALLIDINAE FROM CLOUD FOREST REMNANTS IN THE EASTERN ANDES OF COLOMBIA

Nicolás Gutiérrez Morales[1, 2, 7], Juan Sebastián Moreno[2],
Melisa Alegría-Valencia[3, 4] & Karen Gil-Amaya[2, 5 , 6]

[1]Instituto de Biociências de Rio Claro, Departamento de Botânica, Universidade Estadual Paulista - UNESP, Av. 24 A 1515, Caixa Postal 199, Rio Claro, São Paulo, Brazil.
[2]Grupo de investigación Schultes, Fundación Ecotonos, Valle del Cauca, Cali, Colombia.
[3]Departamento de Biología, Universidad del Valle, Calle 13 # 100-00, Cali, Colombia.
[4]Grupo de Investigación Ecología y Diversidad Vegetal, Universidad del Valle, Calle 13 # 100-00, Cali, Colombia.
[5]Grupo de investigación y conservación de la flora de la Región Capital como estrategia de adaptación al cambio climático, Jardín Botánico José Celestino Mutis, 111071, Bogotá, Colombia.
[6]Jardín Botánico Lankester, Universidad de Costa Rica, PO Box 302-7050, Cartago, Costa Rica.
[7]Author for correspondence: nicolaiequal@gmail.com

Abstract. Two new pleurothallid species of the genera *Lepanthes* and *Pleurothallis*, native to cloud forest remnants of the Eastern Andes of Colombia, are described and illustrated. *Lepanthes pseudoabitaguae* is compared with *Lepanthes abitaguae*, from which it differs by the color of the flowers and by the oblong and biglandular appendix. *Pleurothallis falcata* is similar to *Pleurothallis suspensa*, but can be recognized by the falcate to lanceolate leaves, denser inflorescences, longer sepals, and the lip completely recurved with erose apical margins. We also provide comparisons with similar species and offer comments on their ecology. Furthermore, we discuss the significance of this highly anthropized region and its richness in orchid species.

Resumen. Se describen e ilustran dos nuevas especies de Pleurothallidinae de los géneros *Lepanthes* y *Pleurothallis*, nativas de remanentes de bosque nublado en los Andes Orientales de Colombia. *Lepanthes pseudoabitaguae* se compara con *Lepanthes abitaguae*, de la cual difiere por el color de las flores y por el apéndice oblongo y biglandular. *Pleurothallis falcata* es similar a *Pleurothallis suspensa*, pero puede ser reconocida por las hojas falcadas a lanceoladas, inflorescencias más densas, sépalos más largos y el labelo completamente recurvo con márgenes apicales erosas. También proporcionamos comparaciones con especies similares y ofrecemos comentarios sobre su ecología. Además, discutimos la importancia de esta región altamente antropizada y su riqueza en especies de orquídeas.

Keywords / Palabras clave: endemism, endemismo, flora of Colombia, flora de Colombia, *Lepanthes*, *Pleurothallis*, taxonomy, taxonomía

Introduction. The tropical montane cloud forests constitute nearly 2.5% of the surface of tropical forests. Despite their relatively small extent, they are of utmost priority for biodiversity conservation, considering the outstanding values of endemic and threatened species they harbor (Armenteras *et al*. 2007, Bubb *et al*. 2004). Moreover, these forests play a crucial role in providing fresh water and storing carbon, among other benefits for human well-being (Aparecido *et al*. 2018).

Neotropical cloud forests exhibit exceptional diversity, particularly in certain groups of birds, amphibians, and vascular epiphytes, notably orchids (Carmona-Higuita *et al*. 2023, Gentry & Dodson 1987, Pérez-Escobar *et al*. 2017). Among orchids, the Pleurothallidinae subtribe show one of the highest evolutionary diversification rates, representing a significant portion of the orchid flora found in montane forests (Pérez-Escobar *et al*. 2017). A recently published cata-

ORCID of the Author: NGM, JSM, MAV, KGA
Received 11 October 2023; accepted for publication 23 December 2023.

logue of the Pleurothallidinae subtribe for Colombia listed 1854 species, with almost 60% of them being endemic to the country. The most species richn genera are *Stelis* Sw. (521 species), *Lepanthes* Sw. (377 species) and *Pleurothallis* R.Br. (248 species) (Karremans *et al*. 2023).

In the Neotropics, the major threat to this unique ecosystem is the clearance for cattle ranching. In the case of Colombia, despite trends of rural depopulation, the expansion of grasslands has continued (Bubb *et al*. 2004), resulting in cloud forests becoming isolated islands on mountain tops or along steep hills, remnants of the once extensive areas of Andean forests. The eastern range of the Colombian Andes, known as “Cordillera Oriental,” has undergone extensive transformation, particularly towards the Magdalena Valley. Approximately 51% of its original natural ecosystems have been lost, with only 45% of the original cover of Andean forests remaining, and less than 5% designated as protected areas, as estimated two decades ago (Armenteras *et al*. 2003).

However, small remnants of well-preserved cloud forests within transformed landscapes play a crucial role as a refuge for epiphyte diversity (Koster *et al.* 2009). This significance increases when considering narrow endemic species such as orchids of the Pleurothallidinae subtribe.

Previously unexplored areas of the Neotropics may host several undescribed plant species (Gentry 1982). Recent studies of the orchid flora in remnants of cloud forests in a floristically rich area of the eastern Andes in Santander, Colombia, have led to the discovery of new orchid species (Gutiérrez Morales *et al.* 2018, 2021, 2023, Hágsater *et al.* 2018, Moreno *et al.* 2018, Vieira-Uribe & Gutiérrez 2020). As part of this ongoing research, we present two new orchid species from the same locality, specifically of the genera *Lepanthes* and *Pleurothallis* within the Pleurothallidinae subtribe.

TAXONOMIC TREATMENT

Lepanthes pseudoabitaguae N.Gut., K.Gil-Amaya & J.S.Moreno ***sp. nov.*** (Fig. 1, 2, 3A)

TYPE: COLOMBIA. Santander: La Belleza, Vereda El Chircal-Ojo de Agua, 2530 m. 18 November 2016, *N. Gutiérrez 17* (holotype, JBB 17269).

DIAGNOSIS: *Lepanthes pseudoabitaguae* is most similar to *Lepanthes abitaguae* Luer & L.Jost*,* as its name suggests. The primary distinguishing feature lies in their appendices which in *L. abitaguae* is triangular, positioned below the stigma and acutely reflexed (*vs*. oblong and biglandular in *L. pseudoabitaguae*).

Plant epiphytic, caespitose, up to 22 cm tall. *Roots* slender, flexuous, filiform, *ca.* 1.0–1.2 mm in diameter. *Ramicauls* slender, suberect, 3.5–14 cm long, enclosed by 7–13 ribbed, minutely ciliate, acuminate, lepanthiform sheaths. *Leaves* suberect, papyraceous, purple on the abaxial surface, lustrous, likely iridescent, ovate to elliptical, the margins recurved, reticulate-veined, obtuse, the apex emarginate with an abaxial central apiculum, 4.5–7.2 cm × 1.7–2.3 cm wide, the base cuneate, contracted into a petiole 1.0–1.2 mm long. *Inflorescence* (1–2) per ramicaul, a congested, distichous raceme successively many-flowered, up to 4.5 cm long, borne on the adaxial side of the leaf by a slender and filiform peduncle, 2.0–3.7 cm long; *floral bracts* conical, acuminate, 1.4–1.9 mm long. *Ovary* costate, 3.3–3.9 mm long. *Flowers* with sepals magenta to pale red, with pale yellow at the margins, petals and lip cinnabar, the column vermilion with the apex claret, the anther cap purple. *Dorsal sepal* glabrous, ovate, slightly concave in the middle, acute-attenuate, 3-veined, 5.0–6.7 × 3.8–5.5 mm, connate to the lateral sepals for up to 2.65 mm. *Lateral sepals* shortly papillate along the margins, ovate, oblique, each-2-veined, 4.4–6.1 × 2.4–3.3 mm, connate up to 3.4 mm into an ovate, bifid synsepal with attenuate, divergent apices. *Petals* transversally trilobed, 3-veined, minutely pubescent, the upper lobe quadrate, oblique, 4 × 2 mm, 2 mm long, the flagelliform midlobe uncinate from the outer margin between the lobes, the lower lobe narrowly triangular, acute, 3.7 × 1.2 mm. *Lip* bilaminate, the blades suboblong, 1.7–2.6 × 0.6–0.9 mm, the base obtuse, the apex truncate, minutely pubescent, sharply folded over the thin and broadly cuneate connectives, adnate to the base of the column, with a pubescent, oblong, sinuose, biglandular appendix. *Column* terete, stigma ventral, bilobed, anther dorsal, elongated beyond the stigma, 2.9 mm long. *Anther cap* cucullate, elongate, 1.7 × 0.5 mm. *Pollinia* 2, yellow, narrowly oblanceolate, attached to a viscidium, 1.4 mm long.

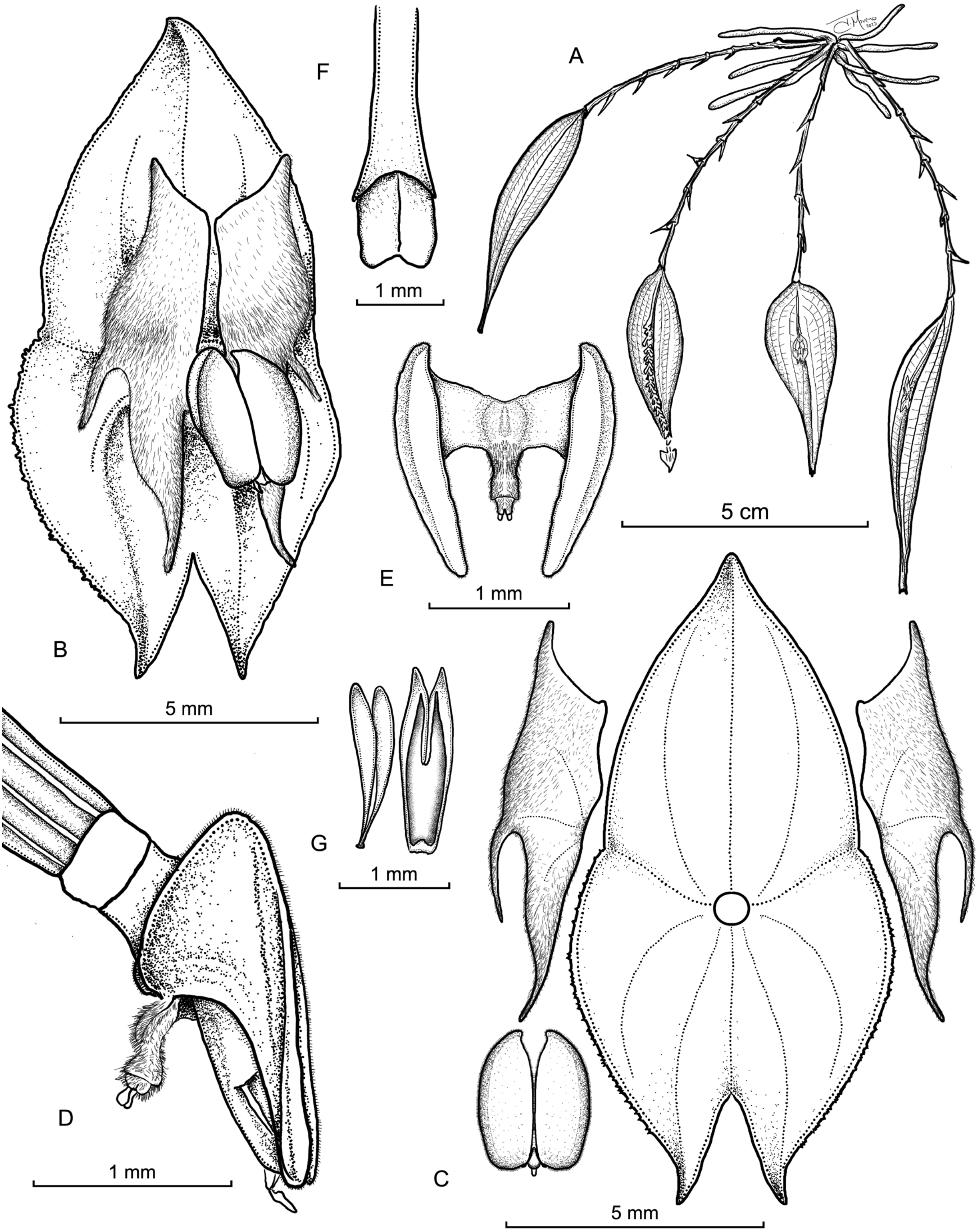


Figure 1. Illustration of *Lepanthes pseudoabitaguae* N.Gut., K.Gil-Amaya & J.S.Moreno. **A**. Habit. **B**. Flower. **C**. Perianth, with lateral view of the synsepal. **D**. Ovary, column and lip, lateral view. **E**. Lip, ventral view. **F**. Column, dorsal view. **G**. Anther cap and pollinia. Illustration by Juan Sebastián Moreno based on the paratype.

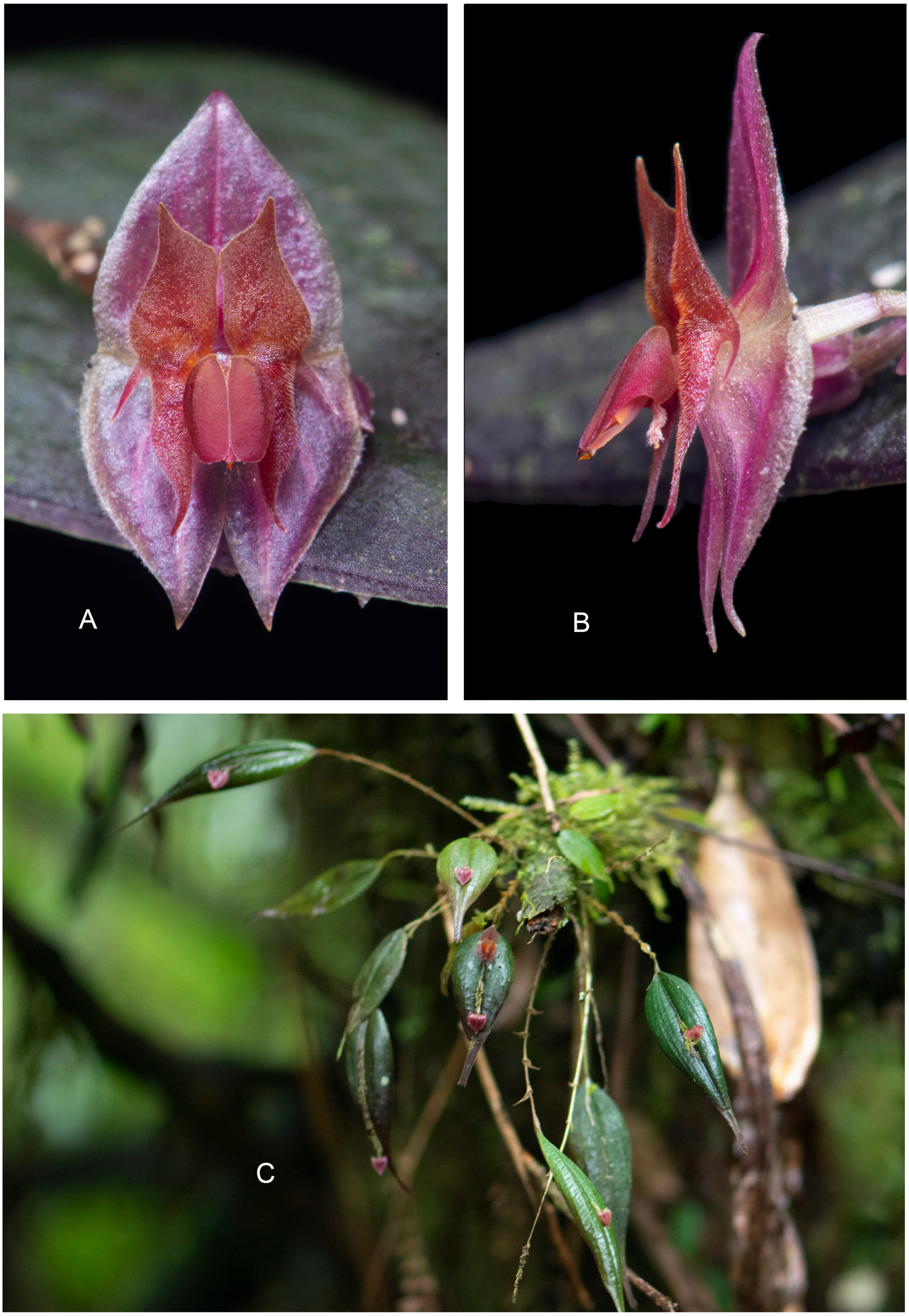


FIGURE 2. *Lepanthes pseudoabitaguae in situ*. **A**. Flower, frontal view. **B**. Flower, lateral view. **C**. Habit. Photos by Juan Sebastián Moreno.

FIGURE 3. Comparison with the most similar species. **A**. *Lepanthes pseudoabitaguae*. **B**. *Lepanthes abitaguae*. Photos by Juan Sebastián Moreno (A) and Andreas Kay (B).

ADDITIONAL MATERIAL EXAMINED: COLOMBIA. Santander: La Belleza, Vereda El Chircal-Ojo de Agua, 2583 m. 11 May 2022, *N. Gutiérrez 232*, (paratype, JBB). Bolivar, Hoya de Panamá, 2790 m. February 2016 (photo voucher: David Haelterman).

EPONYMY: Named due to its remarkable similarity with *Lepanthes abitaguae.*

DISTRIBUTION: *Lepanthes pseudoabitaguae* is apparently restricted to montane humid forests on the western slope of the Eastern Andes of Colombia, in La Belleza Municipality, Santander (Fig. 4). Despite the high degree of fragmentation of these cloud forests, this species has been observed several times in the type locality and once in a second area located near the top of the "Hoya de Panamá," in the Municipality of Bolivar, Santander.

HABITAT AND ECOLOGY: The type specimen was found growing near the ground on branches densely covered by bryophytes, with limited exposure to light. Other *Lepanthes* species registered in these forest remnants include *Lepanthes agglutinata* Luer, *Lepanthes saccata* Luer & R.Escobar, *Lepanthes palaga* Luer & R.Escobar and *Lepanthes dryades* Luer & R.Escobar.

Discussion. The most similar species to *Lepanthes pseudoabitaguae* is undoubtedly *Lepanthes abitaguae* (Fig. 3B), endemic to the eastern slope of the Andes of Ecuador. The plants are similar in overall size and in the proportions between ramicauls and leaves, the leaves are iridescent, suffused with purple beneath. The flowers are apparently identical, just differing in the color of petals and sepals (yellow-orange in *L. abitaguae*, magenta to pale red in *L. pseudoabitaguae*), in the degree of connation of the dorsal sepal to the lateral sepals (1 mm in *L. abitaguae*, 3.4 mm in *L. pseudoabitaguae*), and in the appendix morphology.

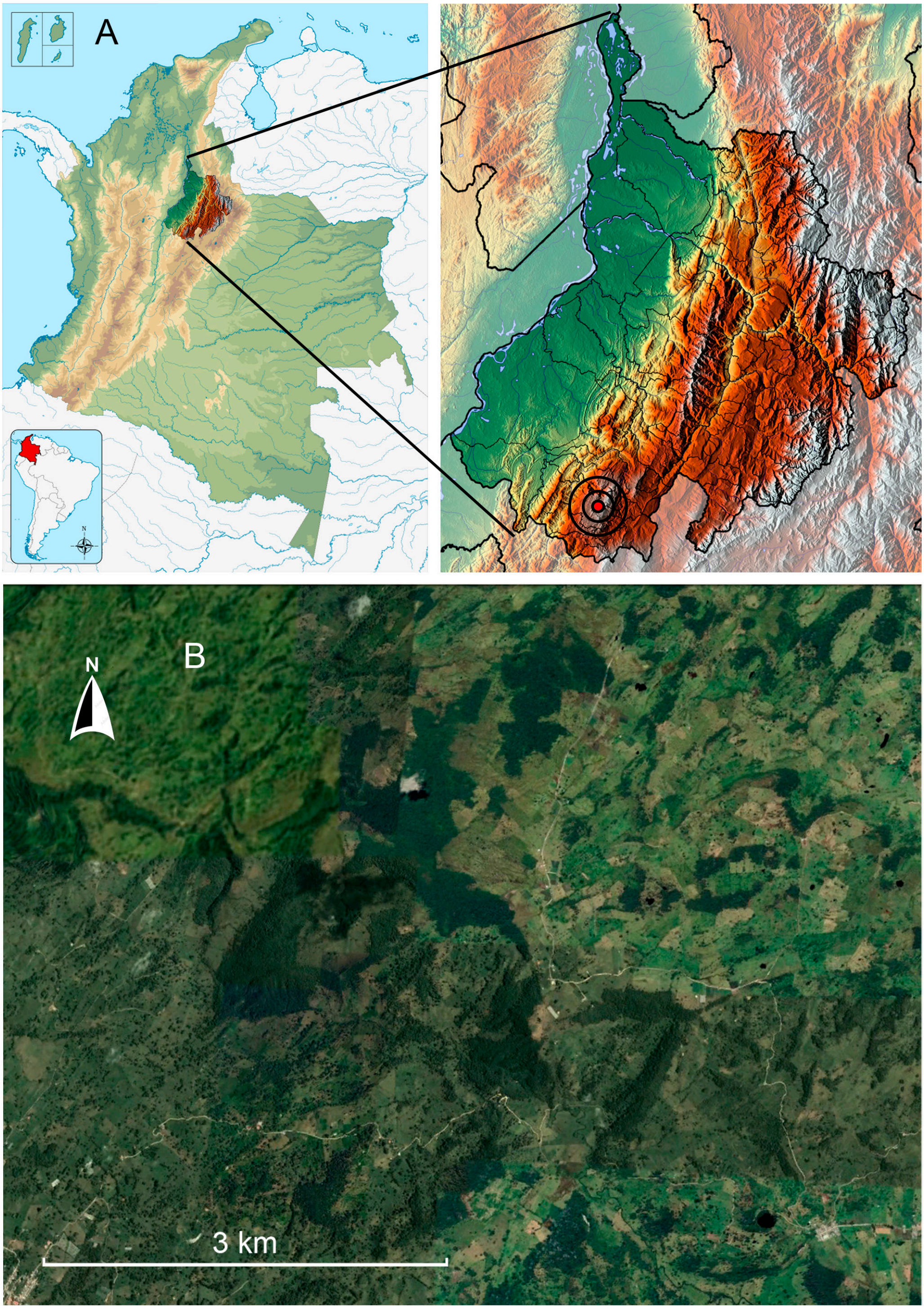


FIGURE 4. **A**. Santander department in the Eastern Andes of Colombia, the specific region is marked to the south. **B**. Satellite images of the forest fragments that harbors the two new species, along with several other endemic orchid species, within a highly transformed landscape. Photos by Wikipedia (A) and Google Earth (B).

When we first collected and photographed the new species, we erroneously identified it as *Lepanthes abitaguae* due to their remarkable similarity in plant and flower morphology. However, considering the distribution range of *L. abitaguae*, and some minor discrepances in flower morphology that we mentioned earlier, we decided to dissect the specimens under a stereo microscope to confirm its identity. Focusing on the defining feature of many *Lepanthes* species, which is the appendix, we found a significant difference in this structure, which is oblong and biglandular in *Lepanthes pseudoabitaguae*, but reflexed and triangular in *L. abitaguae*. This is the most distinct difference between the two species.

On the other hand, it is worth noting that when describing *L. abitaguae*, Luer did not provide detailed descriptions or illustrations of the column, stigma, or anther, which may also vary between both species. Instead, he placed emphasis on the lip blades and the appendix.

Pleurothallis falcata N.Gut. & K.Gil-Amaya, ***sp. nov.*** (Fig. 5, 6, 7A–B)

TYPE: COLOMBIA Santander: La Belleza, Vereda El Chircal-Ojo de Agua, 2457 m. 14 January 2023*, N. Gutiérrez 270* (holotype, JBB 38541; isotype, *N. Gutiérrez 271*, JBB 38542).

Diagnosis: Similar to *Pleurothallis suspensa* Luer, distinguished by the falcate to lanceolate leaves (*vs*. elliptical-ovate), the denser inflorescences with pinkish and pale yellow flowers (*vs*. inflorescences with distant, purple flowers), the larger sepals, (sepals >10.5 mm *vs*. <8.0 mm long), and the lip with the apex completely recurved, with the apiculum recurved and the apical margins erose (*vs*. lip partially recurved, the apiculum straight, the apical margins entire).

Plant epiphytic, caespitose, up to 27 cm tall. *Roots* slender, flexuous, *ca*. 1 mm in diameter. *Ramicauls* erect to suberect, slender, 8.5–16.5 cm long, partially enclosed by a pair of close, tubular, ribbed, truncate sheaths. *Leaf* suberect, thinly coriaceous, falcate to lanceolate, the apex attenuate, acuminate, 6.3–11 × 1.0–1.3 cm, the base cuneate. *Inflorescence* 1–10 per ramicaul, loose, pendant, fragile, subcongested, 5–10 flowered racemes of simultaneous, pinkish to light yellow, non-resupinate flowers, 6.0–9.5 cm long including the peduncle *ca*. 5 cm long, emerging from a spathe *ca*. 1–2 cm long at the base of the leaf; *floral bracts* tubular, slightly dilated, truncate, 4 mm long, pedicels 3 mm long. *Ovary* green to vinaceous, sulcate, 2 mm long. *Flowers* not resupinate, pinkish to pale yellow. *Sepals* membranous, glabrous, the *dorsal sepal* narrowly lanceolate, acute, 9.7 × 1.9 mm, 3-veined, the *lateral sepals* completely connate into a lanceolate, deeply concave, acute synsepal, 10.5 × 2.8 mm, each 2-veined. *Petals* membranous, narrowly linear, acute, 8.6 × 0.4 mm, 3-veined. *Lip* vinaceous, darker centrally, broadly ovate, 3-lobed, arcuate, 1.6 × 1.7 mm unexpanded, the lateral lobes erect, broadly rounded, slightly oblique, the midlobe with the apex apiculate, erose, vinaceous, the disc convex, slightly sulcate, without callus, the base truncate, hinged to the column-foot. *Column* stout, semiterete, 1.2 mm long. The *anther* and *stigma* apical, the rostellum elongate, triangular, tinged with rose. *Pollinia* two, yellow, ovoid, *ca*. 0.4 mm long, attached to a rounded viscidium. *Fruit* 0.8 cm long, 0.6 cm wide.

Additional material examined: COLOMBIA. Santander: La Belleza, Vereda El Chircal-Ojo de Agua, 2530 m. 31 May 2017*, N. Gutiérrez 63 & S. Moreno* (paratype, JBB 17607).

Etymology: From the Latin *falcatus*, "hooked, curved like a scythe or sickle," in allusion to some of the leaves of this species, such character is more evident in the photograph of the paratype specimen (Fig. 7A).

Distribution: Only known from the western slope of the Eastern Andes, in La Belleza, Santander, Colombia, where it inhabits cloud forests at elevations of 2400 to 2600 m, in the same forest remnants that host populations of *Lepanthes pseudoabitaguae*.

Habitat and ecology: Epiphytic in partial shade in mature vegetation, on trunks of several Melastomataceae trees and tree ferns of the genus *Cyathea* Sm. (Cyatheaceae). The type specimen was found alongside other orchid species such as *Lepanthes palaga*, *L. saccata*, and *Oliveriana ortizii* Á.Fernández. Flowering occurs from January to May. Individuals from different populations exhibit variations in overall flower size and color, ranging from entirely white, cream to pink, while the leaves of a single specimen may also display varying degrees of curvature.

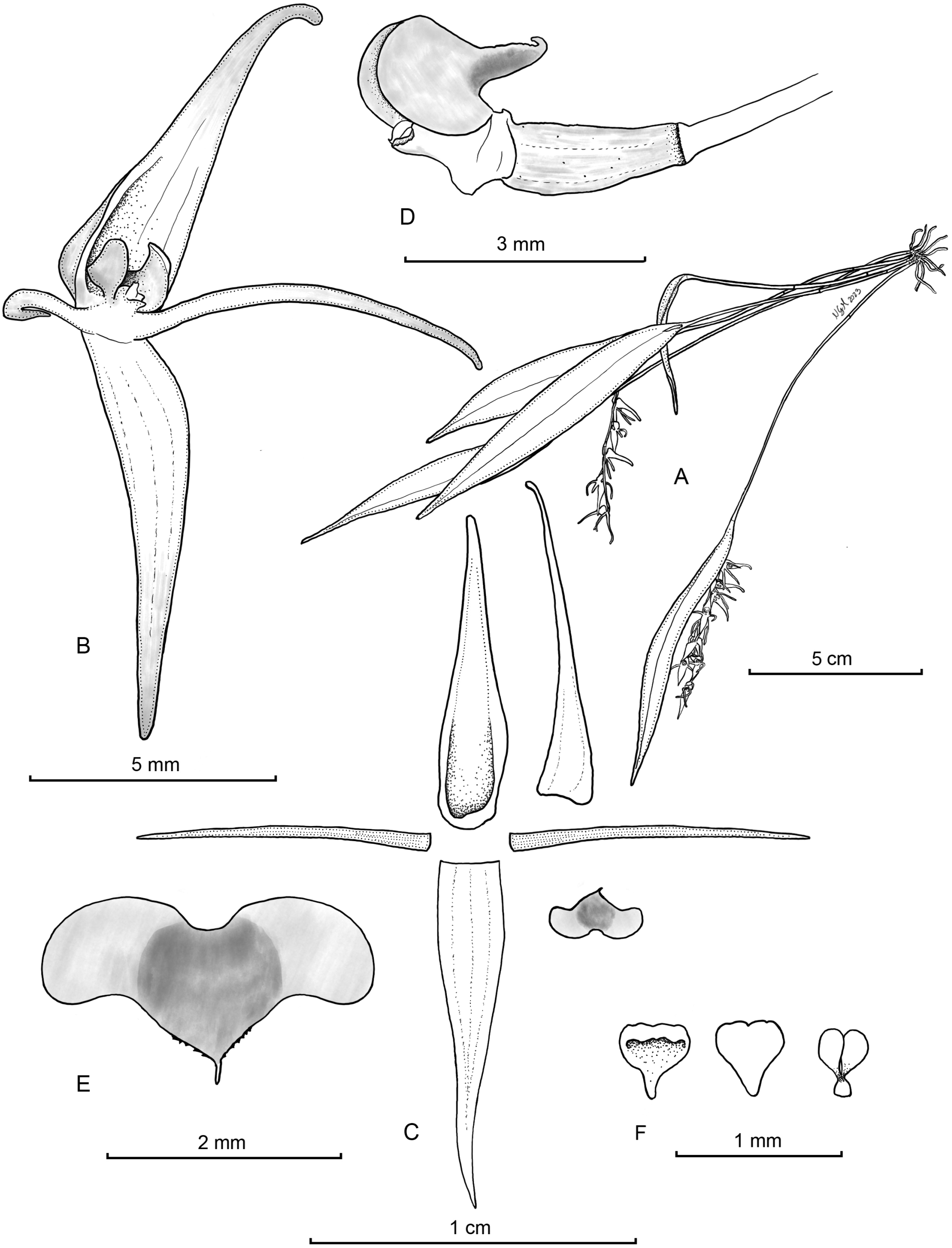


Figure 5. Illustration of *Pleurothallis falcata* N.Gut. & K.Gil-Amaya. **A**. Habit. **B**. Flower. **C**. Perianth, with lateral view of the synsepal. **D**. Ovary, column and lip, lateral view. **E**. Inverted, expanded lip. **F**. Anther cap and pollinarium. Illustration by Nicolás Gutiérrez Morales based on the paratype.

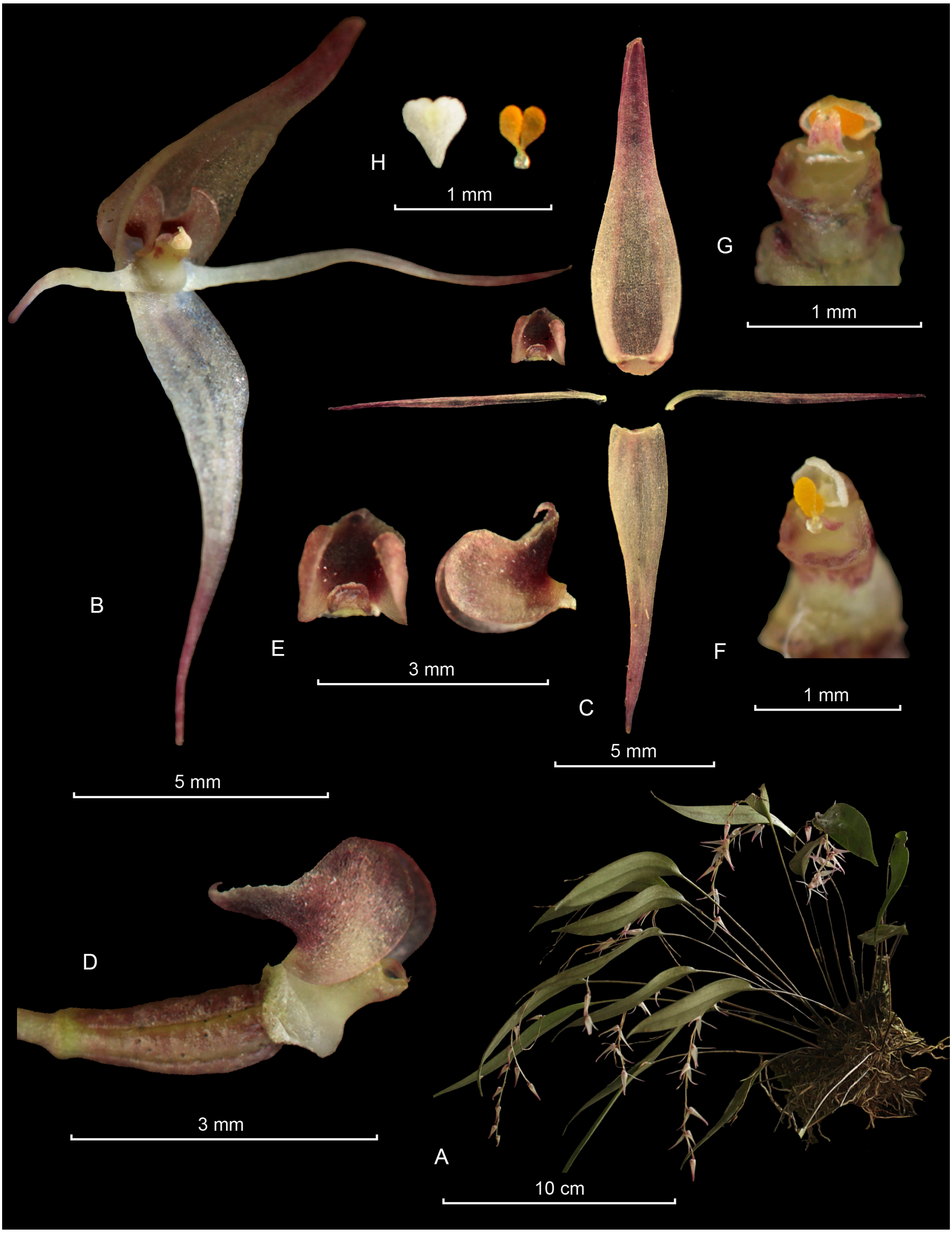
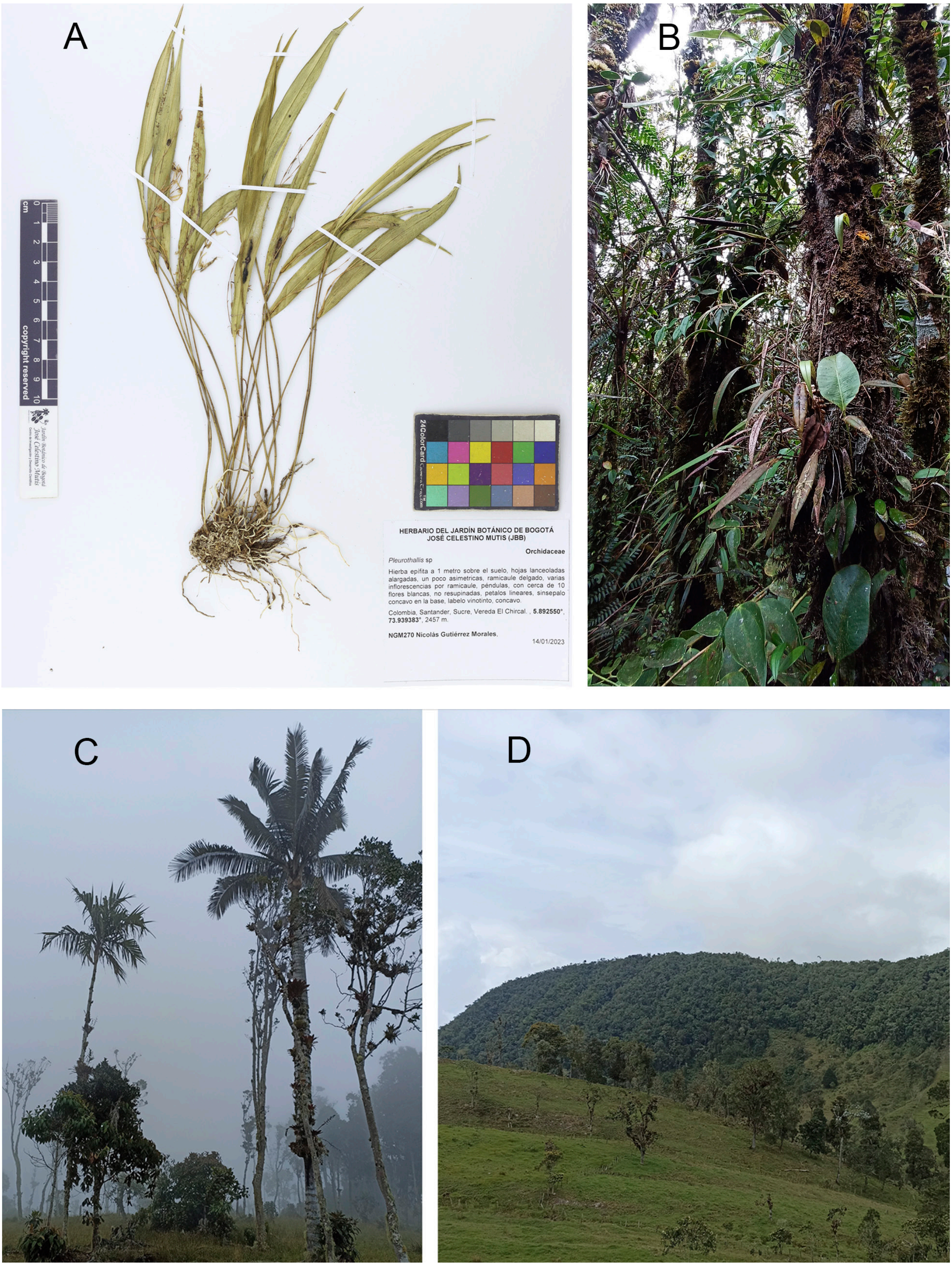


Figure 6. Lankester Composite Digital Plate (LCDP) of *Pleurothallis falcata*. **A**. Habit. **B**. Flower. **C**. Periant. **D**. Ovary, column and lip, lateral view. **E**. Lip, dorsal and lateral views. **F**. Column, front view. **G**. Column, ventral view. **H**. Anther and pollinarium. Photos by Nicolás Gutiérrez Morales.



HERBARIO DEL JARDÍN BOTÁNICO DE BOGOTÁ
JOSÉ CELESTINO MUTIS (JBB)

Orchidaceae

Pleurothallis sp

Hierba epífita a 1 metro sobre el suelo, hojas lanceoladas alargadas, un poco asimetricas, ramicaule delgado, varias inflorescencias por ramicaule, péndulas, con cerca de 10 flores blancas, no resupinadas, petalos lineares, sinsepalo concavo en la base, labelo vinotinto, concavo.

Colombia, Santander, Sucre, Vereda El Chircal. , **5.892550°**, **73.939383°**, 2457 m.

NGM270 Nicolás Gutiérrez Morales,

14/01/2023

FIGURE 7. **A**. Holotype of *Pleurothallis falcata*. **B**. *Pleurothallis falcata in situ*. **C**. Clearance of cloud forest to grasslands. **D**. Forest remnants in steep hills. Photos by Nicolás Gutiérrez Morales (B–D), and courtesy of the JBB (A).

Discussion. *Pleurothallis falcata* can be distinguished by the elongated ramicauls with falcate to lanceolate leaves, pendant, loose racemes of pinkish or yellow, non-resupinate flowers, the synsepal deeply concave, the narrow-linear petals and the recurved lip with prominent lateral lobes, with the apex apiculate and minutely erose. *Pleurothallis falcata* is similar to some species included in Luer's (1999) revision of *Pleurothallis*, subgen. *Pleurothallis*, subsection *Antennifera* Luer, such as *Pleurothallis suspensa*, which occurs in lowlands of Suriname, Guyana, and Venezuela; and *Pleurothallis antennifera* Lindl., widely distributed in the mid to high altitudes in the Andes of Venezuela to Bolivia.

Pleurothallis suspensa is without a doubt the most similar species, because of its overall size of the plant, with slender, elongated ramicauls, loose, pendant racemes with no resupinate, simultaneous flowers, the petals narrowly linear, and the recurved lip with the sides broadly rounded, the disc slightly sulcate and the apex minutely apiculate. *Pleurothallis falcata* differs by the longer, lanceolate to falcate leaves (*vs*. elliptical-ovate leaves), the congested racemes (*vs*. racemes with flowers distant from each other), the flowers pinkish or pale yellow (*vs*. flowers purple), the sepals larger, the dorsal sepal narrowly lanceolate (*vs*. narrowly ovate), the deeply concave synsepal (*vs*. concave), and the lip with the apex completely recurved, with the apiculum recurved and the apical margins erose (*vs*. lip partially recurved, the apiculum straight, the apical margins entire).

Pleurothallis antennifera is also similar to the new species, albeit to a lesser extent. It shares the elongated ramicauls, lanceolate leaves, subcongested inflorescences with simultaneous flowers, linear petals, concave synsepal, lip concave with pronounced lateral lobes, with the apical margins erose and apiculate at the apex. It can be easily distinguished from *P. falcata* by the larger size, reptant habit (*vs*. caespitose habit), the absence of falcate leaves, the erect inflorescences (*vs*. pendant), the shape of the sepals, and the lip with the lateral lobes oblong, incurved, and the apex incurved (*vs*. lobes rounded, straight, apex recurved).

The new species can be treated within *Pleurothallis* subsection *Antennifera* considering the elongate leaves, narrowly linear petals, recurved lip with prominent and broad lateral lobes, and the undeveloped glenion. However, contrary to Luer´s (1999) statement that erect inflorescences with resupinate flowers are typically frequent in subsection *Antennifera,* the pendent raceme of *Pleurothallis falcata* carries no resupinate flowers. Such a combination of characters seems uncommon within the subsection *Antennifera* but is commonly found in subsect *Macrophyllae-Racemosae* Luer.

It's important to emphasize that the subsection *Antennifera*, as noted by Wilson *et al*. (2017), is not a natural group, instead, it is embedded within a larger group that also includes the species of *Pleurothallis* subsect. *Macrophyllae-Racemosae*.

Final considerations. With the discovery of these two new taxa, we have identified seven new species from five orchid genera in this area of fragmented cloud forest. Interestingly, all the species are within 5 km from each other, within an elevational range of 2350 to 2570 m (Fig. 4B, 7C–D). Our comparisons of the orchid community between fragments indicates a high species turnover (Gutiérrez Morales *unpubl*.). For example, there is no more than 2.6 km between the three *Lepanthes* species described, *Lepanthes agatarum* J.S.Moreno, N.Gut. & S.Vieira-Uribe, *Lepanthes marielana* N.Gut., J.S.Moreno & S.Vieira-Uribe, and *Lepanthes pseudoabitaguae*. To date, they have not been seen growing close or together.

Furthermore, the inventory of the orchid species in this specific area has also contributed several new records to the Colombian flora: *Andinia ciliaris* (Luer & Hirtz) Karremans & S.Vieira-Uribe, *Lankesteriana caudatipetala* (C.Schweinf.) Karremans, *Platystele jesupiorum* Luer, and *Ophidion compactum* (Vierling) Karremans & J.S.Moreno, reported in Karremans *et al*. (2023). Additionally, *Myoxanthus parvilabius* (C.Schweinf.) Luer, as reported in Rojas Alvarado *et al*. (2021).

Unfortunately, the specific region of the Eastern Andes in Colombia lacks adequate protected areas. Consequently, the outstanding vegetal diversity in this area faces a high level of threat and can gradually disappear due to the ongoing expansion of grasslands and selective logging (Fig. 7C–D). The absence of protective measures puts these unique species at risk of gradual disappearance. Therefore, the establishment of natural reserves, even if they are small in size, is imperative for the long-term conservation of these species and the preservation of the still undiscovered biodiversity within these forests

Acknowledgements. We would like to thank the José Celestino Mutis Botanical Garden in Bogotá for the collection permits, with special thanks to Boris Villanueva, and the entire staff of the herbarium who assisted with the preparation of voucher specimens. Our sincere appreciation also goes to Fernando Morales, uncle of the first author, for bringing us to the remnant cloud forests where the two new species were discovered. We also thank the anonymous reviewers for their valuable comments on the manuscript.

Literature cited

Aparecido, L. M. T., Teodoro, G. S., Mosquera, G., Brum, M., Barros, F., Pompeu, P. V., Rodas, M., Lazo, P., Muller, C. S., Mulligan, M., Asbjornsen, H, Georgianne W. Moore, G.W. & Oliveira, R. S. (2018). Ecohydrological drivers of Neotropical vegetation in montane ecosystems. *Ecohydrology*, 11(3), e1932.

Armenteras, D., Gast, F. & Villareal, H. (2003). Andean forest fragmentation and the representativeness of protected natural areas in the eastern Andes, Colombia. *Biological conservation* 113, 245–256.

Armenteras, D., Cadena-V, C., Moreno, R. P. (2007). *Evaluación del estado de los bosques de niebla y la meta 2010 en Colombia*. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. Bogotá. D.C, Colombia, 72p.

Bubb, P., May, I. A., Miles, L. & Sayer, J. (2004). *Cloud forest agenda*. Cambridge, UK: UNEP World Conservation Monitoring Centre.

Carmona-Higuita, M. J., Mendieta-Leiva, G., Gómez-Díaz, J. A., Villalobos, F., Ramos, F. N., Elias, J. P. C., Jiménez-López, D. A., Zuluaga, A., Holst, B., Kressler, M., Mathieu, G., Zizka, A., Zotz, G. & Krömer, T. (2023). Conservation status of vascular epiphytes in the Neotropics. *Research Square*, https://doi.org/10.21203/rs.3.rs-2773328/v1.

Gentry, A. H. (1982). Neotropical floristic diversity: phytogeographical connections between Central and South America, Pleistocene climatic fluctuations, or an accident of the Andean orogeny? *Annals of the Missouri Botanical Garden* 69, 557–593.

Gentry, A. H., & Dodson, C. H. (1987). Diversity and biogeography of neotropical vascular epiphytes. *Annals of the Missouri Botanical Garden*, 74(2), 205–233.

Gutiérrez Morales, N., Harding, P., Dalström, S. & Moreno, J. S. (2018). A new species of *Cyrtochilum* (Orchidaceae: Oncidiinae) from the Eastern Cordillera of Colombia. *Lankesteriana* 18(1), 63–68.

Gutiérrez Morales, N., Moreno, J. S., Karremans, A. P. & Gil-Amaya, K. (2023). *Restrepia santanderensis* (Orchidaceae: Pleurothallidinae), a new species from the western slope of the eastern Andes in Colombia. *Phytotaxa*, 598(4), 293–300.

Gutiérrez Morales, N., Vieira-Uribe, S. & Moreno, J. S. (2021). *Lepanthes marielana* (Orchidaceae, Pleurothallidinae), a new species from the eastern Andes in Colombia. *Phytotaxa*, 484(1), 113–120.

Hágsater, E., Gutiérrez Morales, N. & Santiago, E. (2018). *Epidendrum moralesii*. In Hágsater, E. & Santiago, E. (Eds.) *The Genus Epidendrum, Part 12, Icones Orchidacearum 16 (1)*. Instituto Chinoin, A. C., México, t. 1646.

Karremans, A. P., Moreno, J. S., Gil-Amaya, K., Gutiérrez Morales, N., Espinosa, F., Mesa, S., Restrepo, E., Rincón-González, M., Serna, A., Sierra-Ariza, M & Vieira-Uribe, S. (2023). Colombian Orchidaceae: A catalogue of the Pleurothallidinae. *Lankesteriana*, 23(2), 181–400.

Köster, N., Friedrich, K., Nieder, J., Barthlott, W. (2009). Conservation of epiphyte diversity in an Andean landscape transformed by human land use. *Conservation Biology*, 23(4), 911–919. https://doi.org/10.1111/j.1523-1739.2008.01164.x

Luer, C. A. (1999). Icones Pleurothallidinarum XVIII. Systematics of *Pleurothallis*, subgen. *Pleurothallis*, Sect. *Pleurothallis*, Subsect. *Antenniferae*, Subsect. *Longiracemosae*, Subsect. *Macrophyllae-Racemosae*, Subsect. *Perplexae*, Subgen. *Pseudostelis*, Subgen. *Acuminatia*. Addenda to *Dracula*, *Lepanthes*, *Masdevallia* and *Pleurothallis*. Miscellaneous new species of *Dryadella*, *Lepanthes* and *Pleurothallis*. *Monographs in Systematic Botany from the Missouri Botanical Garden* 76: 1–182.

Moreno, J. S., Gutiérrez Morales, N. & Vieira-Uribe, S. (2018). *Lepanthes agatarum* (Orchidaceae: Pleurothallidinae), a new species honoring an ancient tribe from the eastern Andes in Colombia. *Phytotaxa*, 376(2), 89–96.

Pérez-Escobar, O. A., Chomicki, G., Condamine, F. L., Karremans, A. P., Bogarín, D., Matzke, N. J., Silvestro, D., Antonelli, A. (2017). Recent origin and rapid speciation of Neotropical orchids in the world's richest plant biodiversity hotspot. *New Phytologist* 215(2), 891–905. https://doi.org/10.1111/nph.14629

Rojas-Alvarado, G., Blanco, M. A. & Karremans, A. P. (2021). A taxonomic synopsis and morphological characterization of *Myoxanthus* (Orchidaceae: Pleurothallidinae). *Phytotaxa*, 507(3), 211–258.

Vieira-Uribe, S. & Gutiérrez Morales, N. (2020). *Andinia auriculipetala*, sp. nov. *Species Orchidacearum* 4(1), LCDP 37.

Wilson, M., Dupree, K., Garcia Lopera, D., Haelterman, D., Kay, A., Mesa Londoño, C., Niessen, A., Pinnix, W., Portilla, J. & Werner, J. D. (2017). A new species of Pleurothallis (Orchidaceae: Pleurothallidinae) from Valle del Cauca, Colombia and a note on the relationship between subsections *Macrophyllae-Racemosae* and *Antenniferae*. *Lankesteriana*, 17(2), 119–131.

LANKESTERIANA 24(1): 61–68. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.57290

MALAXIS ENGELSII (MALAXIDINAE), A NEW SPECIES FROM THE UPPER MONTANE FOREST OF THE ATLANTIC RAINFOREST IN SOUTHERN BRAZIL

Thiago Faria dos Santos[1,2,3] & Eric de Camargo Smidt[2]

[1]Programa de Pós-Graduação em Ciências Biológicas (Biologia Vegetal), Instituto de Biociências de-Rio Claro, Departamento de Botânica, Universidade Estadual Paulista - UNESP, Av. 24 A-1515, Bela Vista, 13506-900, Caixa Postal 199, Rio Claro, São Paulo, Brazil.

[2]Universidade Federal do Paraná, Setor de Ciências Biológicas, Centro Politécnico, Jardim das Américas, Curitiba - PR, 81531-980. Caixa Postal: 19031, Brazil.

[3]Author for correspondence: tf.santos@unesp.br

Abstract. *Malaxis engelsii* is a newly discovered orchid found in the upper montane forests of the Atlantic Rainforest in Paraná, Brazil. This species is characterized by its small size, elliptic leaves, flowers with partially connate sepals at the base, trilobate lip with four cavities, and a longitudinal keel on the adaxial surface of the lip apex. A detailed description, photographs, drawings, and comparison with similar species, *Malaxis cipoensis*, *M. sertulifera,* and *M. ybytus*, are provided. Currently, it is classified according to the IUCN guidelines as "Endangered (EN)".

Resumo. *Malaxis engelsii* é uma orquídea recém-descoberta encontrada nas florestas alto-montanas da Mata Atlântica no Paraná, Brasil. Esta espécie é caracterizada por seu pequeno porte, folhas elípticas, flores com sépalas parcialmente conadas, labelo trilobado com quatro cavidades e uma quilha longitudinal na superfície adaxial do ápice do labelo. Uma descrição detalhada, fotografias, ilustração e comparação com espécies similares, M*alaxis cipoensis*, *M. sertulifera* e *M. ybytus*, são fornecidas. Atualmente, está classificada de acordo com as diretrizes da IUCN como "Em Perigo (EN)".

Keywords/ Palavras-chave: Cloud Forest, Epifitismo, Epiphytism, Floresta Montana, Floresta Nebulosa, Montane forest, New species, Nova espécie, Orchid, Orquídea, Orchid, Taxonomia, Taxonomy

Introduction. *Malaxis* Sol. ex Sw. (Swartz 1788) belongs to the subtribe Malaxidinae Benth. & Hook.f. (Bentham & Hooker 1883) and has traditionally been regarded as a cosmopolitan genus, encompassing over 300 species across the Americas, Asia, and Europe (Cribb 2005). The application of molecular studies has led to reevaluating the subtribal taxonomy (Cameron 2005). Additionally, the existing classification system within *Malaxis* fails to arrange species based on their evolutionary lineages, and the distribution of this genus is probably primarily limited to the Americas, with only a few species extending into the temperate regions of Eurasia (Radins *et al.* 2014).

The upper montane forest ecosystems of the *Floresta Ombrófila Densa Altomontana* (Montane Dense Rainforest), also known as Cloud Forest, are marked by their hydrophilic nature. This is attributed to several characteristics, but primarily due to the persistent presence of clouds at higher elevations on mountains (Bruijnzeel & Hamilton 2000). Within these upper montane ridges, the forest exhibits a singular vertical stratum composed of small-sized trees (Leigh 1975). As a result of the perpetual humidity, these trees provide a habitat for an abundance of epiphytes (Blum *et al.* 2011, Leigh 1975).

In Brazil, ten species of *Malaxis* are registered within the country's territory (Smidt & Santos 2023). However, an ongoing genus revision is revealing new species, indicating that the diversity of *Malaxis* may be underestimated (Santos & Smidt 2023).

A previously undescribed epiphytic *Malaxis* was discovered by examining the collected material from an expedition to the upper montane forests of the *Ibitiraquire* mountain range. Consequently, we present this taxon, providing a detailed description, diagnosis,

ORCID of the Author: TFdS, ECS
Received 2 November 2023; accepted for publication 4 March 2024. First published online: 17 April 2024.

drawing, photographs showcasing the species in its natural habitat, a plate displaying the type collections, illustrations, comparison with morphologically similar species, comments on its ecological features, and conservation status.

Materials and methods. We examined the morphological characteristics of materials collected by *M.E. Engels 6579* (MBM439143) and *G. Hatschbach 817* (MBM49978; SP54728). The first was designated as the holotype due to its excellent material quality, including well-preserved herbarium specimens and spirit material. We followed the morphological terminology guidelines of Rizzini (1977), Beentje (2010), and Stearn (2004) for descriptions, drawings, and plates, which were based on the types. We also used photographs of specimens in their natural environment. For species with morphological similarities, we studied specimens from the following herbaria: BHCB, CEN, CEPEC, CESJ, CRI, EFC, ESA, FLOR, FURB, HRCR, HST, HUCS, HUEFS, HVASF, IAN, ICN, INPA, IPA, JOI, MAC, MBM, MBML, MO, OUPR, PACA, PEL, RB, RFA, RON, SP, SPF, UB, UEC, UFP, UPCB, and USP. Regarding conservation status, we followed the IUCN (2022) guidelines.

Taxonomic treatment

Malaxis engelsii T.F.Santos & E.C.Smidt, ***sp. nov.*** (Fig. 1–4).

TYPE: Brazil. Paraná: Campina Grande do Sul, Trilha para o Morro Getúlio e Caratuva, 954m, 15 January 2019, *M.E. Engels 6579* (holotype: MBM-439143!). Brazil. Paraná: Piraquara, Queimada, Morro Albino de Souza, 27 December 1947, *G. Hatschbach 817* (paratype: MBM-49978!; SP-54728!). Fig. 2.

Diagnosis: It is most similar to *M. sertulifera* (Barb. Rodr.) Pabst due to its occurrence in montane forested environments, size of the vegetative parts, and lip morphology. However, it can be distinguished by the denser inflorescence in flower numbers, the presence of a longitudinal keel on the adaxial surface of the lip apex, acute lateral lobes of the lip instead of acuminate, and the presence of acute column wings instead of inconspicuous and rounded (Fig. 3).

Plant 40–70 mm tall, epiphytic, rhizome inconspicuous. *Roots* 8–40 mm long, thick. *Pseudobulbs* 5–10 × 4–5 mm, ovoid, covered by whitish to brownish deciduous foliaceous sheets. *Leaves* 20–45 × 20–31 mm, alternate, two per pseudobulbs; several layers of leaf sheets that are enveloped by cataphylls 10–30 mm long, imbricate in each other from the base to near the apex, lamina elliptic to ovate, round to cordate, cordiform, membranaceous, margin entire, apex obtuse to slightly acute, base rounded or cordate. *Inflorescence* 64–120 mm long, corymbose; floral bracts triangular, greenish. *Flowers* non-resupinate, twisted pedicels 2–8 mm long. *Ovary* pedicellate cylindric 1.0 × 1.5 mm. *Dorsal sepal* 2.2–2.7 × 1.0–1.4 mm, whitish-green, turning orangish with age, oblong or oblong-lanceolate, apex acute, margin entire, 3-veined. *Lateral sepals* 1.7–2.0 × 1.0–1.5 mm, whitish green, turning orangish with age, partially connate, ovate, apex acute, margin entire, 3-veined. *Petals* 1.5–2.0 mm, whitish-green, turning orangish with age, linear, usually twisted, apex acute, margin entire, 1-veined. *Lip* 1.2–1.5 × 1.1–1.2 mm, orange, rarely greenish, trilobate, truncate, acute, concave, lateral lobes incurved, apex acute, mid lobe ovate, apex acute, margin entire, disk with four obovate cavities, internal central portion is divided by a thickened pandurate costa, margin entire, longitudinal keel on the adaxial surface of the lip apex. *Column* yellowish, long, wide, erect, dorsoventrally complanate; wings acute. *Pollinarium* with four ovoid naked pollinia. *Fruits* not seen.

Additional specimens examined (similar species). *Malaxis sertulifera*; Distrito Federal: Brasília. Reserva Ecológica do IBGE, 21.II.2003, *J.A.N. Batista 1398* (BHCB, CEN). Minas Gerais: Aiuruoca, Parque Estadual da Serra do Papagaio, 18.I.2008, *J.A.N. Batista 2441* (BHCB).

Etymology: In honor of Mathias Engels, the botanist who rediscovered the species in the field.

Distribution and ecology: Only known in Brazil from two collections, have been documented in the Atlantic Rainforest of Paraná state, Brazil. The species was first recorded by *G. Hatschbach 817* in 1947 within the *Baitaca* mountain range (25º24'S, 49º00'W) (Fig. 5A, C) in the Piraquara municipality. It was rediscovered 72 years later in 2019 in a nearby region by *M.E. Engels 6579* in

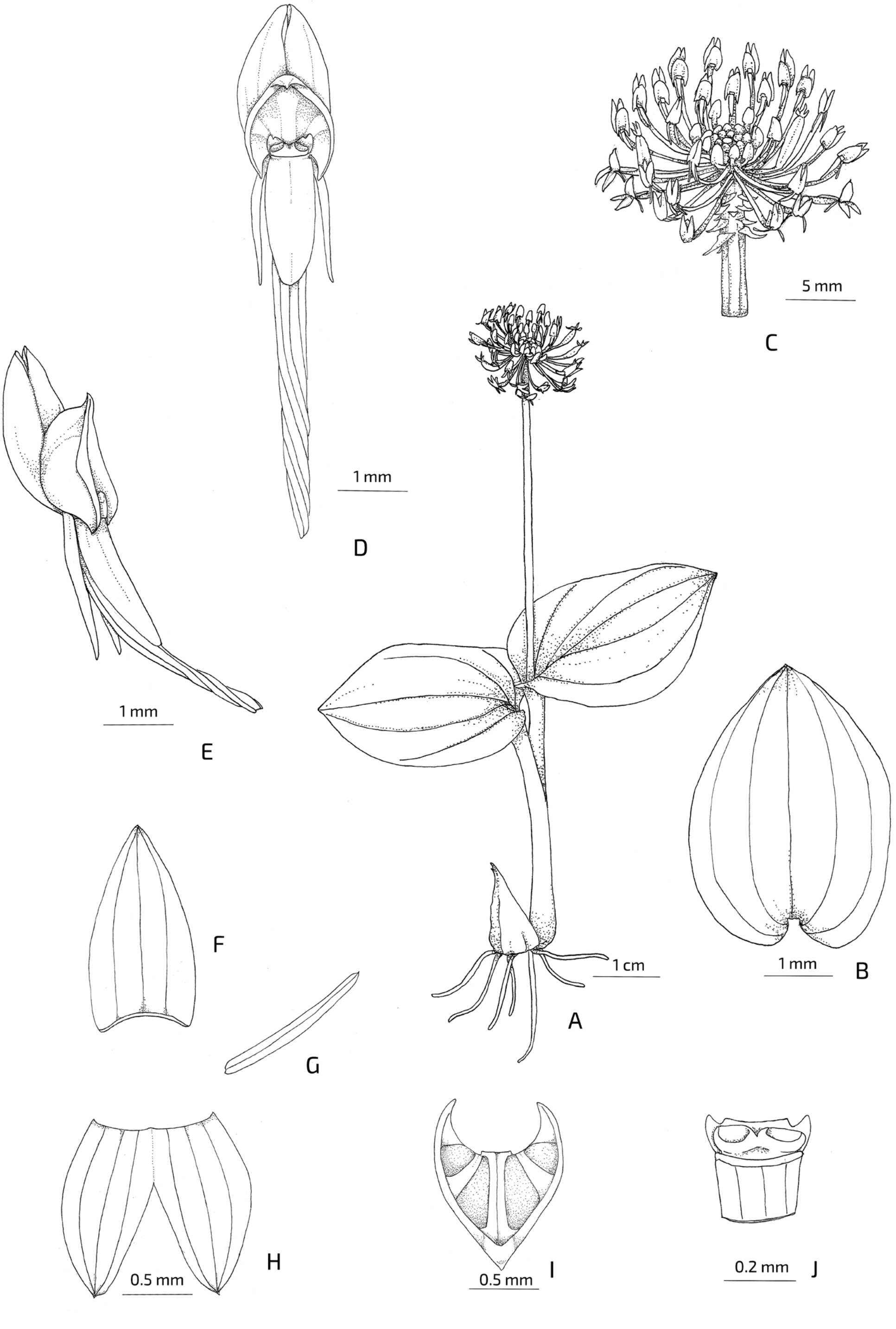


Figure 1. *Malaxis engelsii* illustration. **A**. Habit. **B**. Leaf blade. **C**. Inflorescence. **D**. Frontal view of the flower attached to the pedicel. **E**. Lateral view of the flower attached to the pedicel. **F**. Dorsal petal. **G**. Petal. **H**. Connate lateral sepal. **I**. Lip. **J**. Column. Illustration by L.K.R. Hinoshita, based on the holotype, spirit material, and photographs.

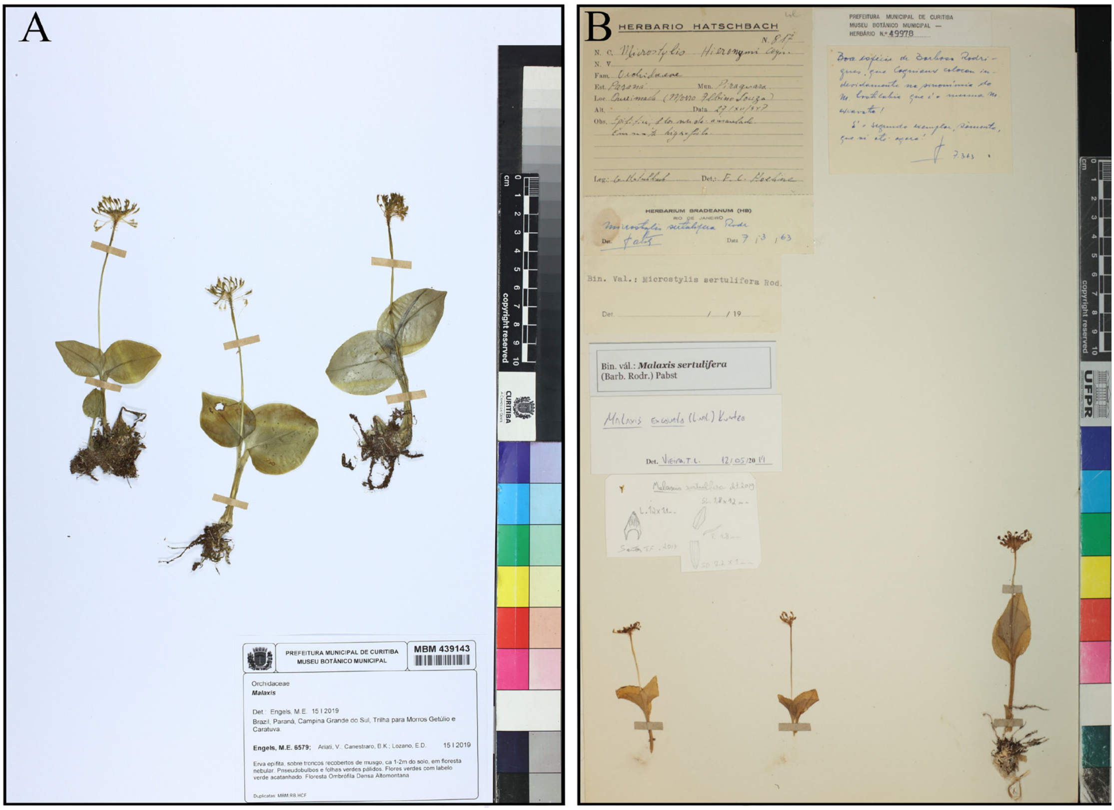


FIGURE 2. Type specimens of *Malaxis engelsii*. **A**. Holotype (MBM 439143). **B**. Paratype (MBM 49978).

the *Ibitiraquire* mountain range (25º14.5'S, 48º50'W) (Fig. 5B, D) of the Campina Grande do Sul municipality. Both localities belong to the *Serra do Mar* of Paraná, a range of elevations formed by tectonic processes involving vertical movements that originated during the Cenozoic era (Almeida 1998, Santos *et al.* 2006). This mountainous region currently separates the inland region from the coastal area of the Paraná state (Maak 1981).

The presence of Mixed Ombrophilous Forest defines the landscape, ecotones between Mixed Ombrophilous Forest and Dense Ombrophilous Forest, and Dense Ombrophilous Forest on higher elevations, with the summits of mountains marked by the presence of the subformation of upper montane forest (Scheer & Mocochinski 2009).

Malaxis engelsii was found as an epiphyte (Fig. 4B, D, E) within hydrophilic environments near streams in the cloud forests of *Serra do Mar* in the *Ibitiraquire* and *Baitaca* mountain range (Fig 5C, D), representing the only known strictly epiphytic species of *Malaxis* in Brazil. However, it should be noted that further fieldwork may reveal the presence of terricolous plants within the same habitat, potentially expanding our understanding of the species distribution and ecological preferences.

CONSERVATION STATUS: In accordance with the IUCN guidelines (2022), despite the limited records of collections making it impossible to delineate the extent of occurrence (EOO) of the taxon, the most plausible inference is that it falls under the Endangered (EN) category. As a result, further research and collection endeavors are imperative to preserve this species.

Discussion. *Malaxis engelsii* differs from most Brazilian *Malaxis* due to its reduced vegetative and reproductive parts size. However, it shares morphological similarities with *M. cipoensis* F.Barros, *M. sertulifera*, and *M. ybytus* T.F.Santos & E.C.Smidt. The following characteristics can differentiate these species: in terms of habit, vegetation domain, and biome, *M. engel-*

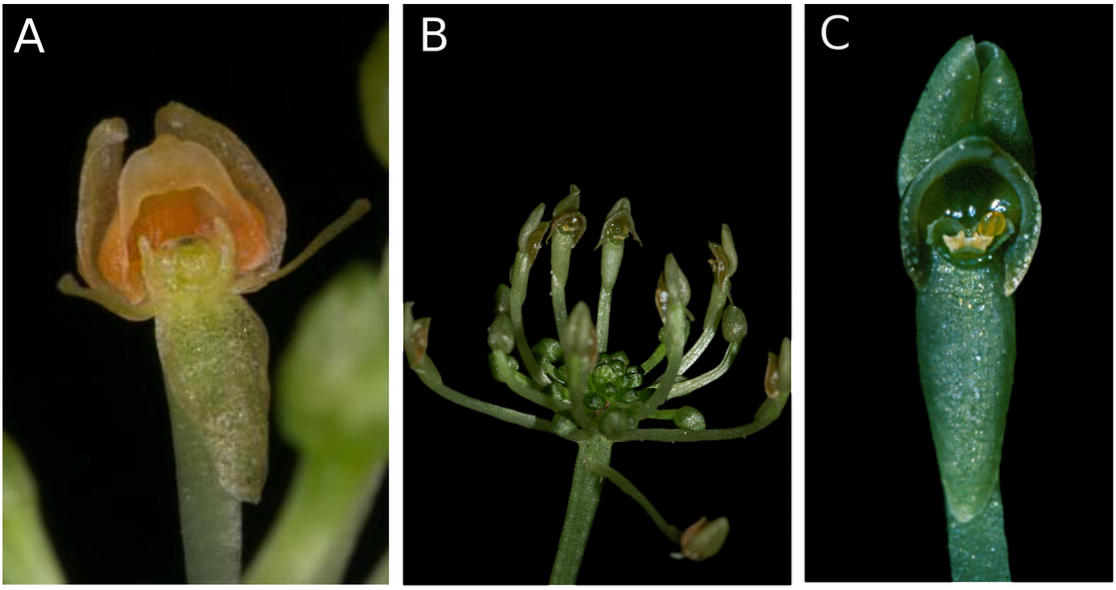


Figure 3. *Malaxis engelsii* and *M. sertulifera*. **A**. Flower of *M. engelsii*; it is possible to observe the longitudinal keel on the adaxial surface of the lip apex and the acute column wings. **B**. Inflorescence of *M. sertulifera*; low density in flower numbers. **C**. Flower of *M. sertulifera*; it is possible to observe the column with rounded wings and the acuminate lateral lobes of the lip. Photographs by Eric de Camargo Smidt (A) and João Aguiar Nogueira Batista (B–C).

sii occurs in the upper montane forest of the Atlantic Rainforest biome. In contrast, *M. cipoensis* is usually found in the *Campos Rupestres* of the Cerrado biome. *M. sertulifera* occurs in any forested environment, but predominantly in the Cerrado biome. Conversely, *M. ybytus* is exclusive to the *Campos de Altitude* of the Atlantic Rainforest biome (Santos & Smidt 2023).

When examining leaf types and shapes, *M. engelsii* is recognized for its flat leaves with elliptic or cordiform shapes, whereas *M. cipoensis* features flat to slightly conduplicate leaves with elliptic shapes. *Malaxis sertulifera* shows lanceolate to oblong-lanceolate leaves, and *M. ybytus* oblong to oblong-elliptic leaf shapes.

Lip characteristics further differentiate these species. *M. engelsii* features a lip with acute lateral lobes and four lip cavities while *M. cipoensis* displays a lip with rounded lateral lobes, and two lip cavities. Additionally, *M. engelsii* is the only species featuring a longitudinal keel on the adaxial surface of the lip apex.

The shape of their column wings differs; *M. engelsii* has an acute column wing, while *M. sertulifera* and *M. ybytus* are inconspicuous and rounded.

These *Malaxis* species exhibit various distinct characteristics encompassing their habitat preferences and flower attributes. These variations serve as essential criteria for differentiating them and contribute to our understanding of their taxonomy and ecological niches in the diverse Brazilian ecosystems.

Acknowledgments. We thank Mathias Engels for generously providing us with photographs of the plant. We acknowledge that the excellent condition of his collected material made recognizing and describing the species possible. We thank J.A.N. Batista for providing us with photographs of *M. sertulifera*. We thank R. Kersten and M. Klingelfus for the photographs of the mountain ranges and cloud forest environment. We extend our appreciation to L.K.R. Hinoshita for the illustrations. We want to thank the UPCB staff. We are grateful for the national herbarium material examined here, loaned to us by the curators. E.C.S. was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for Bolsa de Produtividade em Pesquisa CNPq-Nível 1D (proc. 314642/2020-0) and CNPq/MCTI/FNDCT Nº 18/2021 - Universal, Faixa B (proc. 405493/2021-5). T.F.S. was supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES: 88882.434095/2019-01). We thank Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio: SISBio 54416) and SisGen (A3530D1) for the flora collection authorization.

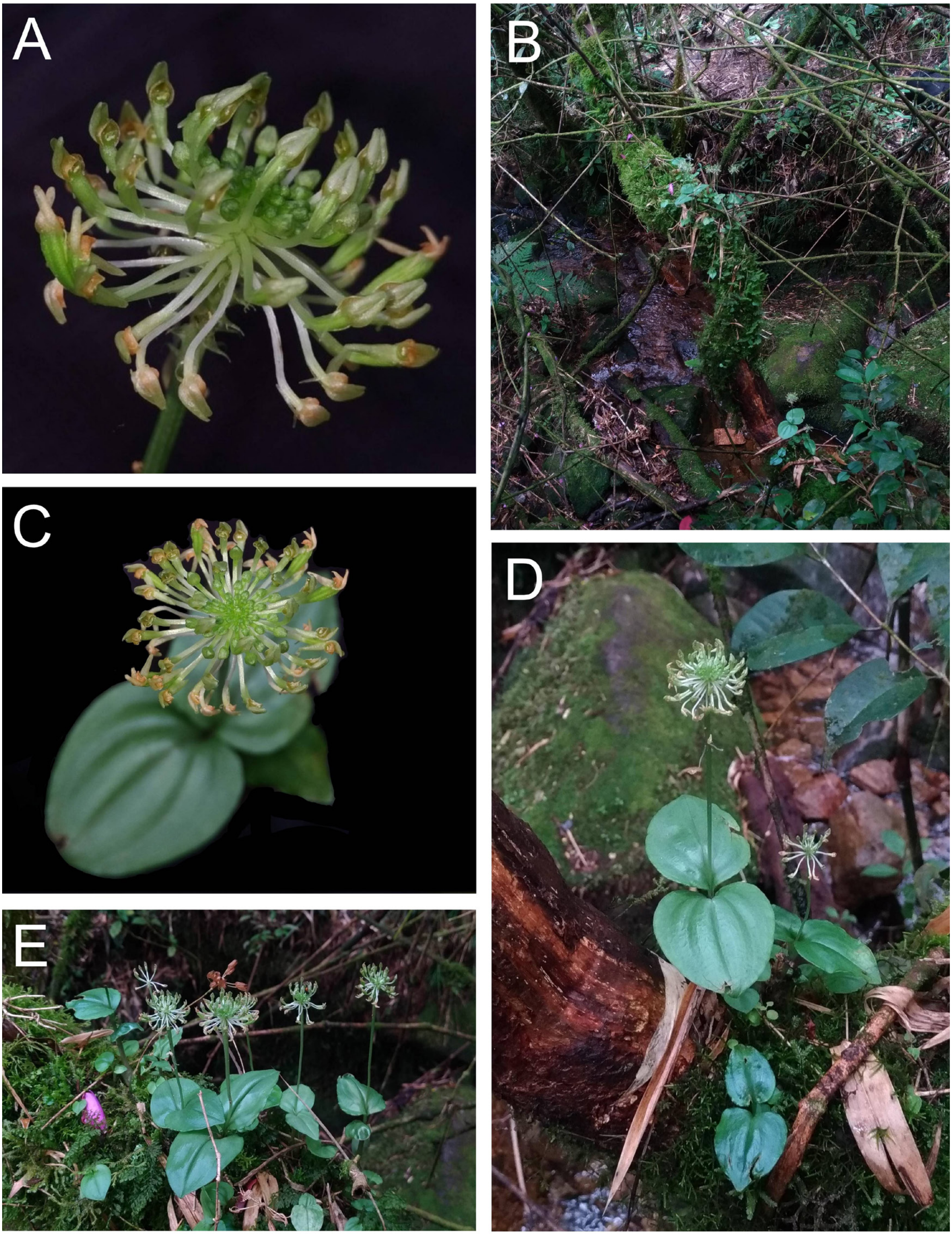


FIGURE 4. *Malaxis engelsii* in the habitat. **A**. Inflorescence viewed from the side. **B**. Population of *M. engelsii* near a stream. **C**. Inflorescence viewed from above. **D**. Zoom in on an individual of *M. engelsii* epiphyte at the base of the host plant. **E**. Zoom in on the epiphytic population of *M. engelsii*. Photographs by M. Engels.

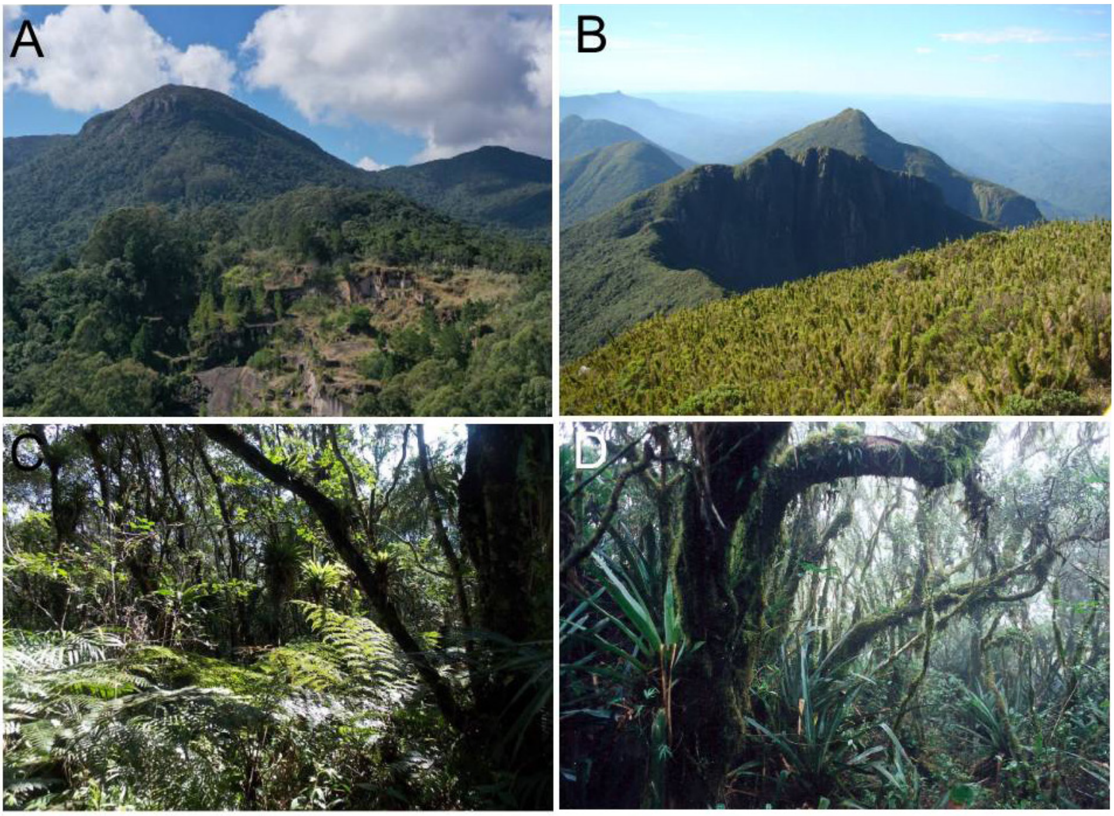


Figure 5. *Baitaca* and *Ibitiraquire* mountain ranges within the Paraná region of *Serra do Mar*. **A**. *Baitaca* Mountain range. **B**. *Ibitiraquire* mountain range. **C**. Cloud Forest within *Baitaca*; abundant epiphytes. **D**. Cloud Forest within *Ibitiraquire*; abundant epiphytes. Photographs by Marcos Klingelfus (A, C) and Rodrigo de Andrade Kersten (B, D).

Literature cited

Almeida, F. F. M. & Carneiro, C. D. R. (1998). Origem e evolução da Serra do Mar. *Revista Brasileira de Geociências*, 28(2), 135–150. doi: https://doi.org/10.25249/0375-7536.1998135150.

Beentje, H. J. (2010). *The Kew plant glossary: an illustrated dictionary of plant terms*. Royal Botanical Gardens, Kew (eds). Richmond, UK: Kew Publishing.

Bentham, G. & Hooker, J. D. (1883). *Genera Plantarum, vol. 3, Pars II*. In: L. Reeve (Eds.), *Orchideae* (pp.465). London: Londini.

Blum, C. T., Roderjan, C. V. & Galvão, F. (2011). Composição florística e distribuição altitudinal de epífitas vasculares da Floresta Ombrófila Densa na Serra da Prata, Morretes, Paraná, Brasil. *Biota Neotropica*, 11, 141–159. doi: https://doi.org/10.1590/S1676-06032011000400015

Bruijnzeel, L. A. & Hamilton, L. S. (2000). *Decision time for cloud forests*. Tropics Program Series 13, IHP Humid (Eds.). Tropics Paris: Unesco.

Cameron, K. M. (2005). Leave it to the leaves: a molecular phylogenetic study of Malaxideae (Epidendroideae, Orchidaceae). *American Journal of Botany,* 92(6), 1025–1032. doi: https://doi.org/10.3732/ajb.92.6.1025

Cribb, P. J. (2005). *Malaxis*. In: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. N. Rasmussen (Eds.), *Genera Orchidacearum. Volume 4. Epidendroideae (Part One)* (pp. 471–475). New York: Oxford University Press.

IUCN. (2022). *The IUCN Red List of Threatened Species*. Version 2022-15.1. Retrieved from https://www.iucnredlist.org.

Leigh, J. E. G. (1975). Structure and climate in tropical forests. *Annual Ecology and Systematics Review*, 6, 67–86.

Maack, R. (1981). *Geografia física do Estado do Paraná*. UEPG (Eds.). Rio de Janeiro: Livraria José Olympio.

Pabst, G. F. J. (1967). Additamenta ad orquideologia brasiliensem VIII. *Orquídea (Rio de Janeiro)*, 29, 112–113.

Radins, J. A., Salazar, G. A., Cabrera, L. I., Jiménez-Machorro, R. & Batista, J. A. N. (2014). A new paludicolous species of *Malaxis* (Orchidaceae) from Argentina and Uruguay. *Phytotaxa*, 175(3), 121–132. doi: https://doi.org/10.11646/phytotaxa.175.3.1

Rizzini, C. T. (1977). Sistematização terminológica da folha. *Rodriguésia*, 42, 103–125.

Santos, L. J. C., Oka-Fiori, C., Canali, N. E., Fiori, A. P., da Silveira, C. T., da Silva, J. M. F. & Ross, J. L. S. (2006). Mapeamento geomorfológico do Estado do Paraná. *Revista Brasileira de Geomorfologia*, 7(2), 3–12. doi: https://doi.org/10.20502/rbg.v7i2.74

Santos, T. F. & Smidt E. C. (2023). A new *Malaxis* (Orchidaceae: Malaxidinae) from the *Campos de Altitude* of the Atlantic Rainforest in southern Brazil. *Nordic Journal of Botany*, 12, 1–5. doi: https://doi.org/10.1111/njb.04164

Scheer, M. B. & Mocochinski, A. Y. (2009). Florística vascular da Floresta Ombrófila Densa Altomontana de quatro serras paranaenses. *Neotropical Biota*, 9, 51–69. doi: https://doi.org/10.1590/S1676-06032009000200005

Smidt, E. C. & Santos, T. F. (2023). *Malaxis* in Flora e Funga do Brasil. Jardim Botânico do Rio de Janeiro. Retrieved from https://floradobrasil.jbrj.gov.br/FB11814 [Accessed on: 30 Aug. 2023].

Stearn, W. T. (2004). *Botanical Latin*. Portland: Timber Press.

Swartz, O. (1788). Orchidaceae. In: bibliopoliis acad. M. Swederi, Holmiæ (Eds.), *Nova Genera et Species Plantarum seu Prodromus* (pp. 118–126). Stockholm: Holmia, Upsala & Abo.

LANKESTERIANA 24(1): 69–77. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.59556

TWO NEW SPECIES OF *TELIPOGON* (ONCIDIINAE) FROM COSTA RICA

DIEGO BOGARÍN[1,2,3,7], FRANCO PUPULIN[1,4,5] & OSCAR A. PÉREZ-ESCOBAR[6]

[1]Lankester Botanical Garden, University of Costa Rica, P.O. Box 302-7050 Cartago, Costa Rica.
[2]Evolutionary Ecology Group, Naturalis Biodiversity Center, 2300 RA Leiden, the Netherlands.
[3]Herbario UCH, Universidad Autónoma de Chiriquí, David, Panamá.
[4]Harvard University Herbaria, Cambridge, MA, U.S.A.
[5]The Marie Selby Botanical Gardens, Sarasota, FL, U.S.A.
[6]Royal Botanic Gardens, Kew, TW9 3AE, London, UK.
[7]Author for correspondence: diego.bogarin@ucr.ac.cr

ABSTRACT. The Neotropical genus *Telipogon* (Oncidiinae), comprising approximately 250 species, exhibits remarkable species diversity in the humid, montane forests of southern Central America and the Tropical Andes. *Telipogon*, when broadly defined, encompasses both the large-flowered species that mimic tachinid flies and the small-flowered species formerly classified under *Stellilabium*. In Costa Rica, this genus includes 55 species, with 16 classified as small-flowered species. While the large-flowered species of *Telipogon* (in the strict sense) have been taxonomically revised, the small-flowered species have yet to be the subject of a thorough taxonomic revision. Our research aims to partially fill this gap by focusing on a comparative morphological analysis of two novel small-flowered *Telipogon* species. We describe and illustrate *Telipogon lateritius* and *T. muntzii*, both discovered in the humid mid-elevation forest of the Caribbean watershed in Cordillera de Talamanca, Costa Rica. *Telipogon lateritius* is notable for its distinctive brick-colored flowers, featuring sepals, petals, and lips striped in chestnut brown; the lateral sepals connate into a triangular-ovate synsepal, complemented by sparse, stiff pubescence at the base of the lip. *Telipogon muntzii*, although closely resembling *T. anacristinae*, differs in its unique olive-green flowers, sparse trichomes on the lip, narrowly oblong lateral lobes of the column, and a helmet-shaped median lobe of the column exclusively covered by simple trichomes. This study provides new additions for a future taxonomic revision of *Telipogon* in Costa Rica.

RESUMEN. El género neotropical *Telipogon* (Oncidiinae), que comprende aproximadamente 250 especies, exhibe una notable diversidad de especies en los bosques húmedos montanos del sur de Centroamérica y los Andes tropicales. *Telipogon*, en sentido amplio, abarca tanto las especies de flores grandes que imitan a las moscas taquínidas como las especies de flores pequeñas anteriormente clasificadas en *Stellilabium*. En Costa Rica, este género incluye 55 especies, de las cuales 16 están clasificadas como especies de flores pequeñas. Mientras que las especies de *Telipogon* de flores grandes (en sentido estricto) han sido revisadas taxonómicamente, las especies de flores pequeñas aún no han sido objeto de una revisión taxonómica exhaustiva. Nuestra investigación tiene como objetivo llenar parcialmente este vacío centrándose en un análisis morfológico comparativo de dos nuevas especies de *Telipogon* de flores pequeñas. Describimos e ilustramos *Telipogon lateritius* y *T. muntzii*, ambos descubiertos en el bosque húmedo de elevación media de la cuenca del Caribe en la Cordillera de Talamanca, Costa Rica. *Telipogon lateritius* se destaca por sus distintivas flores de color ladrillo, con sépalos, pétalos y labios con rayas de color marrón castaño, los sépalos laterales connados en un sinsépalo triangular-ovado, complementados con una pubescencia escasa y rígida en la base del labio. *Telipogon muntzii*, aunque similar a *T. anacristinae*, difiere por sus flores únicas de color verde oliva, escasos tricomas en el labelo, lóbulos laterales de la columna estrechamente oblongos y un lóbulo mediano de la columna en forma de casco cubierto exclusivamente por tricomas simples. Este estudio proporciona nuevas adiciones para una futura revisión taxonómica de *Telipogon* en Costa Rica.

KEYWORDS / PALABRAS CLAVE: biodiversity, biodiversidad, Neotropical orchids, new species, nuevas especies, Orchidaceae, orquídeas neotropicales, taxonomía, taxonomy

ORCID of the Author: DB, FP, OAPE
Received 11 October 2023; accepted for publication 8 April 2023. First published online: 18 April 2024.

Introduction. *Telipogon* Kunth (Oncidiinae) comprises approximately 250 species ranging from Mexico to South America and the Antilles. This genus is notably diverse in the humid, montane forests of southern Central America and the Tropical Andes (Amezcua-Trigos *et al*. 2018, Pérez-Escobar *et al*. 2017a, POWO 2024, Pupulin & Bogarín 2023), where it likely originated and rapidly diversified (Pérez-Escobar *et al*. 2017b). Phylogenetically, *Telipogon*, *Hofmeisterella* Rchb.f., and *Trichoceros* Kunth form the Telipogon Alliance within the Oncidiinae (Williams *et al*. 2005). These genera are distinguished by their unique morphological features, including actinomorphic or zygomorphic fly-like flowers, four pollinia, and lamellate viscidia in *Hofmeisterella*; uncinate viscidia in *Telipogon*; and cochleariform viscidia in *Trichoceros* (Martel *et al*. 2020b). Additionally, some species of *Telipogon* and *Trichoceros* employ mimicry of tachinid flies, using specialized pollination strategies like pseudocopulation, deceiving pollinators into mating with the flowers (Martel *et al*. 2019, 2020b).

Dressler (1993) treated the members of the Telipogon Alliance, including *Stellilabium* Schltr., within the subtribe Telipogoninae. Later, Dressler (1999) classified *Stellilabium* into four sections: *Stellilabium* (including *Cordanthera* L.O.Williams, *Darwiniera* Braas & Lückel, and *Sodiroella* Schltr.), *Dipterostele*, *Rhamphostele*, and *Taeniorhachis*. Therefore, *Stellilabium,* as circumscribed by Dressler (1999), comprises smaller plants, typically with deciduous leaves during flowering, inflorescences with a flattened peduncle and rachis, and smaller, monosymmetrical flowers (less than 2 cm) with ciliate or denticulate petals. However, molecular studies showed *Stellilabium* nested within *Telipogon* in the Oncidiinae (Chase 2009, Neubig *et al*. 2012, Williams *et al*. 2005). Despite the ongoing debate regarding the broad circumscription of *Telipogon* (Kolanowska *et al*. 2017, Martel *et al*. 2020a), we follow the classification initially proposed by Williams *et al*. (2005) until further research involving more comprehensive clade sampling and multiple molecular markers, provides more precise insights into the relationships within the Telipogon alliance.

Telipogon, in a broad sense, is recognized by the epiphytic or terrestrial (in humus-rich soil) growth habit, absent or reduced pseudobulbs, conduplicate, persistent or deciduous, distichous leaves, and inflorescences featuring either a cylindrical, flattened or triquetrous peduncle and rachis and the uncinated viscidia. *Telipogon*, in the strict sense, is known for its showy, large-flowered plants, which are either monosymmetric or semi-actinomorphic, displaying subequal, inconspicuous triangular sepals and often larger, more visually striking petals and lips adorned with reddish or purple stripes or reticulations (Martel *et al*. 2019, Pabón-Mora & González 2008) including *Hofmeisterella* and *Stellilabium*.

While the taxonomy of the large-flowered *Telipogon* species in Costa Rica has been revised (Dodson & Escobar 1987a, 1987b, Pupulin & Bogarín 2023), its closely related group (Williams *et al*. 2005), the Central American clade of small-flowered *Telipogon* (formerly *Stellilabium*) lacks a comprehensive taxonomic treatment (Dressler 2001, Pupulin 2003). This group, comprising 16 of the 55 species of *Telipogon* in the country, is predominantly epiphytic and found at elevations between 500 and 2500 meters (Bogarín 2012, Pupulin & Bogarín 2023, Pupulin *et al*. 2023).

Given the need for further taxonomic revision, this paper focuses on the small-flowered *Telipogon* group in Costa Rica. Our study involves a morphological comparison of two newly identified species with the known species from the Neotropics. This comparative study has resulted in the identification and description of two novel small-flowered *Telipogon* species.

Materials and methods. We collected plants in the wild in September 2002, November 2022, and February 2023 from the Orosi and Pejibaye regions adjacent to Tapantí National Park, Cartago, Costa Rica. The living specimens were photographed using advanced macro photography equipment, including a Nikon D850 camera paired with a Nikon AF-S DX NIKKOR 18-105mm f/3.5-5.6 G ED macro lens. We utilized Nikon PB6 bellows and a 40 mm Zeiss Luminar lens for enhanced detail. Photo stacking, which improves the depth of field in the images, was performed using ZereneStacker® software. Detailed botanical drawings were produced using a range of Leica® stereomicroscopes (MZ7.5, MZ9.5, and M80) equipped with drawing tubes to complement the photographic documentation. These hand-drawn sketches were digitized and compiled into comprehensive composite plates using Adobe Photoshop 2024®.

Further, detailed botanical illustrations in black and white were created using an Apple Pencil® on an iPad Pro® tablet, adhering to specific settings (8.5 × 11 inches, 800 dpi resolution). The digitized sketches were further printed and refined with stippling and shading using a 0.1 mm Rotring rapidograph® to enhance three-dimensional details. Our species descriptions and comparative analysis were based on wild-collected specimens. We referred exclusively to the protologues or taxonomic studies cited in the literature section for species comparisons and plant descriptions. Voucher specimens were deposited in the JBL and USJ herbaria.

Taxonomic treatment

Telipogon lateritius Pupulin, ***sp. nov***.

TYPE: Cartago: Orosi, Purisil, road to Monte Sky, 1550-1600 m, premontane wet forest, epiphytic on trees in thick layers of debris along the roadside, 29 September 2002, *F. Pupulin 4186, R.L. Dressler, K. Dressler, H. Léon-Páez, A.C. Rodríguez & E. Salas* (holotype, USJ). Fig. 1, 3A.

Diagnosis: *Species quae ad Stellilabium globi pertinet, ab omnibus aliis generis sui speciebus floribus glabris, lateritiis brunneo striatis, sepalis lateralibus in triangulari-ovato synsepalo connatis, disco labelli paucis trichomatibus sparsis recedit*.

Plant epiphytic, small, monopodial herb to 6 cm long, including the inflorescence. *Roots* flexuous, numerous, short, to 2 mm in diameter, with green apices. *Stem* abbreviated, completely concealed by the base of the amplectant leaf-sheaths. *Leaves* 2, elliptic, acute, gently ribbed on the underside, 16–22 × 4–6 mm, often deciduous at flowering. *Inflorescence* lateral, from the base of the stem, a successively few-flowered (to 4–5) raceme to 6 cm long, sometimes with a short branch about 2 cm long in the lower half; the peduncle born terete and becoming dorsiventrally flattened-ancipitous toward the apex, the flattened internodes with a faint longitudinal keel, provided with a triangular, obtuse, weakly keeled, pale green, glumaceous bract at the apex, decurrent on the peduncle, becoming dry-papyraceous with age; the rachis subtrigonous, straight to lightly sigmoid. *Floral bract* triangular, acute, strongly conduplicate-keeled, 1.5 × 1.0 mm. *Pedicellate ovary* terete-subclavate, rounded in section, ca. 2 mm long. *Flowers* non-resupinate, the sepals not completely spreading, brick-colored, the sepals, petals, and lip longitudinally striped with chestnut brown, the anther cap brownish red. *Dorsal sepal* triangular, acute, the margins shortly inflexed, 1.6 × 0.9 mm, 3-veined. *Lateral sepals* connate into a triangular-ovate synsepal, acute, minutely emarginate, 1.5 × 1.0 mm, 5-veined, the margins lightly involute to become adpressed to the apex of the lip. *Petals* asymmetrically lanceolate, acute, 1.7 × 0.5 mm, 3-veined. *Lip* narrowly ovate from a broad base, acute, conduplicate-involute at apex, 1.2 × 0.6 mm, the basal third provided with short, stiff, scattered hairs. *Column* semiterete, 1 mm long, the stigma recessed under a long stigmatic lobe, the anther dorsal (facing down in natural position), the rostellum long-attenuated, reaching the apex of the stigmatic lobe. *Anther cap* cucullate, cordate, acute, with two large flaps protecting the pollinia. *Pollinia* 4, discoid-complanate, in two pairs of different size, on a lanceolate, conduplicate, hyaline stipe and a hook-shaped, brown viscidium.

Distribution: endemic to Costa Rica.

Etymology: from the Latin *lateritius*, “made of brick”, in reference to the brick-colored flowers.

Habitat and Ecology: The species has only been observed in the type collection from the premontane wet forest of the Caribbean watershed of the Cordillera de Talamanca, near the Monte Sky area, close to Tapantí National Park in Costa Rica. This area is known as one of the country’s rainiest regions (Boza 1986).

Phenology: Flowering of *T. lateritius* was documented in September.

Notes: *Telipogon lateritius* is part of a group of species characterized by their small size, often deciduous at flowering, with dorsiventrally complanate and ancipitous inflorescences and small, glabrous flowers. Dressler (1999) previously assigned these species to

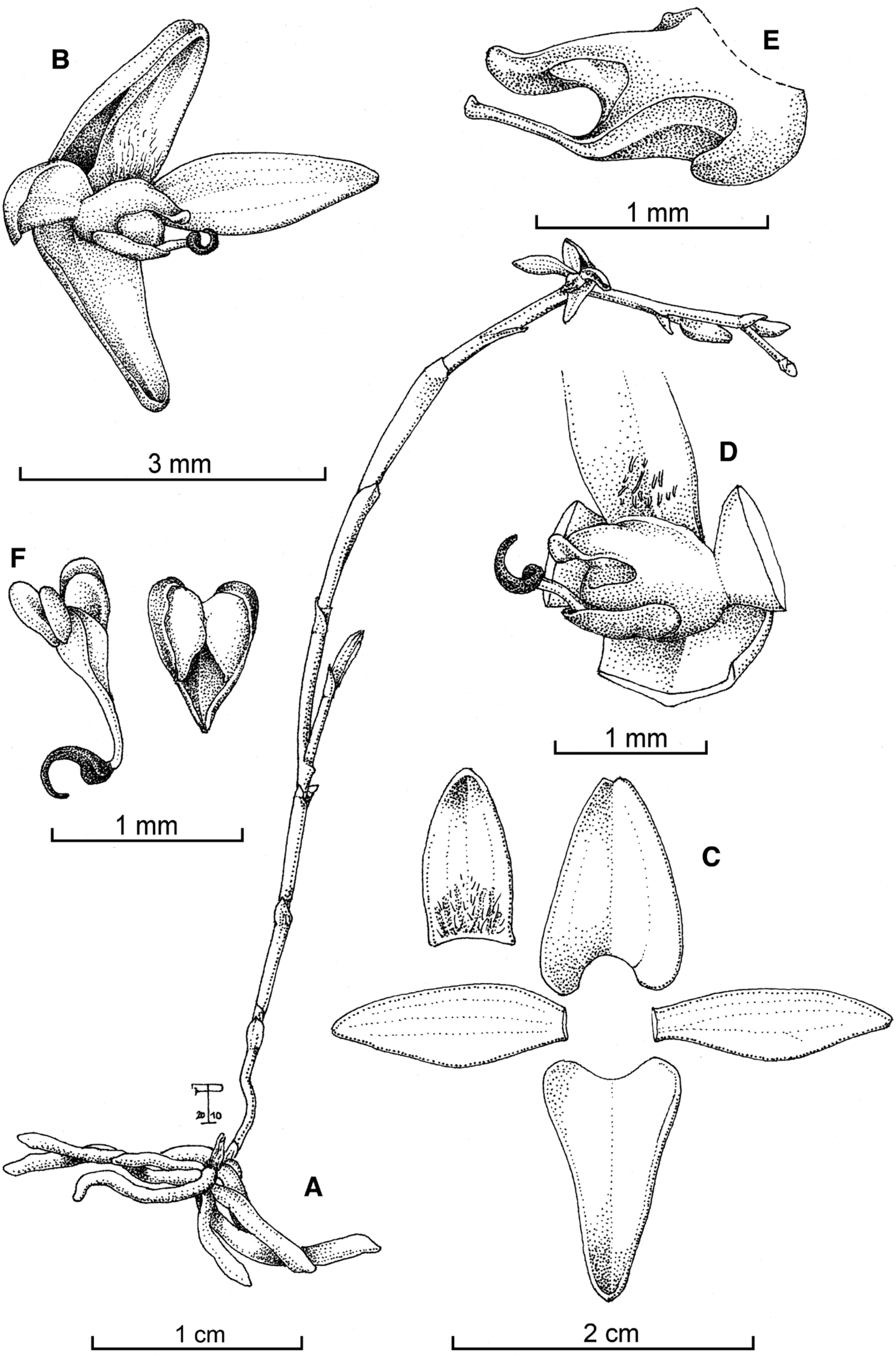


FIGURE 1. *Telipogon lateritium* Pupulin. **A**. Habit. **B**. Flower. **C**. Dissected perianth. **D**. Column with pollinarium and anther cap, part of the lip and petals, ¾ view. **E**. Column, emasculate, lateral view. **F**. Pollinarium and anther cap. Drawn by F. Pupulin from the holotype.

the *Stellilabium* Section *Rhamphostele*. This group predominantly inhabits the southern region of the Mesoamerican isthmus, including species such as *T. barbozae* (J.T.Atwood & Dressler) N.H.Williams & Dressler, *T. campbelliorum* (J.T.Atwood) N.H.Williams & Dressler, *T. fortunae* (Dressler) N.H.Williams & Dressler, along with other yet-to-be-described species from Costa Rica and Panama. *Telipogon lateritius* is distinguished within this group by its brick-colored flowers, sepals, petals, and lip striped with chestnut brown; the lateral sepals connate into a triangular-ovate synsepal and the sparse, stiff pubescence at the base of the lip.

Telipogon muntzii Bogarín, O.Pérez & Pupulin, ***sp. nov***.

TYPE: Costa Rica. Cartago: Jiménez, Pejibaye, Reserva Biológica Guaitil, ca. 6 km al norteste de El Humo, entre Ríos Humo y Río Taus, 9°47'44.48"N 83°45'07.82"W, 1152 m, bosque pluvial premontano, epífita en bosque secundario a orillas del sendero, 25 noviembre 2022, *D. Bogarín 14185, R. Gómez, G. Villalobos & R. Müntz* (holotype, JBL; isotype, JBL). Fig. 2, 3B, 4.

DIAGNOSIS: *Species praecipue Telipogoni anacristinae* (Pupulin) Dressler & N.H.Williams *similis, sed floribus viridi-olivaceis, labello sparsim trichomatoso, lobulis lateralis columnae anguste oblongis trichomatibus dendromorphibus solum apice munitis, galea lobuli medii apicaliter decrescenti solum trichomatibus simplici fornita recedit*.

Plant epiphytic, small, nearly acaulescent. *Roots* thick, flexuous, grayish with green tips, rounded in section, 2 mm in diameter. *Stem* subterete, abbreviated about 3 mm long, completely concealed by the base of the amplectant leaf sheaths. *Leaves* 2 (-3), green, distichous, conduplicate, narrowly elliptic to lanceolate, acute, 1.0 × 0.3 cm, the base enclosing the stem, frequently leafless at flowering. *Inflorescence* a simple, successively flowered (to 6) raceme to 8 cm long; peduncle terete, to 5 cm long, with 2-6 infundibuliform, triangular, acute bracts about 1.5 mm long; rachis flattened, 2 mm wide; floral bracts triangular, obtuse, slightly carinate along the middle, the margins decurrent along the edges of the rhachis, 1 × 2 mm. *Ovary* linear-subclavate, ca. 3 mm long, including the pedicel. *Flowers* non-resupinate, small, with greenish-yellowish sepals, olive green petals, and lip, the lip with purple bases of the bristles, the column greenish-purplish with purple dendroid bristles, and purple anther cap, to 0.7 mm in diameter. *Dorsal sepal* elliptic, acute, 3.4–3.5 × 2.2–2.3 mm. *Lateral sepals* ovate to lanceolate-elliptic, acute, concave, strongly deflexed in natural position, 2.9–3.0 × 2.0–2.2 mm wide. *Petals* elliptic to obovate, subobtuse to acute, ciliate-denticulate, 3.2–3.3 × 1.5–1.7 mm, 3-veined. *Lip* 3-lobed, hastate, 3.7–3.9 × 3.7–3.9 mm wide across the lateral lobes, the basal lobules narrowly linear, acute, the margins finely ciliate, the median lobe ovate-elliptic, subacute, the lamina convex, rounded up to near the acute apex, sparsely covered with stiff hairs, the margins minutely ciliate-denticulate. *Column* 3-lobed, the lateral lobes narrowly oblong, flattened, V-shaped, pubescent, 2.4–2.5 × 0.9–1.0 mm, the apices ca. 2.0–2.2 × 2.3–2.4 mm, covered with short dendroid-stellate bristles, the median lobe cucullate, narrowing towards the apex, 1.3 × 0.9 mm, covered with short, simple hairs; stigma rounded, shiny, surrounded by the lobes of the column. *Anther cap* cucullate, cordate, 1-celled, 8 × 5 mm. *Pollinia* 4 in two pairs of different sizes, oblong, laterally complanate-concave, on an oblong, basally attenuate stipe; viscidium uncinate.

ADDITIONAL MATERIAL EXAMINED: Cartago: Jiménez, Pejibaye, Reserva Biológica Guaitil, ca. 6 km al norteste de El Humo, entre Ríos Humo y Río Taus, 9°47'35.615"N 83°45'14.05444"W, 1186 m, bosque pluvial premontano, epífita en bosque secundario a orillas del sendero, 3 febrero 2023, *D. Bogarín 14494, J. Fernández, R. Müntz & F. Pupulin* (JBL) (Fig. 4).

DISTRIBUTION: endemic to Costa Rica.

EPONYMY: Dedicated to Dr. Robert Müntz, founder of Remedia Homeopathy GmbH and a visionary in the field of homeopathic pharmacy. Beyond his professional interests, Robert is an avid jungle explorer and nature conservationist. His active involvement in preserving Costa Rica's tropical forests through the Guaitil Biological Reserve in Pejibaye de Jiménez, Cartago, has been inspiring. We are pleased to dedicate this species to Robert for his unwavering support for orchidological research and his passionate commitment to conserving their fragile ecosystems.

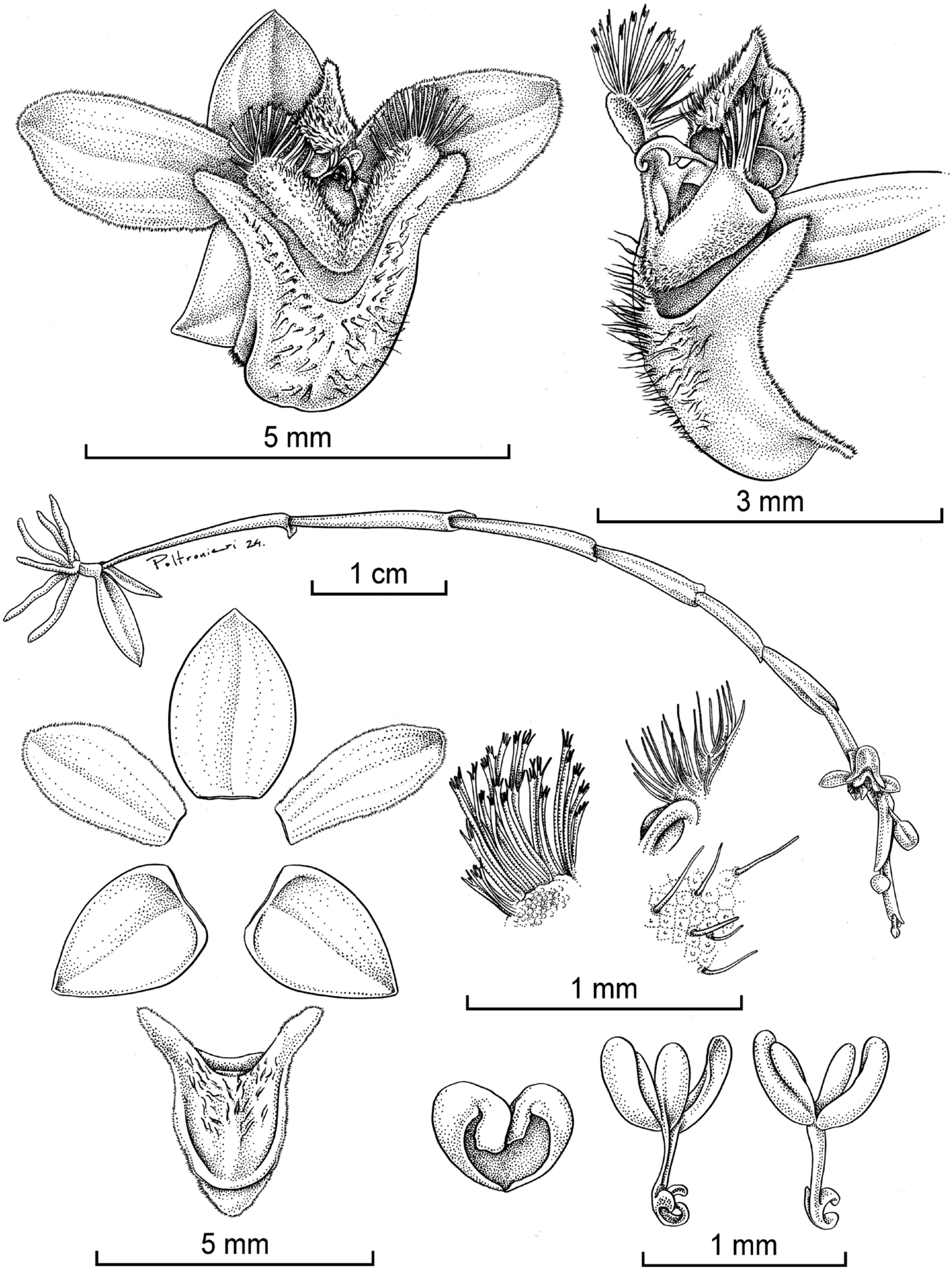


FIGURE 2. *Telipogon muntzii* Bogarín, O.Pérez & Pupulin. **A**. Habit. **B**. Flower. **C**. Ovary, column, and lip, lateral view. **D**. Dissected perianth. **E**. Setae of the lateral, median lobe of the column and the lip, from left to right. **F**. Pollinarium and anther cap. Drawn by D. Bogarín and S. Poltronieri from the holotype.

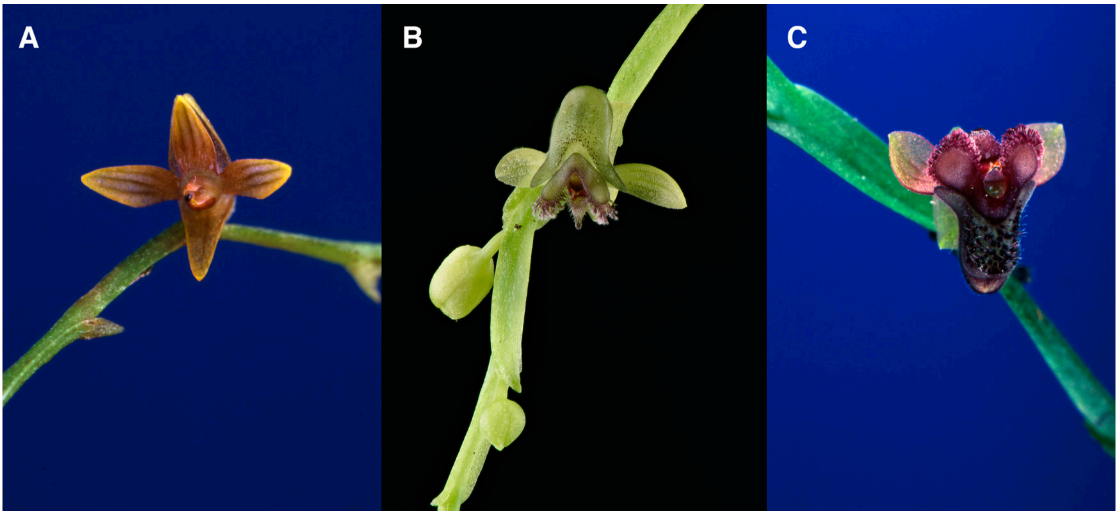


Figure 3. Flower morphology of **A**. *Telipogon lateritium* (*F. Pupulin 4186*, USJ). **B**. *Telipogon muntzii* (*D. Bogarín 14185*, JBL). **C**. *Telipogon anacristinae* (*D. Bogarín 14185*, JBL). Photos by F. Pupulin (A, C) and D. Bogarín (B).

Habitat and ecology: The species has only been observed in the type collection from the premontane wet forest of the Caribbean watershed of the Cordillera de Talamanca, near El Humo de Pejibaye and Taus area, close to the northern boundaries of Tapantí National Park in Costa Rica. Plants grow on branches of young trees in secondary forest.

Phenology: Plants flower from November to February.

Notes: *Telipogon muntzii* exhibits morphological similarities to a group of species characterized by their distinctly 3-lobed lips and columns, with dendroid bristles on the lateral lobes and either simple or dendroid bristles on the median lobe. Dressler (1999) previously assigned these species to what was then known as the *Stellilabium* Section *Taeniorhachis*. Among these species, *T. muntzii* is morphologically similar to *T. anacristinae* (Pupulin) Dressler & N.H. Williams (Fig. 3C). However, it can be distinguished by several key features: *T. muntzii* has olive green flowers, compared to the pale rose to greenish-rose of *T. anacristinae*. Additionally, the lip of *T. muntzii* is sparsely covered with trichomes that develop from black glands, unlike the densely stiff-trichomed lip of *T. anacristinae*. The lateral lobes of the column in *T. muntzii* are narrowly oblong, bearing dendroid trichomes solely at the apex, a contrast to the elliptic, rounded lobes with dendroid trichomes along the lobes seen in *T. anacristinae*. Lastly, the helmet-shaped median lobe of the column in *T. muntzii*, which narrows towards the apex and is covered exclusively by simple bristles, differs from the rounded median lobe of *T. anacristinae*, which is covered by both simple and dendroid trichomes.

Other morphologically similar species to *T. muntzii* are *T. distantiflorus* (Ames & C.Schweinf.) N.H.Williams & Dressler and *T. smaragdinus* (Pupulin & M.A.Blanco) N.H.Williams & Dressler, especially in the green emerald color of flowers; however, these species have longer inflorescences, more than 10 cm in length, and an abruptly acute median lobe of the lip with an acute apicule (as opposed to less than 5 cm in *T. muntzii* and with an acute median lobe of the lip). Additionally, both species occur at higher elevations in oak montane forests (between 1500-2400 m) along the Cordillera de Talamanca, whereas *T. muntzii* occurs in the premontane wet forest of the Caribbean watershed of Cordillera de Talamanca.

Also, *T. erratus* (Dressler) N.H.Williams & Dressler, a common species around the Tapantí area, differs from *T. muntzii* in the inflorescences, longer than 16 cm in length, and the dark wine-purple flowers (as opposed to the greenish-yellowish sepals and olive-green petals of *T. muntzii*).

FIGURE 4. Macrophotography of *Telipogon muntzii* (*D. Bogarín 14494*, JBL). Photo by D. Bogarín from the paratype.

ACKNOWLEDGEMENTS. This research was funded by the Vicerrectory of Research at the University of Costa Rica under project C0051, titled "Taxonomía de *Telipogon* s.l. and *Ornithocephalus* in Costa Rica: addenda to Oncidiinae". We thank Sara Poltronieri for inking the illustration of *T. muntzii*. Special thanks to Manrique Quesada and the Guaitil Biological Reserve staff for providing research facilities and continuous support. We thank Reinaldo Gómez and Gerson Villalobos (JBL) for their assistance during fieldwork at the reserve. We collected wild specimens under the permits issued by the Sistema Nacional de Áreas de Conservación, SINAC-SE-DT-PI-006-2021, SINAC-PI-LC-012-2023 for *T. muntzii* and Pasaporte Científico N. 01285 granted to Franco Pupulin for *T. lateritius*.

LITERATURE CITED

Amezcua-Trigos, M., Pérez-Farrera, M. A., Archila, F., Cházaro-Basáñez, M. & Sosa, V. (2018). A New Species of *Telipogon* (Orchidaceae) from Mexico and its Phylogenetic Position among MesoAmerican Species. *Systematic Botany*, 43(1), 9–16. https://doi.org/10.1600/036364418X697067

Bogarín, D. (2012). A new *Telipogon* from Mexico close to *Telipogon standleyi* (Orchidaceae: Oncidiinae). *Lankesteriana: International Journal on Orchidology*, 12(2). https://doi.org/10.15517/lank.v0i0.11761

Boza, M. A. (1986). *Parques Nacionales Costa Rica*. Fundación de Parques Nacionales, Costa Rica. Incafo, Madrid.

Dodson, C. H. & Escobar, R. (1987a). The Telipogons of Costa Rica I. *Orquideología*, 38(2), 1–69.

Dodson, C. H. & Escobar, R. (1987b). The Telipogons of Costa Rica II. *Orquideología*, 17(1), 71–137.

Dressler, R. L. (1993). *Phylogeny and Classification of the Orchid Family*. Dioscorides Press. Portland.

Dressler, R. L. (1999). Reconsideration of *Stellilabium* and *Dipterostele*. *Harvard Papers in Botany*, 4(2), 469–473.

Dressler, R. L. (2001). *Stellilabium erratum*, a comedy of blunders. *Lankesteriana*, 1(2), 11–13.

Kolanowska, M., Trejo, R. M. & Lipińska, M. (2017). A new species of *Stellilabium* (Orchidaceae) segregated from *S . morganiae*. *Polish Botanical Journal*, 62(1), 21–26. https://doi.org/10.1515/pbj-2017-0002

Martel, C., Edquen, J., Collantes, B. & Ocupa, L. (2020a). *Telipogon chachapoyensis* (Orchidaceae), a New Species from Peru Similar to *T. microglossus*. *Systematic Botany*, 45(2), 227–232. https://doi.org/10.1600/036364420X15862837791285

Martel, C., Francke, W. & Ayasse, M. (2019). The chemical and visual bases of the pollination of the Neotropical sexually deceptive orchid *Telipogon peruvianus*. *New Phytologist*, 223, 1989–2001. https://doi.org/10.1111/nph.15902

Martel, C., Neubig, K. M., Williams, N. H. & Ayasse, M. (2020b). The uncinate viscidium and floral setae, an evolutionary innovation and exaptation to increase pollination success in the *Telipogon* alliance (Orchidaceae: Oncidiinae). *Organisms Diversity and Evolution*, 20(3), 537–550. https://doi.org/10.1007/s13127-020-00457-w

Neubig, K. M., Whitten, W. M., Williams, N. H., Blanco, M. A., Endara, L., Burleigh, J. G., Silvera, K., Cushman, J. C. & Chase, M. W. (2012). Generic recircumscriptions of Oncidiinae (Orchidaceae: Cymbidieae) based on maximum likelihood analysis of combined DNA datasets. *Botanical Journal of the Linnean Society*, 168(2), 117–146. https://doi.org/10.1111/j.1095-8339.2011.01194.x

Pabón-Mora, N. & González, F. (2008). Floral ontogeny of *Telipogon* spp. (Orchidaceae) and insights on the perianth symmetry in the family. *International Journal of Plant Sciences*, 169(9), 1159–1173. https://doi.org/10.1086/591982

Pérez-Escobar, O. A., Rodríguez, L. K. & Martel, C. (2017a). A new species of *Telipogon* (Oncidiinae; Orchidaceae) from the paramos of Colombia. *Phytotaxa*, 305(4), 262–268.

Pérez-Escobar, O. A., Chomicki, G., Condamine, F. L., Karremans, A. P., Bogarín, D., Matzke, N. J., Silvestro, D. & Antonelli, A. (2017b). Recent origin and rapid diversification of Neotropical orchids in the world's richest plant biodiversity hotspot. *New Phytologist,* 215(2), 891–905.

POWO. (2024, August 1st). Plants of the World Online. Facilitated by Kew Royal Botanic Gardens. Retrieved from https:// powo.science.kew.org/

Pupulin, F. (2003). Two new species of *Stellilabium* (Orchidaceae: Telipogoninae) from Costa Rica. *Harvard Papers in Botany*, 8(1), 29–34.

Pupulin, F. & Bogarín, D. (2023). *Telipogon* Kunth. In F. Pupulin & collaborators (Ed.), *Vanishing Beauty: Native Costa Rica orchids. Vol. 3. Restrepia–Zootrophion and Appendices* (pp. 1247–1273). Oberreifenberg: Koeltz Botanical Books.

Pupulin, F., Bogarín, D. & Karremans, A. P. (2023). The Lankester Catalogue of Costa Rican Orchidaceae. *Lankesteriana: International Journal on Orchidology*, 23(Supplement), 1–254. https://doi.org/10.15517/lank.v23iSupplement.58145

Williams, N., Whitten, W. & Dressler, R. (2005). Molecular Systematics of *Telipogon* and its allies: nuclear and plastid DNA sequence data. *Lankesteriana: International Journal on Orchidology*, *5*(3), 163–184. https://doi.org/10.15517/lank.v5i3.19754

LANKESTERIANA 24(1): 79–91. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.56756

A NEW SPECIES OF *MAXILLARIA* (MAXILLARIINAE) FROM THE NORTHERN ANDES AND A NEW SYNONYM OF *MAXILLARIA FLORIBUNDA*

Gustavo Adolfo Pisso-Florez[1, 2, 7], Juan Sebastián Moreno[3, 4], Patricia A. Harding[5] & Luis E. Baquero[6]

[1]Parque Nacional Natural Puracé, Carrera 9 # 25 N-06, Cauca, Popayán, Colombia.
[2]Fundación Herencia Natural, Calle 32 EE # 80C-24, Antioquia, Medellín, Colombia.
[3]Departamento de Biología, Universidad del Valle, Calle 13 # 100-00, Cali, Colombia.
[4]Grupo de Investigación Schultes, Fundación Ecotonos, Valle del Cauca, Cali, Colombia.
[5]39127 Griggs Dr., Lebanon, Oregon 97355, U.S.A.
[6]Grupo de Investigación en Medio Ambiente y Salud BIOMAS,
Facultad de Ingeniería y Ciencias Aplicadas, Universidad de Las Américas,
vía a Nayón, Quito 170124 Ecuador.
[7]Author for correspondence: tapiflo@gmail.com

Abstract. *Maxillaria andina,* a new orchid species from high-Andean ecosystems of southwestern Colombia and northern Ecuador, is described. The new species is distinguished by having long and narrowly linear white sepals and petals with revolute margins, lip with mucronate epichile, and callus without hairs or trichomes. Distinguishing characters are provided to differentiate it from morphologically similar species, along with ecological and taxonomical notes. Additionally, *Maxillaria sibundoyensis* is synonymized with *Maxillaria floribunda*.

Resumen. *Maxillaria andina*, una nueva especie de orquídea de ecosistemas altoandinos del suroccidente de Colombia y norte de Ecuador, es descrita. La nueva especie se distingue por presentar sépalos y pétalos blancos, largos y estrechamente lineales, con los márgenes revolutos, el labelo con un epiquilo mucronado y el callo sin pelos ni tricomas. Presentamos caracteres distintivos que diferencian a la nueva especie de sus especies morfológicamente similares, así como notas ecológicas y taxonómicas. Adicionalmente, *Maxillaria sibundoyensis* es sinonimizada con *Maxillaria floribunda.*

Keywords/ Palabras clave: Colombia, ecosistemas altoandinos, Ecuador, flora neotropical, high-Andean ecosystems, Neotropical flora, taxonomía, taxonomy

Introduction. *Maxillaria* Ruiz & Pav. *sensu lato* is one of the most diverse orchid genera in the world, embracing about 651 species (Christenson *et al.* 2012, Engels & Smidt 2023, Lipińska *et al.* 2022, Schuiteman & Chase 2015, Whitten *et al.* 2007). Plants of *Maxillaria* grow as epiphytes, lithophytes, or terrestrials in cloudy, wet, or more rarely in seasonally dry forests, from the United States (Florida) and Mexico to northern Argentina, including the Antilles (Schuiteman & Chase 2015). In last decades, the circumscription of *Maxillaria* has been a subject of controversy (Barros 2002, Blanco *et al.* 2007, Dressler 1993, Ojeda *et al.* 2005, Szlachetko *et al.* 2006, Szlachetko & Miszek 2007, Whitten *et al.* 2007, Whitten & Blanco 2011); it was divided into 17 genera (Blanco *et al.* 2007), later expanded into 37 genera (Szlachetko *et al.* 2012), but has recently been lumped into a single genus, including other genera that no previous authors had synonymized with *Maxillaria sensu lato* (Schuiteman & Chase 2015). This new reclassification includes the genus *Chrysocycnis* Linden & Rchb.f., *Cryptocentrum* Benth., *Cyrtidiorchis* Rauschert, *Mormolyca* Fenzl, *Pityphyllum* Schltr., and *Trigonidium* Lindl. According to Schuiteman and Chase (2015), *Maxillaria* groups species with single-flowered

ORCID of the Author: GAPF, JSM, LEB
Received 9 Febrero 2024; accepted for publication 4 Abril 2024.

inflorescences, sepals, and petals free or partially fused, with a free labellum articulated at the base of the stout column or rigidly fused to the column foot, and conduplicate leaves (Moreno *et al.* 2017, Schuiteman & Chase 2015, Zambrano-Romero & Solano-Gomez 2016).

The Andean countries of northern South America are the richest in *Maxillaria* species. Colombia and Ecuador together have more than 400 species recorded (Govaerts *et al.* 2021, Ortiz Valdivieso & Uribe Vélez 2007), with several new species discovered and described in the last years (Moreno *et al.* 2017, Szlachetko *et al.* 2017, Zambrano-Romero *et al.* 2020; Lipińska *et al.* 2022). Nonetheless, taxonomic studies for *Maxillaria* remain scarce in both countries, and new species can still be found (Zambrano-Romero & Solano-Gómez 2016). Recent explorations conducted in the last few years in the Andes of southwestern Colombia and northern Ecuador expanded our knowledge of orchid diversity, notably in the poorly studied Puracé National Natural Park (PNNP), where two new species of orchids have been described in recent years (Moreno *et al.* 2020). In the latest expeditions in Colombia and Ecuador, we found two populations of a morphologically distinctive species from the genus *Maxillaria*, which we propose here as a new species. Furthermore, we found a specimen of *Maxillaria* within PNNP that aligns with the characteristics of *Maxillaria sibundoyensis* Szlach., Kolan., Lipińska & Medina Tr. However, upon conducting an extensive review of the literature concerning related taxa and examining the type specimens of *Maxillaria floribunda* Lindl., we observed significant morphological similarities between these species. Consequently, we consider *M. sibundoyensis* as synonymous with *M. floribunda*, based on the compelling morphological evidence.

Materials and methods. The location visited by the first author was the southern area of PNNP, municipality of San Agustín, department of Huila, Colombia, between September and October 2022 and March 2023, when two specimens of the new species were collected. Additionally, one specimen of *Maxillaria sibundoyensis syn. nov.* was collected from a nearby locality (Colombia, Huila, Municipality of Isnos, Puracé National Natural Park, road Paletará-Isnos, 2.081 -76.355, WGS 84, 2742 m a.s.l. 12 October 2022). In October 2018, the senior author collected living plants of the new species in a site near the village of Huaca, in Sucumbios province, northwestern Ecuador. The photographic plates are based on the specimens collected in Colombia. The composite photographic plate was prepared in Adobe Photoshop CS6. The *Maxillaria* specimens were pressed and mounted as herbarium specimens to be deposited at the CAUP (Universidad del Cauca in Popayán, Colombia) and QCNE (Quito, Ecuador) herbaria. We used the software QGIS 3.22 (QGIS.org 2023) to prepare the distribution map for the new taxon, based on the available collections. To validate the identification of the collected plants as a species new to science, available literature for *Maxillaria* was reviewed (Bennett & Christenson 1998, 2001, Christenson *et al.* 2012, Lindley 1845, Schlechter 1921). Also, we examined eight specimens (type and isotypes) of *Maxillaria floribunda* available on JSTOR Global Plants (https://plants.jstor.org/) from different herbaria (Kew Herbaria (K): K000793155 (Type); K000799448-49, Natural History Museum (BM): BM000533577; Muséum National d'Histoire Naturelle (P): P00445883; Herbarium Russian Academy of Sciences - V. L. Komarov, Botanical Institute (LE): LE00006574; Conservatoire et Jardin botaniques de la Ville de Genève (G): G00355249; Lund University Botanical Museum (LD): LD1411678) and used selected references to compare the morphological descriptions of *M. sibundoyensis* with *M. floribunda*. Morphological and coloration terms were based on Beentje (2010).

TAXONOMIC TREATMENT

Maxillaria andina Pisso-Florez, J.S.Moreno, P.A.Harding & Baquero, ***sp. nov.***

TYPE: Colombia. Huila: Municipio de San Agustín, Corregimiento de San Antonio, Parque Nacional Natural Puracé, Camino Nacional. 3204 m. 12 September 2022. *G.A. Pisso Florez GAP 290* (Holotype: CAUP 53405). (Fig. 1).

DIAGNOSIS: *Maxillaria andina* is most similar to *M. floribunda* and *Maxillaria caveroi* D.E.Benn. & Christenson. It is distinguished from *M. floribunda* by having the entirely white sepals and petals (*vs*. yellow, white and brownish petals), the longer and narrower sepals (6.08–6.55 × 0.26–0.57 *vs*. 5.3 × 1.0 cm), the smaller lip (0.78 × 1.14 *vs*. 1.3 × 1.8 cm), with the mid-lobe

Figure 1. *Maxillaria andina* Pisso-Florez, J.S.Moreno, P.A.Harding & Baquero. **A**. Habit. **B**. Flower. **C**. Dissected perianth, not flattened. **D**. Ovary, column and lip, lateral view. **E**. Adaxial view of lip. **F**. Column, oblique, ventral, and lateral views. LCDP by G.A. Pisso-Florez and J.S. Moreno based on the holotype.

apex verrucose (*vs*. scabrous), and the base of the lip scabrous (*vs*. slightly verrucose or spiculate). The new species differs from *M. caveroi* by having narrower, linear sepals and petals (*vs*. lanceolate) and the absence of sparse trichomes on the lip.

Plant terrestrial, ascendent, evergreen, sympodial with pseudobulbs between the ascending rhizome segments, rhizome segments *ca*. 15 cm long. *Roots* white, 0.11 cm in diameter, profuse, flexuous, produced from the base of the rhizome. *Pseudobulbs* ovate-pyriform, grooved, compressed, 2.94–5.04 × 0.66–3.49 cm, partially or completely covered by leaf sheaths, unifoliate, base with 1–2 foliaceous rigid sheaths. *Leaves* distichous, 1–4 per rhizome segment, 7.24–15.9 × 2.06–2.92 cm, monomorphic, coriaceous, blade oblong-elliptic, apex acute, base conduplicated with a clear abscission line. *Phyllopodium* 1.23–1.80 × 0.36–0.55 cm, conduplicate and articulated with the leaf, coriaceous. *Inflorescences* 1–10 flowers produced from the basal leaf sheath's axils. *Peduncles* 11–16 cm long, with 3–5 alternate and distichous bracts; bracts acute, grooved, red-brown or green in the medial-upper part and green in the base, papyraceous, including the floral bract, the latter not surpassing one-third of the pedicel. *Ovary* pedicellate, 3.57 cm long including the pedicel, verrucose, and sulcate with six longitudinal grooves. *Flower* spidery, without detectable odor. Sepals and petals white, immaculate, lip white, lateral margins heavily colored deep red-purple, mid-lobe with white margin and central portion yellow, callus white with base yellow and red-purple dots, column white, the foot deep red-purple, becoming yellow with red-purple spots distally. *Sepals* narrowly linear with the base widest and concave, margins revolute, apex attenuate and circinate; dorsal sepal incurved towards the apex, 6.55 × 0.37 cm, 12-veined; lateral sepals falcate 6.08–6.54 × 0.26–0.57 cm, 11-veined. *Petals* narrowly linear, 4.42–4.74 × 0.16–0.32 cm, 7–8 veined, with the base widest and concave, margins revolute, apex attenuate and circinate. *Lip* three-lobed, elliptical, 1.14 × 0.78 cm; base scabrous, slightly truncate; callus oblong-elliptic, apex obtuse, smooth, extending from the base of the lip to the base of the mid-lobe, simple, verrucose at base; lateral lobes 0.54 × 0.23 cm entire, obtuse, elliptic; mid-lobe 0.44 × 0.68 cm, fleshy, broadly obovate, subtruncate, obtuse with a small mucron at the apex, thickened with a rugose surface, margins thinner, sub-crenate. *Column* stout, arching, with the apex broad. *Anther* apical, 0.3–0.4 cm long. *Stigma* ventral. *Pollinia* 2-paired, obovoid, 0.1 × 0.14 cm; viscidium inverted V-shaped, ivory-colored. *Fruits* saffron-colored, narrowly ellipsoid, 3.90 × 0.95 cm, dehiscent by 6 longitudinal slits.

Paratypes: **Colombia**. Huila: Municipio de San Agustín, Corregimiento de San Antonio, Parque Nacional Natural Puracé, Camino Nacional. 1.935, -76.586, WGS84. 3204 m. October 2022. *G.A. Pisso-Florez GAP 291* (CAUP 53406). **Ecuador**. Sucumbios: cerca de Huaca, 3100 m. October 2018. *L. Baquero LB-3143* (QCNE).

Etymology: Named in reference to the Andean region of Colombia and Ecuador in South America, where the new species was found. The Andean region is a key area for conserving the diversity of Maxillariinae species.

Distribution and ecology: *Maxillaria andina* is known from Camino Nacional (Fig. 2A), Paramo de Las Papas, PNNP, municipality of San Agustín, Department of Huila, southwestern Colombia (1.935, -76.586, WGS84), at 3204 m (Fig. 2B), with one individual observed at 3425 m in elevation (Fig 2C), and near Huaca, Sucumbíos province in northeastern Ecuador (0.610, -77.699, WGS84), at 3100 m in elevation (Fig. 3). At present, our observations suggest that the species has not yet been found in other localities, but it may be present in other high-Andean ecosystems in southwestern Colombia and northern Ecuador. The plant grows on the ground, surrounded by mosses (Fig. 2B). Colombian populations of this species are present in well-conserved high-Andean ecosystems inside the PNNP, with sympatric species such as *Blechnum loxense* (Kunth) Hieron. ex Salomon (Blechnaceae), *Bomarea linifolia* (Kunth) Baker (Alstroemeriaceae), *Calamagrostis* sp. (Poaceae), *Cortaderia* sp. (Poaceae), *Epidendrum fimbriatum* Kunth (Orchidaceae), *Epidendrum macrostachyum* Lindl. (Orchidaceae), *Macleania* sp. (Ericaceae), *Weinmannia* sp. (Cunoniaceae), all representative of the ecotone between sub-paramo and high-Andean forest. In Ecuador, a population of the *M. andina* was found growing in sub-paramo remnants of forest near the town of Huaca sympatrically with both species of *Epidendrum* mentioned above, but the native forest cover is rapidly disappearing due to strawberry

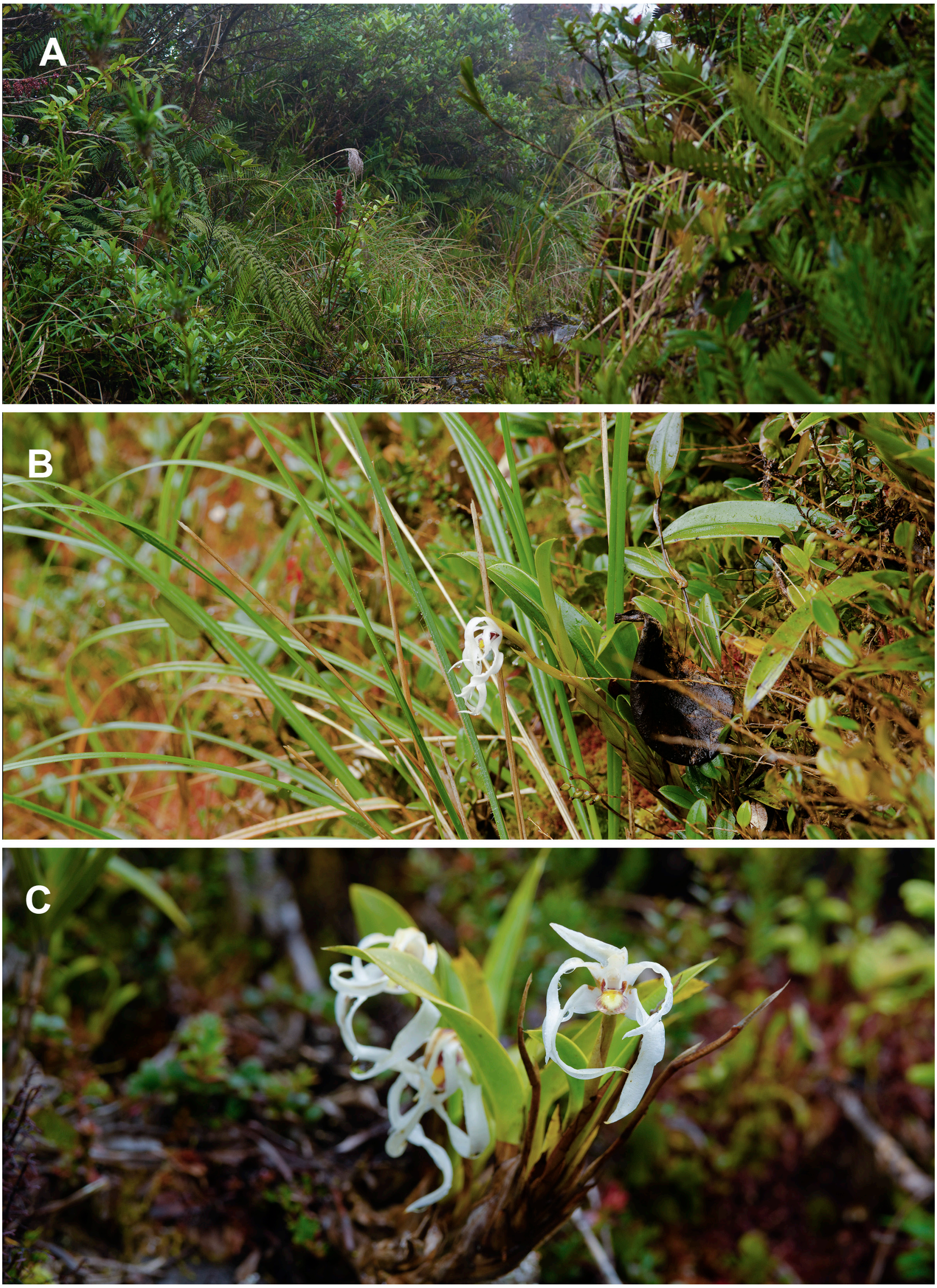


Figure 2. Habitat and habit of *Maxillaria andina* Pisso-Florez, J.S.Moreno, P.A.Harding & Baquero. **A**. The "Camino Nacional", a historical route traversing the southern portion of Puracé National Natural Park where the new species was found. Image of the plant *in-situ*. **B**. Lateral view (type specimen at 3204 m). **C**. Frontal view (individual observed at 3250 m). Photographs by G.A. Pisso-Florez

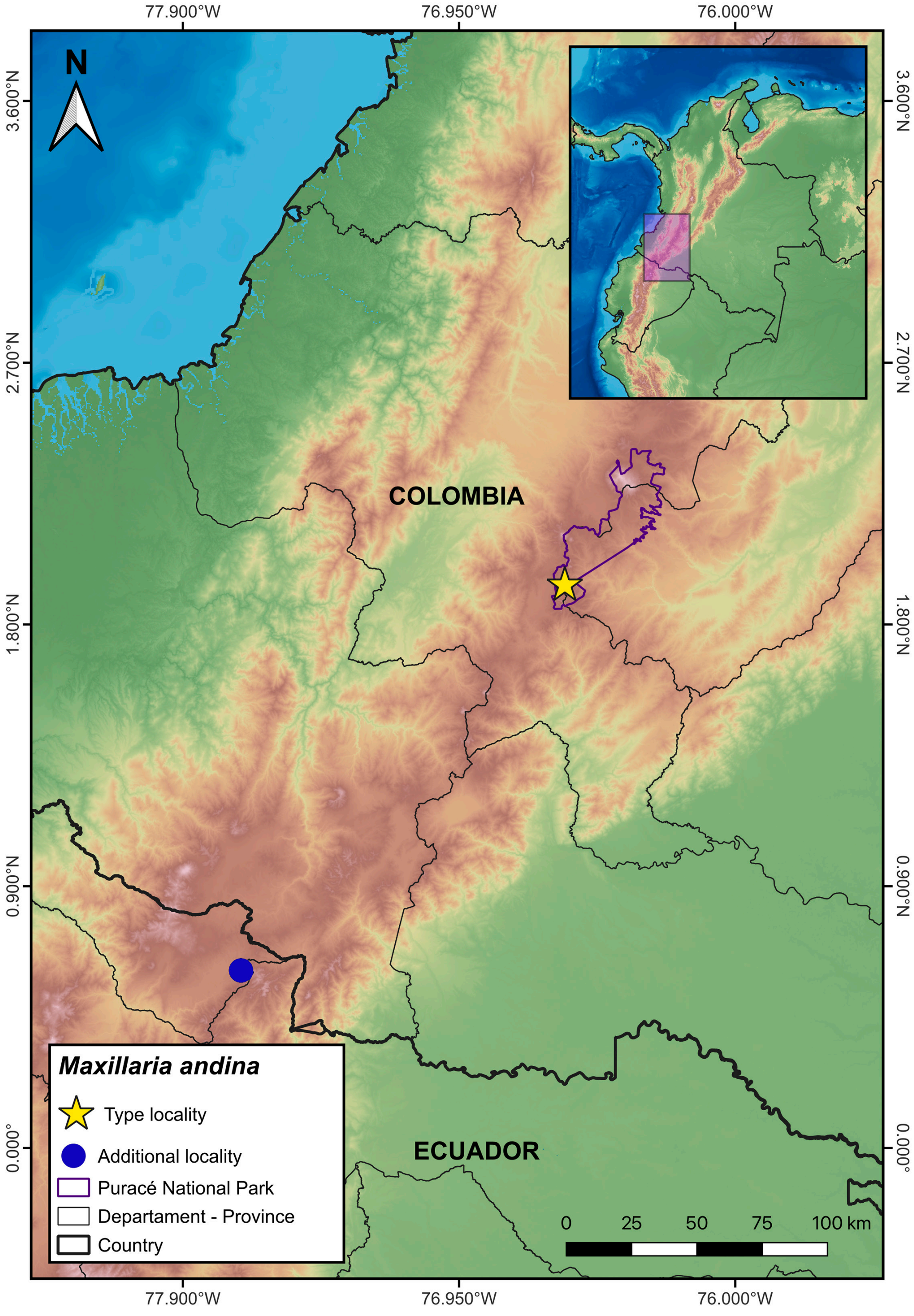


Figure 3. Geographical locations of *Maxillaria andina* Pisso-Florez, J.S.Moreno, P.A.Harding & Baquero in Colombia and Ecuador. Names in capital letters indicate countries.

cultivation and cow pastures and it does not occur in a protected area. On the other hand, we found populations of *M. floribunda* (Fig. 4) within PNNP growing sympatrically with *M. andina*, according to our field observations with unvouchered individuals. Given the little knowledge available for *Maxillaria andina*, we propose an IUCN categorization as data deficient (DD) because adequate information on population status and distribution to assess the conservation status of the species is unavailable.

Phenology: Flowering occurs from August to March (Figure 2B–C), with additional observations of immature fruits in March. The records from August and March are based on unvouchered observations.

Additional notes: The University of Florida Herbarium website provides compilation of early drafts for the project "Phylogenetics of Maxillariinae" and includes proposed *Maxillaria* species alliances (Atwood *et al.* 2015). Though not all of these alliances have been formally recognized, the authors do provide their thoughts on species that would fit into each alliance. They list a "Floribunda Alliance", including species such as *Maxillaria caveroi*, *M. dodsonii* (Carnevali) Molinari, *M.* × *dunstervillei* Carnevali & I.Ramirez, *M. floribunda*, *M. merana* Dodson, *M. platyloba* Schltr., *M. quelchii* Rolfe, and *M. yanganensis* Dodson.

This alliance shares the traits of having crawling, rambling growth habit, long rhizome segments between pseudobulbs, oblong leaves, long thin tepal segments, a lip mid-lobe that is thickened with a rugose or scaly surface and with thinner margins.

Maxillaria andina, having the characteristics of a rambling growth habit, long rhizome segments between pseudobulbs, oblong leaves, long, narrow tepal segments, and most notably a lip mid-lobe that is thickened with a rugose or scaly surface with thinner margins, fits into this "Floribunda Alliance". The species is distinguished from others by occurring at higher elevations than other members of the alliance, except *M. floribunda,* which has been recorded at 3500 m a.s.l. in La Paz-Bolivia (Herbario Nacional de Bolivia: *LPB 3843*), the color of the flower being white with deep purple on the margins of the lip and base of the column, and the central portion of the lip mid-lobe yellow. The base of the callus is scaly and irregular; some species in this alliance have trichomes on the callus and even on the surface of the lip, but none are described as having a callus that is rough at the base and smooth apically. A comparison of flower, ovary, column and lip of *M. andina* with those of the most similar species, *M. floribunda*, is shown in Figure 5.

A new synonym of *Maxillaria floribunda*. Szlachetko *et al.* (2017) described and illustrated six new *Maxillaria* species from the Department of Putumayo in southwestern Colombia. Among these species, *Maxillaria sibundoyensis* was described, and it was compared with *Maxillaria floribunda* in the diagnosis and discussion as the most similar species. They state that *M. sibundoyensis* can be distinguished by the wider, linear-ligulate to linear-lanceolate sepals and petals, compared to the lanceolate sepals and petals of *M. floribunda*. However, in the extended description of *M. floribunda* by Schweinfurth (1945), the sepals and petals are described as linear-lanceolate, which is the same shape as in the new species' description. Szlachetko *et al*. (2017) ignored that the species they described has the same shape and size of sepals and petals as *M. floribunda*.

Szlachetko *et al.* (2017) also described the lateral lobes of the lip in *M. sibundoyensis* as obliquely triangular-obovate with rounded apices, contrasting to *M. floribunda*, whose lateral lobes they describe as obliquely elliptic and acute. However, the lateral lobes in *M. floribunda* display a broad variation in shape. In this way, the original description by Lindley (1845) does not detail the shape of the lateral lobes specifically but describes the lip as oblong and three-lobed, with an oblong and concave callus and lobes obtuse, and a fleshy, elongated mid-lobe ("*…labello oblongo trilobo callo oblongo excavato in medio laciniis obtusis intermedia carnosa longiore…*") (Lindley 1845). In other published descriptions of *M. floribunda* (Bennett & Christenson 2001, Dodson & Bennett 1989, Dunsterville & Garay 1979), the lateral lobes are described as obliquely oblong (e.g., Fig. 6), which is practically the same description as the lateral lobes of *M. sibundoyensis*. Similarly, the mid-lobe in *M. sibundoyensis* is described as transversely elliptic to rhombic, with an oblong, thick callus that, at its basal part, is covered by erect, somewhat thick hairs. In contrast, the mid-lobe in *M. floribunda* was originally described as fleshy and longer (Lindley 1845), while Bennet and Christenson

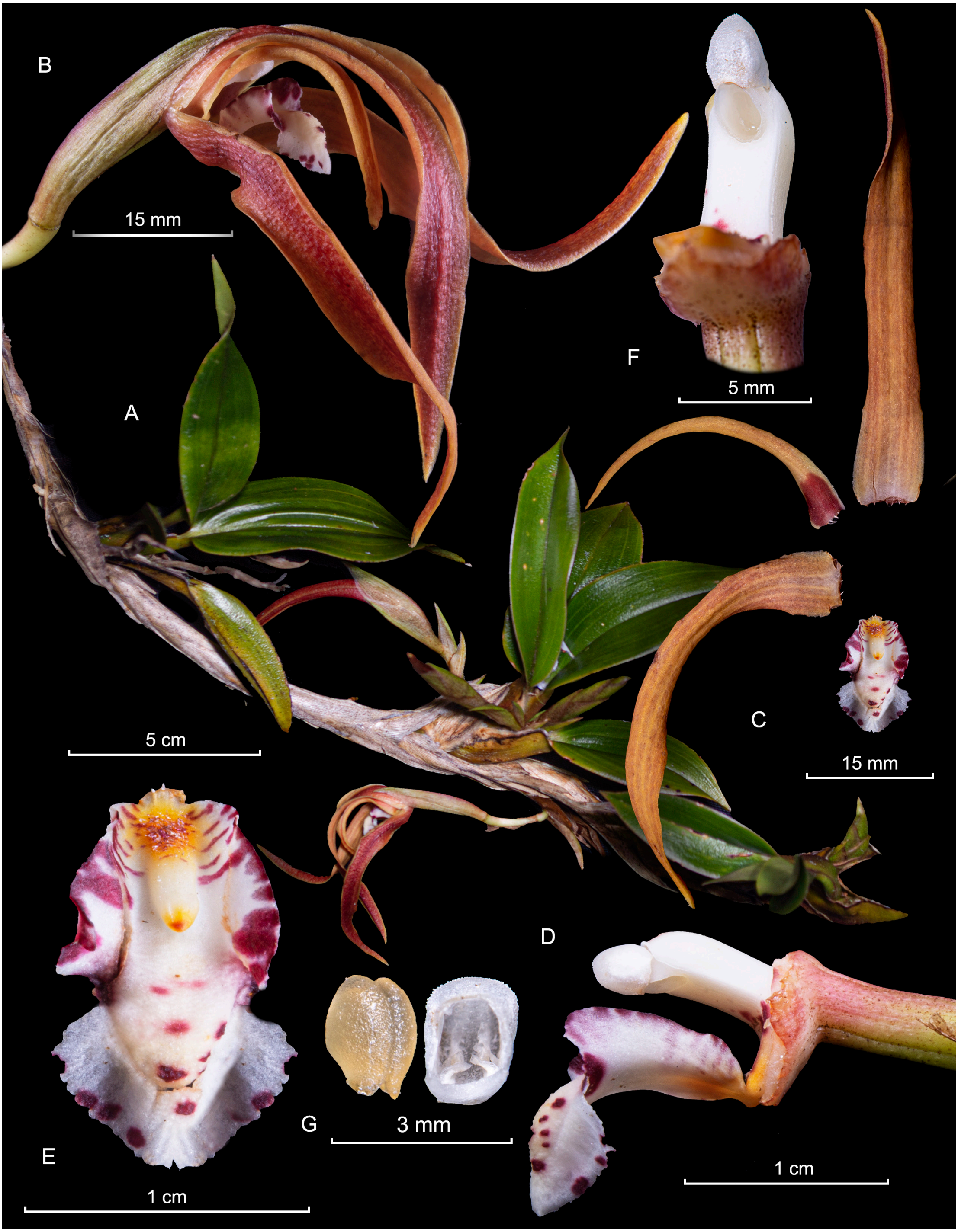


FIGURE 4. *Maxillaria floribunda* Lindl. **A**. Habit. **B**. Flower. **C**. Dissected perianth (one of the lateral sepals and one of the lateral petals omitted). **D**. Ovary, column and lip, lateral view. **E**. Adaxial view of lip. **F**. Column, oblique view. **G**. Anther cap and pollinia. LCDP by J.S. Moreno based on collected specimen by G.A. Pisso-Florez (*GAP 392*) in Puracé National Natural Park (CAUP!).

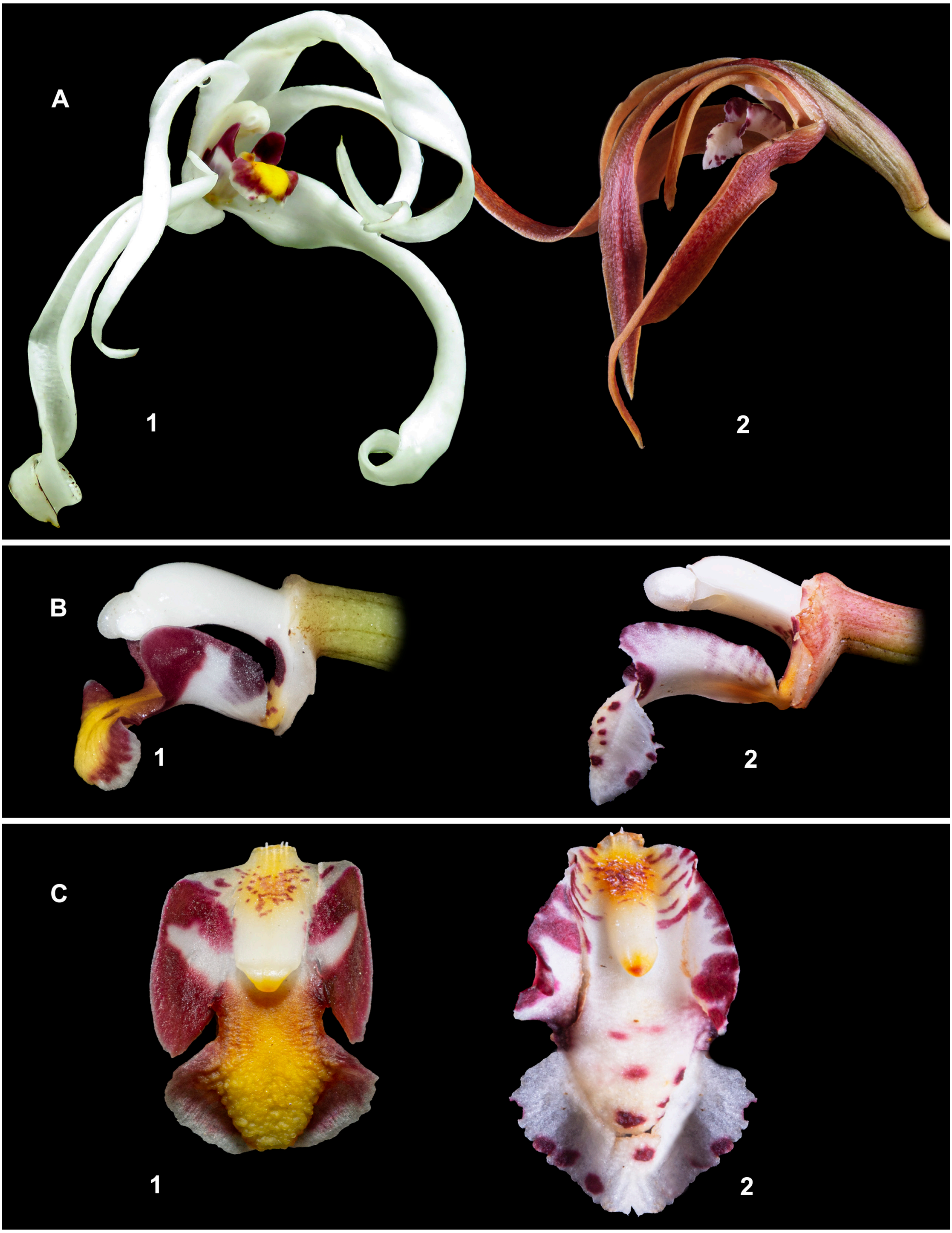


Figure 5. Comparison of *Maxillaria andina* (1) and *Maxillaria floribunda* (2). **A**. Flowers. **B**. Ovaries, columns, and lips. **C**. Lips (not flattened). Photographs by G.A. Pisso-Florez and J.S. Moreno based on the holotype of *M. andina* and collected specimen by G.A. Pisso-Florez (*GAP 392*) in Puracé National Natural Park (CAUP!).

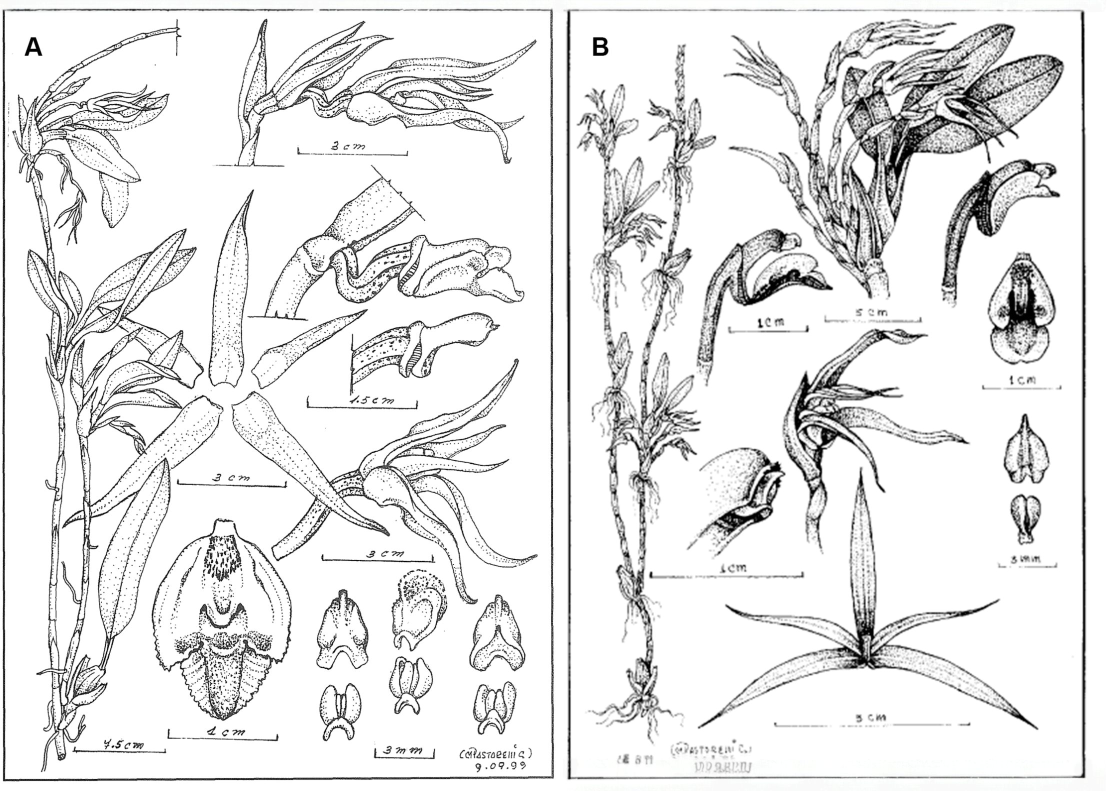


FIGURE 6. Drawings of *Maxillaria floribunda* Lindl. **A**. Drawing by M. Pastorelli A., Plate 693 in Icones Orchidacearum Peruviarum (Bennett & Christenson 2001). **B**. Drawing by M. Pastorelli, Plate 106 in Icones Plantarum Tropicarum, Series II (Dodson & Bennett 1989).

(2001) described it as transversely broadly ovate to suborbicular, with an oblong and scabrous callus in the basal part. Furthermore, the description of *M. floribunda* by Schweinfurth (1945) mentions a mid-lobe that is transversely broadly oblong or reniform and broadly ovate. These descriptions could represent a broad variation of the transversely elliptic to rhombic mid-lobe, including the shape of *M. sibundoyensis*. Finally, in the description of *Maxillaria floribunda* of Bennett and Christenson (2001), it is clearly shown that the lip is slightly verrucose or verruculose and spiculate at the base, which is what Szlachetko *et al*. (2017) describe as "thick hairs at the base," and not scabrous.

Maxillaria floribunda, a species distributed throughout the Andes from Venezuela to Bolivia, is, in fact, a variable species in the shape of the plant due to its prolific and terrestrial habit and varies in the coloration of the flowers in the sepals and petals, which can vary in color from white tinted with yellow to orange, red-brown tinted with orange along the margins, and in some specimens, red with the base of the sepals and petals white on the adaxial and abaxial surfaces (Fig. 7).

For the reasons mentioned above, we consider *Maxillaria sibundoyensis* as a synonym of *Maxillaria floribunda.*

Maxillaria floribunda Lindl. Plantas Hartwegianas imprimis Mexicanas 154. (1845). TYPE: Ecuador. Hartweg collected the specimens in this country extended to the Río Marañón and the capital of the Province, [Date unknown], *K. T. Hartweg 851* (holotype, (K), K000793155).

Maxillaria sibundoyensis Szlach., Kolan., Lipińska & R.Medina. Botany Letters 164 (2): 162–163 (2017), ***syn. nov.*** Type: Colombia. Putumayo: Mpio. San Francisco, collected in the place called La Torre, La Siberia pathway, [6 Jul 2009], *R. Medina 345* (holotype, HPUJ !).

Figure 7. Color and shape variation of *Maxillaria floribunda* Lindl. throughout the Andes. **A**. Photograph by Nelson Apolo in Yangana, Ecuador. **B**. Photograph by Alfredo F. Fuentes (*Fuentes 8703*, BOLV, HSB, LPB, MO) in Bolivia. **C**. Photograph by Thibaud Aronson in Peru. **D**. Photograph by Eric Hunt in Peru. **E**. Photograph by Brayan Coral Jaramillo from Putumayo, Colombia.

ACKNOWLEDGEMENTS. We are grateful for the support of Parques Nacionales Naturales de Colombia and Parque Nacional Natural Puracé. We specifically acknowledge the director, Isaac Bedoya, who encouraged us to undertake this research via contract 024 - 21 January 2022, to enhance the understanding of biodiversity in this protected area. Our thanks also go to the park rangers Carlos Becerra, Carlos Sanchez, Doris Rojas, Faber Jiménez, and Gustavo Papamija, as well as researcher Gabriel Loaiza, for accompanying us on field trips. We are very grateful to the anonymous reviewers who provided suggestions that helped to substantially improve the article. We extend our gratitude to Jorge Becoche-Mosquera, Diego Macias-Pinto, and the CAUP herbarium for their support. Our appreciation goes to Andres Felipe Lievano-Bonilla for assisting with the map creation and for his support during one field trip. We offer special thanks to the Papallaqta indigenous community, as well as the Valencia and San Antonio rural farmers, for their efforts in protecting the high Andean forests where the species was discovered and for granting us permission to explore their lands. Luis Baquero wishes to acknowledge Edmundo Coral, the first individual to identify plants of *Maxillaria andina* in Ecuador, and UDLA (Universidad de las Américas) for funding orchid research in Ecuador. We also thank the Ministerio de Ambiente del Ecuador for issuing the Environmental Research Permit No. 008-2016-IC-FLO-DNB/MA.

LITERATURE CITED

Atwood, J. T., Carnevali, G. & Dodson, C. H. (2015). Subtribe Maxillariinae: Proposed Species Alliances [PDF of website screenshots]. In: N. H. Williams & W. M. Whitten (Eds.), *Phylogenetics of Maxillariinae*. The Florida Museum of Natural History. Originally part of the "Phylogenetics of Maxillariinae" project supported by U.S. National Science Foundation grant No. DEB-0234064. Retrieved from https://www.floridamuseum.ufl.edu/wp-content/uploads/sites/67/2021/08/Phylogenetics-of-Maxillariinae-Orchidaceae.pdf (Accessed 14 October 2023).

Barros, F. (2002). Notas taxonomicas para especies brasileiras dos generos *Epidendrum* e *Heterotaxis* (Orchidaceae). *Hoehnea*, 29, 109–113.

Bennett, D. E. & Christenson, E. A. (1998). *Icones Orchidacearum Peruvianum*. Plates 401–600. Sarasota: A. Pastorelli de Bennett.

Bennett, D. E. & Christenson, E. A. (2001). *Icones Orchidacearum Peruvianum*. Plates 601–800. Sarasota: A. Pastorelli de Bennett.

Beentje, H. (2010). *The Plant Glossary: An Illustrated Dictionary of Plant Terms*. Richmond, Surrey, UK: Royal Botanic Gardens, Kew.

Blanco, M. A., Carnevali, G., Whitten, W. M., Singer, R. B., Koehler, S. & Williams, N. H. (2007). Generic realignments in Maxillariinae (Orchidaceae). *Lankesteriana*, 7, 515–537. https://doi.org/10.15517/lank.vi.7935

Christenson, E. A., Harding, P. A., McIllmurray, M. & Blanco, M. A. (2012). *Maxillaria*: An Unfinished Monograph (Vol. 1–2). Lebanon OR, USA: Robert Christenson and Patricia Ann Harding.

Dressler, R. L. (1993). *Phylogeny and classification of the orchid family.* Portland, Oregon, USA: Dioscorides Press.

Dodson, C. H. & Bennett, D. E. Jr. (1989). Orchids of Peru. *Icones Plantarum Tropicarum*, Series 2, Fasc. 1–2, 1–200.

Dunsterville, G. C. K. & Garay, L. A. (1979). *Orchids of Venezuela. Volume II*. Cambridge, Massachusetts: Botanical Museum of Harvard University.

Engels, M. E. & Smidt, E. d. C. (2023). *Maxillaria luizotavioi* (Orchidaceae: Maxillariinae): a new species from the Oriental Brazilian Amazon. *Nordic Journal of Botany*, e03815. https://doi.org/10.1111/njb.03815

Govaerts, R., Nic Lughadha, E., Black, N., Turner, R. & Paton, A. (2021). The World Checklist of Vascular Plants, a continuously updated resource for exploring global plant diversity. *Scientific Data*, 8, 215. https://doi.org/10.6084/m9.figshare.15035046

Lindley, J. (1845). *Maxillaria floribunda*. In: G. Bentham (Ed.), *Plantas Hartwegianas Imprimis Mexicanas Adjectis Nonnullis Grahamianis* (p. 154). London: Societate Linnaeana Londinensi.

Lipińska, M. M., Olędrzyńska, N., Portilla, A., Łuszczek, D., Sumbembayev, A. A. & Szlachetko, D. L. (2022). *Maxillaria anacatalinaportillae* (Orchidaceae, Maxillariinae), a new remarkable species from Ecuador. *PhytoKeys*, 190, 15–33. https://doi.org/10.3897/phytokeys.190.77918

Moreno, J. S., Harding, P. A. & Pina, L. (2017). Una nueva especie de *Maxillaria,* sección *Maxillaria*, de la Cordillera Oriental de los Andes en Colombia. *Orquideología*, 34(1), 25–33.

Moreno, J. S., Pisso-Florez, F. A. & Vieira-Uribe, S. (2020). Discoveries in indigenous territories: two new species of *Lepanthes* (Orchidaceae: Pleurothallidinae) in southwestern Colombia. *Lankesteriana*, 20, 229–239. https://dx.doi.org/10.15517/lank.v20i2.43358.

Ojeda, I., Carnevali Fernández-Concha, G. & Romero, G. A. (2005). New species and combinations in *Heterotaxis* Lindley

(Orchidaceae: Maxillariinae). *Novon*, 15, 572–582.

Ortiz Valdivieso, P. & Uribe Vélez, C. (2007). *Galería de Orquídeas de Colombia*. Asociación Bogotana de Orquideología. Retrieved from https://sco.org.co/ (Accessed 12 August 2023)

QGIS.org. (2023). QGIS Geographic Information System. QGIS Association. Retrieved from http://www.qgis.org

Schlechter, R. (1921). Die Orchideenfloren der sudamerikanischen Kordillerenstaaten IV. Peru. *Repertorium Specierum Novarum Regni Vegetabilis, Beihefte*, 8, 1–182.

Schuiteman, A. & Chase, M. (2015). A reappraisal of *Maxillaria* (Orchidaceae). *Phytotaxa*, 225(1), 1–78. https://doi.org/10.11646/phytotaxa.225.1.1

Schweinfurth, C. (1945). Some Peruvian Maxillarias. *Botanical Museum Leaflets*, 11, 261–296.

Szlachetko, D. L. & Miszek, M. S. (2007). Nouveaux genres dans le complex *Maxillaria* (Orchidaceae). *Richardiana*, 7, 26–32.

Szlachetko, D. L., Mytnik-Ejsmont, J., Rniak, M. G. & Miszek, M. S. (2006). Genera et species orchidalium. 15. Maxillarieae. *Polish Botanical Journal*, 15, 57–59.

Szlachetko, D. L., Sitko, M., Tukałło, P. & Mytnik-Ejsmont, J. (2012). Taxonomy of the Subtribe Maxillariinae (Orchidaceae, Vandoideae) revised. Biodiversity: *Research and Conservation*, 25, 13–38.

Szlachetko, D. L., Kolanowska, M., Medina Trejo, R. & Lipińska, M. (2017). New species of *Maxillaria* (Orchidaceae) from the Sibundoy valley, Colombia. *Botany Letters*, 164(2), 159–170. https://doi.org/10.1080/23818107.2017.1318091

Whitten, W. & Blanco, M. (2011). Defining generic limits in *Maxillaria*. *Orchids*, 80, 104–113.

Whitten, W. M., Blanco, M. A., Williams, N. H., Koehler, S., Carnevali, G., Singer, R. B., Endara, L. & Neubig, K. M. (2007). Molecular phylogenetics of *Maxillaria* and related genera (Orchidaceae: Cymbidieae) based on combined datasets. *American Journal of Botany*, 94(11), 1860–1889. https://www.jstor.org/stable/27733360.

Zambrano–Romero, B. J. & Solano–Gómez, R. (2016). Una nueva especie de *Maxillaria* (Orchidaceae: Maxillariinae) del suroccidente de Ecuador. *Revista Mexicana de Biodiversidad*, 87, 29–34.

Zambrano–Romero, B. J., Carnevali, G. & Solano, R. (2020). *Maxillaria purpureo-nigra* (Orchidaceae: Maxillariinae), a new species from Southwestern Ecuador belonging to *Maxillaria* sect. *rufescens*. *Phytotaxa*, 477(2), 205–216. https://doi.org/10.11646/phytotaxa.477.2.5

LANKESTERIANA 24(1): 93–114. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.59617

HOST SUITABILITY FOR GERMINATION DIFFERS FROM THAT OF LATER STAGES OF DEVELOPMENT IN A RARE EPIPHYTIC ORCHID

Normandie González-Orellana[1,2], Aragne Salazar Mendoza[1],
Raymond L. Tremblay[1] & James D. Ackerman[1]

[1]Department of Biology, University of Puerto Rico, 17 Avenida Universidad Suite 1701, San Juan, Puerto Rico, 00925-2537, U.S.A.

[2]Author for correspondence: normandie.gonzalez@upr.edu

Abstract. We explore phorophyte suitability for germination and establishment of the epiphytic orchid, *Psychilis kraenzlinii*. We found that the orchid grows on a subset of the available tree species and shows preference for the endemic *Machaonia portoricensis* (Rubiaceae). The orchid preferred trees with smoother bark, high water holding capacity and low water retention capacity. Microclimatic conditions under which embryos began pre-germination stages mirrored that of the adult orchid, but germination did not, suggesting that suitable germination sites are not necessarily the best sites for later stages of development.

Resumen. Exploramos la utilización de árboles y los patrones de germinación de la orquídea epífita, *Psychilis kraenzlinii*. Encontramos que *P. kraenzlinii* crece en un subconjunto de las especies de árboles disponibles y muestra preferencia por la endémica *Machaonia portoricensis*. La orquídea prefiere árboles con corteza lisa y alta capacidad de sostener agua y baja capacidad de retención de agua. Las condiciones microclimáticas bajo las cuáles los embriones empienzan etapas pre-germinacíon, reflejan los de la orquídea adulta, pero las condiciones bajo las cuáles los embriones llegan a etapas de germinación no. Lo que sugiere que los sitios de germinación adecuados no son necesariamente los lugares donde mejor se producirá el desarrollo a etapas más avanzadas de la germinación.

Keywords / Palabras clave: community dynamics, dinámica comunitaria, dinámica poblacional, epiphytes, epífitas, forófitos, germinación, germination, phorophytes, population dynamics, Orchidaceae

Introduction. Orchids are generally characterized by small, scattered populations (Ackerman 1986, Tremblay 1997), making many species vulnerable to deforestation, habitat fragmentation, and illegal collection (Adhikari & Fischer 2011). Factors of paramount importance that limit orchid abundance and distribution are believed to be pollinator availability and its influence on seed production (Ackerman *et al.* 1996), and OMF availability, which may be microsite-limited (Izuddin *et al*. 2019a, 2019b, Otero & Flanagan 2006). Because of their highly variable and important symbiotic relationships, orchid conservation and management strategies might need to be developed individually for genera or even species and include the entire communities in which they occur (Fay 2018, Phillips *et al.* 2020, Rasmussen *et al.* 2015).

Approximately 70% of orchid species are epiphytes, accounting for approximately 72% of epiphyte species in the world (Gentry & Dodson 1987, Gravendeel *et al.* 2004). Epiphytic orchid conservation and management techniques may include the protection of suitable and existing phorophytes, as well as planting new ones (Adhikari & Fischer 2011). While our knowledge of the relationship between epiphytes and phorophytes has advanced, relatively few epiphytic species have been studied in detail (e.g., Benzing 1990, Gowland *et al.* 2011, Sáyago *et al.* 2013, Zotz *et al.* 2021) yet we do know that phorophyte specificity is rare. Still, some degree of preference is commonly found within sites (Gowland *et al*. 2011, Laube & Zotz 2006, Migenis & Ackerman 1993, Sulit 1950, 1953, Trapnell & Hamrick 2006, Tremblay *et al.* 1998, Wagner *et al.*

ORCID of the Author: NGO, RLT, JDA
Received 12 October 2023; accepted for publication 8 Abril 2024.

2015). On the other hand, among sites, Hietz & Hietz-Seifert (1995) found epiphyte community composition was more closely associated with elevation rather than the availability of particular phorophyte species.

The epiphytic environment is in constant change, as host trees grow and age. Changes in the crown of the tree, for example, affect radiation, temperature, and humidity along the entire tree (Benzing 1979, 2004, Rasmussen & Rasmussen 2018). Physical and chemical characteristics of the bark can also affect the presence of mycorrhizal fungi, probability of seed attachment, germination and/or establishment (Frei & Dodson 1972, Sáyago *et al*. 2013, Siaz-Torres *et al*. 2021). Bark traits that may affect the presence of epiphytes include rugosity (which might be affected by age), water storage capacity (that could be affected by bark rugosity), pH, and secondary metabolites (Adhikari & Fisher 2011, Frei 1973, Frei & Dodson 1972, Migenis & Ackerman 1993, Sáyago *et al*. 2013, Siaz-Torres *et al*. 2021, Timsina *et al*. 2016). Here we study an epiphytic orchid endemic to Puerto Rico, *Psychilis kraenzlinii* (Bello) Sauleda. The genus *Psychilis* is composed of 15 epiphytic species that are distributed among Hispaniola, Puerto Rico, the US and British Virgin Islands, and Northern Lesser Antilles (Ackerman & Collaborators 2014, Sauleda 1988). The genus is severely understudied, lacking conservation and management strategies for most species. The present study uses a population of *P. kraenzlinii* in the Susúa State Forest as a model to explore the relationship of orchids with their phorophytes (González-Orellana *et al.* 2022).

First, we asked if *P. kraenzlinii* shows phorophyte preferences and whether these preferences correspond to where germination occurs most frequently. Like the closely related species, *Psychilis monensis* Sauleda (Otero *et al.* 2007), *Psychilis krugii* (Bello) Sauleda (Ackerman *et al*. 1989), and *Psychilis truncata* (Cabrera-García *et al.* 2023), we expected *P. kraenzlinii* will not be host-specific and would instead show a preference for a subset of the available phorophyte species. Using different taxa as phorophytes could be advantageous for epiphytes as the epiphytic habitat is a stressful one and constantly changing (Benzing 1979, Trapnell & Hamrick 2006, Tremblay *et al.* 2006). We also hypothesized that seed germination would mirror phorophyte associations of established epiphytic orchids since one may assume that, like terrestrial orchids, the presence of an established orchid can be an indicator of suitable environmental conditions and OMF availability (Jacquemyn *et al.* 2007, McCormick *et al*. 2016, Petrolli *et al*. 2021).

Secondly, we explored other factors that may affect germination and establishment of *P. kraenzlinii* in the Susúa State Forest. We measured Water Storage Capacity (WSC) and bark roughness of phorophytes to determine whether these traits differed among phorophyte species and between trees with and without the orchid. Epiphytes are prone to be water stressed (Benzing 2004). Rough-barked trees are generally colonized more frequently by epiphytes (Callaway *et al.* 2002) perhaps due to better water retention capacity or because seeds more readily attach to them (Adhikari & Fisher 2011, Timsina *et al*. 2016). Consequently, we expected to find higher seed germination rates and more orchids on phorophytes with high roughness and water retention capacity.

Finally, we used the germination stages of seeds as a proxy for the presence of orchid mycorrhizal fungi (OMF) on phorophytes. Orchid seed imbibition must occur before mycorrhizal infection (Bidartondo 2005, Rasmussen 1995). Imbibition is indicated when the embryo swells and breaks the seed testa (Brandner 2005). Afterwards, fungal infection can occur, which leads to the uptake of nutrients by the plant making cell division and growth possible (Arditti 1992, Rasmussen 1995). Hence, we assumed that seeds that reached germination were infected by their OMF. If orchids and their OMF share similar niche requirements (Izuddin *et al*. 2019a, 2019b), then we expect that protocorm formation will be more likely on phorophyte species that have a higher occurrence of established orchids.

Materials and methods. *Study system—. Psychilis kraenzlinii* is a rewardless, self-incompatible epiphyte that produces long, erect peduncles topped by racemes of sequentially produced red-carmine flowers (Ackerman & Collaborators 2014). Populations flower and set fruit throughout the year, but studies done on the closely related species *P. krugii* and *P. monensis* (Ackerman *et al.* 1989, Aragón & Ackerman 2004, Otero *et al.* 2007) suggest that peak flowering occurs from April through July. *Psychilis kraenzlinii* resides in the limestone hills and margins of mangrove swamps on the north side of the island, and in tropical moist forest regions on the southern slopes of the Cordillera Central. Although it is widely distributed across the island of Puerto Rico, many populations are now believed to be extinct due to habitat destruction through anthropogenic activities such as deforestation, limestone mining and urbanization. Populations have also been severely affected by legal and illegal collection. There are no published ecological studies on this species, but it was classified as vulnerable by Miller *et al*. (2013).

Study site—. Susúa State Forest is a Natural Reserve under the jurisdiction of the Department of Natural and Environmental Resources of Puerto Rico. The forest occupies about 13 km^2 across the municipalities of Yauco and Sabana Grande (18°04'14.6" N 66°54'23.4" W), on the southwestern slope of the Cordillera Central (Departamento de Recursos Naturales y Ambientales 2015). This moist forest is characterized by serpentine and volcanic soils, and has 157 tree species, 16 of which are classified as rare or endangered. Average annual precipitation is 1413 mm and average temperature is 23.9°C. Before the establishment of the State Forest in 1935, the area was almost completely deforested for agriculture, wood products, and minerals (DRNA 2015). The combination of secondary growth and nutrient-poor ultramafic soils has resulted in a mostly evergreen forest comprised of slender trees averaging 12 m tall, with a light canopy (Miller & Lugo 2009).

Phorophyte Specificity Assessment—. The study site consisted of a single population in one area of the forest. To cover as much of the area as possible, we established four 15 × 5 m plots at approximately 5 m from each other. Trees and shrubs inside the plots were identified, DBH was measured, and we noted if they had *P. kraenzlinii*. All *P. kraenzlinii* plants inside plots were tagged. Given the small sample size, for the analysis we filtered the data and kept only the tree species that had a frequency higher than 3%. We applied a Fisher's Exact Test to see if there was a relationship between each tree species and the presence of the orchid.

Phorophyte Physical Characteristics—. The two physical characteristics of the bark that we considered were Water Storage Capacity (WSC) and Fissuring Index (FI), both of which influenced orchid host tree preferences in Mexico (Zarate-García *et al*. 2020). The tree species from which we collected bark data were chosen based on the Phorophyte Specificity Assessment described previously to create a gradient from positive to negative relationship as follows: *Machaonia portoricensis* Baill. (Rubiaceae)*, Phyllanthus cuneifolius* (Britton) Croizat (Phyllanthaceae)*, Ouratea littoralis* Urb. (Ochnaceae), *Rondeletia inermis* (Spreng.) Krug & Urb. (Rubiaceae), *Tabebuia haemantha* (Bertol. Ex Spreng.) DC. (Bignoniaceae), *Swietenia mahagoni* (L.) Jacq. (Meliaceae) and *Coccoloba microstachya* Willd*.* (Polygonaceae). Because most orchids grew attached to phorophytes at a height below 0.75 m, we collected bark samples no higher than that. When possible, half the samples were collected near the roots of adult orchids, and half from trees where the orchid was absent.

Water Storage Capacity Assessment (WSC)—. To measure WSC we adapted the methodologies described by Callaway *et al*. (2002) and Zarate-García *et al.* (2020). In the laboratory, samples were cut to approximately 1 cm^2 and dried in an oven at 40°C. Drying time fluctuated between 24 h and 72 h for each species, since bark rugosity and thickness of the bark varies among species. After drying, samples were weighed to obtain *dry mass* and their length, width, and thickness was measured with a caliper to calculate volume. We then submerged the samples in water treated with Triton X-100 for 30 min, allowed to drip for a minute and weighed to obtain *wet mass*. Finally, they were left to air dry for 24 h, after which they were weighed again to obtain *held mass*. Water Holding Capacity (WHC) and Water Retention Capacity (WRC) were calculated per volume of the sample as defined by Callaway *et al*. (2002):

$$WHC = \frac{wet\ mass\ (g) - dry\ mass\ (g)}{volume\ (mm^3)}$$

$$WRC = \frac{held\ mass\ (g) - dry\ mass(g)}{volume\ (mm^3)}$$

Where WHC refers to how much water adheres to the bark immediately after it becomes wet (cohesion), while WRC refers to how much water adheres and remains within the bark after 24h of becoming wet.

We collected 187 samples of bark from which 74 were from trees with *P. kraenzlinii*. Samples from *S. mahagoni* were collected only from trees without the orchid because it rarely served as a host to *P. kraenzlinii* in our study site. The number of samples per species is described in Appendix 1. We applied a Kruskal-Wallis Test to determine if WSC was different among species, and a Mann-Whitney U to evaluate if differences in indices between trees with and without *P. kraenzlinii* where significantly different. If significant differences were found, then a Conover-Iman Pair-Wise Comparison was applied to detect which species had a significant effect. Intraspecific differences between trees with and without *P. kraenzlinii* could only be evaluated by removing *S. mahagoni*, since no data for trees with the orchid was surveyed. The following trees species were excluded when evaluating the effect of WRC because no differences was observed between trees with and without orchids and all values were 0.0 g/mm^3 (*M. portoricensis*, *R. aculeata*, and *R. inermis*).

Fissuring Index Assessment—. We used two methods for preparing bark to calculate a Fissuring Index (FI). In the first method, the bark samples were dried and cleaned carefully with alcohol (Zarate-Gracía *et al.* 2020). The second procedure was to use untreated, fresh bark samples. To test which was the better method, we took 3 samples from 3 trees of 3 species growing on campus of University of Puerto Rico, Río Piedras. We selected flaky bark from *S. mahagoni*, smooth bark from *Ficus macrocarpa* L.f. (Moraceae), and rough bark from *Tabebuia heterophylla* (DC.) Britton (Bignoniaceae). All samples were photographed, and photos were cropped to cover 1 cm^2. Photos were uploaded into R where they were transformed into gray scale and then into binary (black and white) images using the package *imager* v.45.2 (Barthelme *et al*. 2023). We counted the number of black (fissured bark) and white (non-fissured bark) pixels, and with these data calculated the fissuring index of Zarate-García *et al*. (2020):

$$FI = \frac{\text{white pixels}}{\text{black pixels}} = \frac{\text{nonfissured bark}}{\text{fissured bark}}$$

We compared the FI measured by each method using a Mann-Whitney U Test that revealed no significant difference ($p > 0.05$) between the two methodologies. Since there was no significant difference, we decided to use fresh samples for the *P. kraenzlinii* work. The fissuring index is a measure of the texture of the surface of the bark (fissures, bumps, and irregularities) (See Zarate-García *et al*. 2020). The higher the fissuring index, the less rough or irregular the surface of the bark.

We collected 194 samples of bark of which 83 were from trees with *P. kraenzlinii*. The number of samples per species is described in Appendix 2. Samples from *R. aculeata* and *S. mahagoni* were only from trees without the orchid, since finding the orchid growing on these species was rare. A Kruskal-Wallis Test was applied to see if FI was different among species. If a significant difference was found, a Conover-Iman Pair-Wise Comparison was applied to know which species had a significant effect. Mann-Whitney U test was used to detect significant differences between trees with and without the orchid, both in general and within each species of phorophytes.

In situ *seed germination*—. Seed packets were built by sewing 3 × 5 cm nylon plankton netting fabric with mesh size 45 µ (an adaptation of Zi *et al.* 2014). A sample of the seeds from each fruit was tested for viability with tetrazolium chloride (TTC). Once viability was confirmed, 200–230 seeds were placed inside packets which were then secured to tree bark with gutter mesh (Khamchatra *et al.* 2016). On each of six phorophyte species selected, we placed one packet on 20 trees, and on *Coccoloba microstachya* and *Machaonia portoricensis*, we placed one packet on 30 trees in May and June 2021. After 7 months we collected the packets and examined them under a dissecting microscope in the laboratory. We then created a developmental stage classification system for *P. kraenzlinii* based on Stenberg & Kaine (1998) and Brandner (2005) (Table 1).

We recovered 174 seed packets from the forest of which 51 were on trees with *P. kraenzlinii*. (The imbalance between numbers of trees with and without *P. kraenzlinii* in *C. microstachya*, *R. aculeata*, *R. inermis* and *S. mahagoni* is because *P. kraenzlinii* rarely grew on them.) Packets on *C. microstachya* and *R. aculeata* were only placed on trees without the orchid. Only 6 packets were placed on trees with the orchid on *R. inermis,* and only 2 packets were placed on trees with the orchid on *S. mahagoni* (Appendix 3).

We investigated the influence of the presence of *P. kraenzlinii* and/or the phorophyte species on the number of packets with developing seeds by applying a Generalized Linear Model (GLM) with a binomial distribution. Odds ratios were calculated to measure the association between the presence of the orchid or the species of phorophyte and the number of packets with developing seeds. Odds ratio is used to measure the strength of an association between an observation and an outcome, where an odds ratio equal to 1 suggests no association, odds ratio greater than 1 suggests positive association, and odds ratio less than 1 suggests a negative association (see Szumilas 2010). To detect an association between the presence of *P. kraenzlinii* and orchid developing seeds, we excluded data from *R. aculeata* and *C. microstachya* because no trees with the orchid were available to place packets for comparisons. Packets placed on *R. inermis* were removed from all analyses related to embryo development because there was no development on *R. inermis*.

To analyze the influence of the presence of *P. kraenzlinii* and/or the phorophyte species on the percentage of developing seeds, we applied a Generalized Linear Model (GLM) using a nonbinomial distribution. Odds ratios were calculated to measure the association between the presence of the orchid or the species of the phorophyte and the percentage of developing seeds (Szumilas 2010). Then we asked whether some phorophyte species had a higher percentage of seeds at each developmental stage and used a Kruskal-Wallis test for each germination stage among the different phorophyte species, and a Mann-Whitney test to compare trees with and without an established *P. kraenzlinii*. If a difference was detected when using the Kruskal-Wallis, then a Conover-Iman test was applied to identify which species were significantly different. This would suggest that some tree species were a better substrate for seeds to develop than others. Finally, we explored if the presence of *P. kraenzlinii* or the species of the phorophyte could predict the presence of OMF by using the germination stages as a proxy for the presence of OMF on a GLM with binomial distribution. Odds ratio for the association between the presence of *P. kraenzlinii* or the phorophyte species and the presence of the OMF were calculated (Szumilas 2010).

Table 1. Description of embryo development stages of *Psychilis kraenzlinii* grown in situ developed by the authors based on Stenberg & Kaine (1998) and Brandner (2005). Stages 1 and 2 are early development, whereas Stages 3 and 4 are considered the first germination stages, since the protocorm is formed.

Stage	**Description**
Stage 1	Seed has imbibed, embryo has swollen and become green, still covered by testa.
Stage 2	The embryo has grown to the point of breaking testa.
Stage 3	Testa is almost or entirely gone, protocorm is formed with a pointed shoot apex.
Stage 4	Disc-like or elongated protocorm.

Results.

Phorophyte Utilization Assessment—.<u>Size of the trees</u>: The plots had 568 trees belonging to at least 27 species. Most trees in our plots had a DBH less than 3.0 cm ($\bar{x}$ = 2.5 cm, $Q_{0.25}$= 1.3 cm, $Q_{0.5}$ = 1.9 cm, $Q_{0.75}$ = 2.9 cm), and trees with *P. kraenzlinii* growing on them had a larger mean ($\bar{x}$ = 2.7 cm) than the median ($Q_{0.5}$ = 2.0 cm). We tagged 117 *P. kraenzlinii* growing on 13 (48%) tree species (Table 2). Most orchids grew less than 0.75 m above ground ($\bar{x}$ = 0.42 m, $Q_{0.25}$= 0.22 m, $Q_{0.5}$ = 0.36 m, $Q_{0.75}$ = 0.58 m).

<u>Phorophyte and orchid association</u>: There was a significant association between the presence of *Psychilis kraenzlinii* and the species of tree (Fisher Exact Test, $p < 0.01$, *Monte Carlo Simulation* = 2000). A Fisher's pairwise comparison of pooled plot data revealed significant differences between *Machaonia portoricensis* and *Coccoloba microstachya* ($p < 0.005$, Fig. 1), where the former has a higher number of orchids than the latter. There were more orchids growing on *M. portoricensis* than expected if the presence of the orchid among phorophyte species was random. Conversely, there were fewer orchids growing on *C. microstachya* than expected.

Water Storage Capacity—. <u>Water Holding Capacity</u>: We found WHC to be significantly different among phorophyte species (WHC, Kruskal-Wallis test: X^2 = 82.62, df = 7, $p < 0.005$,), but not between trees with or without the orchid (Mann-Whitney: U = 4074.5, p = 0.77). The Conover-Iman Pairwise test for the WHC (Appendix 4) showed that *M. portoricensis* has

TABLE 2. Distribution of established *Psychilis kraenzlinii* among phorophytes surveyed in 30 m.

Family	Species	Number of Trees	Number of *P. kraenzlinii*	Number of Trees Occupied	Percent of Trees Occupied
Primulaceae	*Bonellia umbellata*	2	4	2	100
Rubiaceae	*Machaonia portoricensis*	20	10	7	35
Rubiaceae	*Rondeletia inermis*	14	3	3	21
Phyllanthaceae	*Phyllanthus cuneifolius*	35	12	7	20
Rubiaceae	*Guettarda scabra*	112	36	21	19
	Dead tree	26	7	5	19
Ochnaceae	*Ouratea littoralis*	28	7	5	18
	Unidentified tree	12	2	2	17
Anacardiaceae	*Comocladia dodonaea*	8	2	1	13
Malpighiaceae	*Byrsonima lucida*	24	5	3	13
Myrtaceae	*Myrcia citrifolia*	25	3	3	12
Bignoniaceae	*Tabebuia haemantha*	133	19	13	10
Myrtaceae	*Pimenta racemosa*	13	2	1	8
Meliaceae	*Swietenia mahagoni*	12	1	1	8
Polygonaceae	*Coccoloba microstachya*	65	4	3	5
Apocynaceae	*Plumeria krugii*	1	0	0	0
Asteraceae	*Lepidaploa sericea*	1	0	0	0
Boraginaceae	*Varronia lima*	2	0	0	0
Celastraceae	*Gyminda latifolia*	2	0	0	0
Ehretiaceae	*Bourreria succulenta*	1	0	0	0
Ehretiaceae	*Bourreria virgata*	1	0	0	0
Fabaceae	*Poitea punicea*	5	0	0	0
Malpighiaceae	*Stigmaphyllon floribundum*	5	0	0	0
Polygalaceae	*Badiera penaea*	1	0	0	0
Primulaceae	*Ardisia elliptica*	3	0	0	0
Rubiaceae	*Randia aculeata*	10	0	0	0
Schoepfiaceae	*Schoepfia obovata*	1	0	0	0
Solanaceae	*Cestrum citrifolium*	4	0	0	0
Theaceae	*Ternstroemia stahlii*	1	0	0	0

the highest WHC, being significantly different from all species except *R. inermis*. The lowest WHC is that of *O. littoralis*, which was significantly different from all species but *S. mahagoni*. Among trees occupied by *P. kraenzlinii*, *T. haemantha* had a significantly higher WHC, whereas *Coccoloba microstachya* and *M. portoricensis* had a significantly lower WHC (Appendix 5).

Water Retention Capacity: We discovered differences in WRC among phorophyte species (Kruskal-Wallis test: $X^2 = 43.22$, df = 7, $p < 0.005$), but not between trees with or without the orchid (Mann-Whitney: $U = 4560.5$, $p = 0.22$). The Conover-Iman Pairwise Comparison test for WRC (Appendix 4) showed that the highest WRC was that of *S. mahagoni*, and it was significantly different from all other species. *Randia*

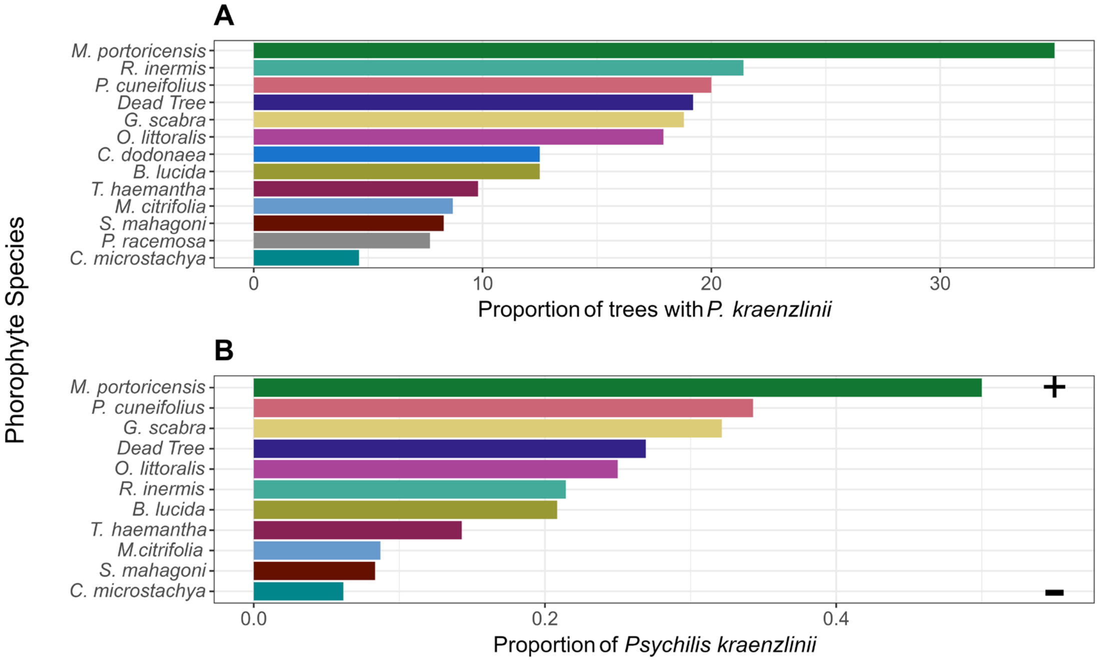


FIGURE 1. **A**. Proportion of trees of each phorophyte species harboring *Psychilis kraenzlinii* (unidentified phorophytes not included). **B**. Average number of *P. kraenzlinii* growing on the most common phorophyte species (Plus sign (+) marks a positive and significant association, whereas minus sign (-) marks a negative significant association. Associations based on residuals from Fisher Exact Test with Monte Carlo Simulation ($p < 0.05$, simulations = 2000).

aculeata, *R. inermis* and *M. portoricensis* have WRC of <0.01 g/mm^3 which was significantly lower than *S. mahagoni*, *T. haemantha*, and *O. littoralis*. *Phyllanthus cuneifolius* has a WRC significantly higher than *M. portoricensis* and *R. inermis*, and although higher than *R. aculeata*, this last difference is not significant. When comparing trees of each species with and without the orchid, we also found no statistically significant differences (Appendix 5).

Fissuring Index Assessment—. Phorophyte species differed significantly in FI (Kruskal-Wallis: X^2 = 15.07, df = 7, p = 0.04). *Phyllanthus cuneifolius* had the higher FI, but the difference was only significant when compared to *C. microstachya, O. littoralis*, *R. inermis*, or *T. haemantha*. We found that *P. cuneifolius* and *R. inermis* had the greatest variation in FI among species, but in general *P. cuneifolius* had a higher FI while *R. inermis* had the lowest (Appendix 4, Fig. 2A). We observed that 3 out of the top 4 species with higher fissuring index also had high WHC, while 3 out of the 4 species with lower FI had higher WRC.

Significant differences exist in the fissuring index between trees with and without the orchid (Mann-Whitney: U = 5.29, df = 1, p = 0.02). Trees with *P. kraenzlinii* had a significantly lower FI. When evaluating this relationship for each species, the trend repeated within most, but it was only significant for *M. portoricensis* (Mann-Whitney: U = 208, $p < 0.005$, Fig. 2B).

In situ *seed germinations*—. Of the 174 recovered packets, only 37 (21%) contained developing seeds. Of the 37 packets with developing seeds, 20 (54%) were near an established *P. kraenzlinii*. Of the 118 packets without developing seeds, 90 (76%) were on trees without an established orchid. A chi-square revealed that the number of packets with developing seeds near an established orchid is not significantly higher than if an established orchid was not present (X^2 = 0.24, df = 1, p = 0.62). The best model to explain the number

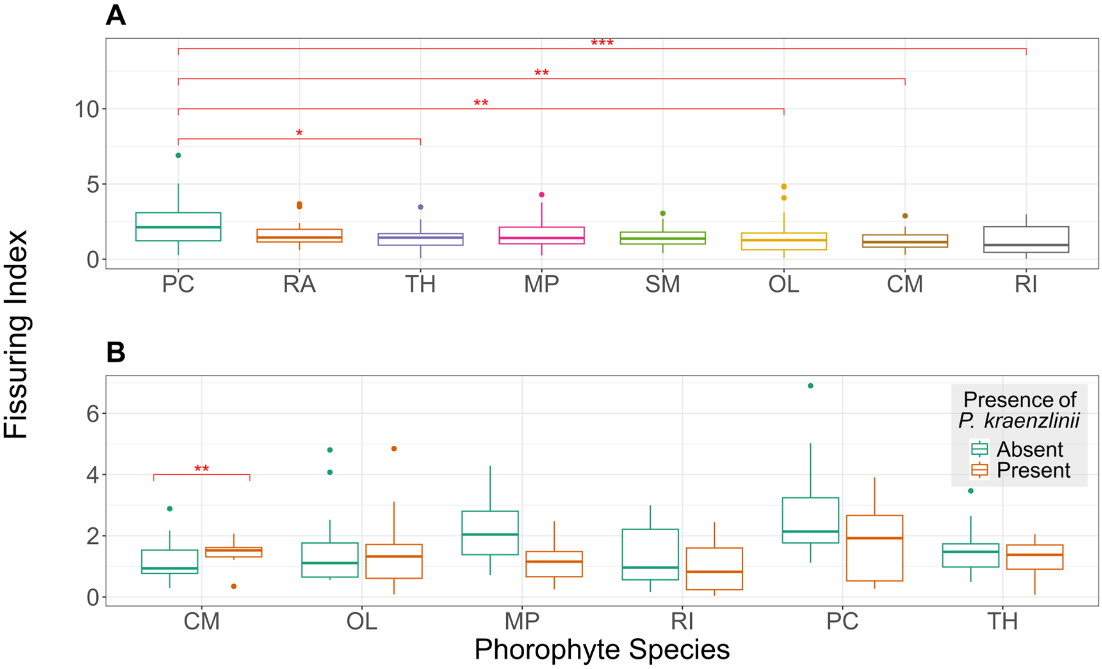


Figure 2. **A**. Box plots of fissuring index of the bark among phorophyte species. **B**. Box plots of the fissuring index of the bark of trees with and without *Psychilis kraenzlinii* among phorophyte species. *Randia aculeata* and *Swietenia mahagoni* not shown because data of trees with a *P. kraenzlinii* was not available. Red brackets with asterisks mark significant differences where: * = $p \leq 0.05$; **= $p \leq 0.01$; ***= $p \leq 0.001$.

of packets with and without developing seeds was a binomial one where *C. microstachya* was placed as the intercept (Model A in Table 3). The odds of a packet with developing seeds were higher near an established orchid (OR = 1.4) and if it was located on *T. haemantha* (OR = 2.2) or *M. portoricensis* (OR = 1.9, Model A in Table 4, Fig. 3).

We observed 228 developing seeds among all packets, 121 of which were in packets near a *P. kraenzlinii*. The proportion of developing seeds per packet near an established orchid was significantly higher than that of packets in trees without the orchid (Mann-Whitney test, U = 2049.5, p = 0.02). The development stage of the seeds was evaluated according to our classification scheme (Table 1). We found 85 (40%) seeds in Stage 1, 76 (35%) in Stage 2, 35 (16%) in Stage 3, and 7 (3%) in Stage 4. No germination was noted from packets on *R. inermis*. The distribution of developing seeds in different stages among phorophytes is shown in Figure 4.

The best model to explain the percentage of developing seeds was a negative binomial GLM with the phorophyte species as predictor variable (Model B in Table 3). The presence of an established *P. kraenzlinii* did not have a significant effect on the percentage of such seeds. Among all phorophytes, *M. portoricensis* is the only species with a significant and positive effect on the percentage of developing seeds, while *C. microstachya* is the intercept with a significant and negative effect. The odds of *P. kraenzlinii* developing on *C. microstachya* are near zero, while the odds for developing on *M. portoricensis* are 5.22. Other species with high odds of *P. kraenzlinii* seeds developing are *S. mahagoni* (OR = 4.18), *T. haemantha* (OR = 3.76), and *P. cuneifolius* (OR = 3.10, Model B in Table 4).

When comparing the percentage of seeds in each germination development stage among phorophytes, *O. littoralis, C. microstachya* and *R. aculeata* had significantly more seeds that did not develop (stage 0) than *T. haemantha; O. littoralis* and *R. aculeata* also had more seeds in stage 0 than *P. cuneifolius* (Conover-Iman: $p < 0.05$) (Appendix 6). Conversely, *T. haemantha* had significantly more seeds that went through imbibition

Table 3. Factors associated with the effect of phorophyte species on seed germination. Analyses are based on coefficients generated by Generalized Linear Models. **Model A**: Negative Binomial Model for the effect of phorophyte species and the presence of an established *Psychilis kraenzlinii* on the number of packets with germinated seeds. **Model B**: Negative Binomial Model for the effect of phorophyte species on the percent developing seeds. **Model C**: Effect of phorophyte species and presence of established *Psychilis kraenzlinii* over the presence of Orchid Mycorrhizal Fungi (OMF) when using embryo development stages as a proxy for OMF presence. SE = Std. Error.

Phorophyte Species	**Model A**				**Model B**				**Model C**			
	Estimate	**SE**	***z***	***p***	**Estimate**	**SE**	***z***	***p***	**Estimate**	**SE**	***z***	***p***
Intercept *(Coccoloba microstachya)*	-1.65	0.49	-3.38	**<0.01***	-1.49	0.61	-2.43	**0.02***	-3.43	1.02	-3.38	**<0.01***
Machaonia portoricensis	0.63	0.68	0.92	0.36	1.65	0.81	2.03	**0.04***	-0.56	1.6	-0.35	0.73
Ouratea littoralis	-1.82	1.19	-1.53	0.13	0.28	0.95	0.3	0.76	-0.22	1.43	-0.16	0.88
Randia aculeata	-0.43	0.9	-0.48	0.63	0.21	0.99	0.21	0.83	0.54	1.44	0.38	0.71
Phyllanthus cuneifolius	0.56	0.74	0.76	0.45	1.13	0.9	1.26	0.21	1.31	1.23	1.07	0.29
Swietenia mahagoni	0.28	0.76	0.37	0.72	1.43	0.91	1.57	0.12	-0.62	1.45	0.04	0.97
Tabebuia haemantha	0.78	0.72	1.08	0.28	1.33	0.89	1.49	0.14	0.06	1.45	0.04	0.97
P. kraenzlinii Present	0.88	0.48	1.83	0.07	NA	NA	NA	NA	1.55	0.86	1.79	0.07
	Null deviance: 170.37 on 154 df				Null deviance: 80.77 on 154 df				Null deviance: 80.96 on 165 df			
	Residual deviance: 152.9 on 147 df				Residual deviance: 152.9 on 147 df				Residual deviance: 74.5 on 158 df			

(stage 1) than *C. microstachya*, *O. littoralis*, and *R. aculeata* (Conover-Iman: $p < 0.05$) (Appendix 6). *Tabebuia haemantha* and *P. cuneifolius* had significantly more seeds whose embryo swelled to the point of breaking the testa (stage 2) than *C. microstachya and O. littoralis*; *T. haemantha* also had more seeds in stage 2 than *M. portoricensis*, and *P. cuneifolius* had more than *R. aculeata* (Conover-Iman: $p < 0.05$, Appendix 6). There was no difference in the occurrence of stage 3 (Kruskal-Wallis: $X^2 = 4.16$, df = 6, p = 0.66) and 4 (Kruskal-Wallis: $X^2 = 8.36$, df = 6, p = 0.21) among phorophytes. Trees with an established orchid had significantly fewer non-germinated seeds (Mann-Whitney: U = 2997.5, $p < 0.005$), and significantly more seeds in stage 1 (Mann-Whitney: U = 2048.5, p = 0.006), stage 2 (Mann-Whitney: U = 1891.5, $p < 0.005$), and stage 3 (Mann-Whitney: U = 2228.5, p = 0.04). There was no difference in the percentage of seeds on stage 4 between trees with and without an established *P. kraenzlinii.*

The best model to predict if the OMF was present or not was a GLM with binomial distribution that had both the phorophyte species and the presence of an established orchid as predictor variables. *Coccoloba microstachya* had a significant and negative effect over the presence of the OMF (Model C in Table 3). The OMF was 4.7 (OR) times more likely to be found near an established *P. kraenzlinii* and 3.7 (OR) times more likely to be found on *S. mahagoni*, irrelevant of whether there was an established orchid or not, according to the odds ratio (Model C in Table 4).

Discussion. We evaluated the phorophyte preferences in a population of *Psychilis kraenzlinii* and found that they are not randomly distributed among the available tree species in our study population. Furthermore, the best phorophytes for germination are not necessarily the same as those for adults. The best phorophytes for *P. kraenzlinii* are either rare or endemic species. None-

TABLE 4. Association among phorophyte species, presence of adult *Psychilis kraenzlinii*, and germination success based on Odds Ratios (OR) calculated for each Generalized Linear Model with 95% Confidence Intervals (CI). **Model A**: Negative Binomial Model for the effect of phorophyte species and the presence of an established *Psychilis kraenzlinii* on the number of packets with germinated seeds. **Model B**: Negative Binomial Model for the effect of phorophyte species on the percent developing seeds. **Model C**: effect of phorophyte species and presence of established *Psychilis kraenzlinii* over the presence of Orchid Mycorrhizal Fungi (OMF) when using embryo development stages as a proxy for OMF presence.

Phorophyte Species	**Model A**			**Model B**			**Model C**		
	OR	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**	
Intercept (*Coccoloba microstachya*)	0.19	0.07	0.46	0.23	0.07	0.82	0.03	0	0.15
Machaonia portoricensis	1.87	0.50	7.50	5.22	1.05	27.44	0.80	0.05	21.54
Ouratea littoralis	0.16	0.01	1.24	1.33	0.21	9.43	0.57	0.02	21.54
Randia aculeata	0.65	0.09	3.42	1.23	0.18	9.57	1.72	0.07	45.36
Phyllanthus cuneifolius	1.75	0.41	7.69	3.10	0.55	20.38	0.54	0.02	17.32
Swietenia mahagoni	1.32	0.28	5.87	4.18	0.73	29.24	3.70	0.39	80.85
Tabebuia haemantha	2.19	0.53	9.47	3.76	0.68	24.48	1.06	0.06	29.2
P. kraenzlinii Present	2.41	0.95	6.30	NA	NA	NA	4.70	0.97	31.63

theless, the population is healthy and with recruitment, which underscores the importance of continued protection of the forest.

Phorophyte Specificity Assessment—. Migenis & Ackerman (1993) suggested that host preference rather than specificity is common in Puerto Rico and the Neotropics. As for closely related species *P. monensis* and *P. krugii* of Puerto Rico (Ackerman *et al*. 1989, Otero *et al*. 2007), and *P. truncata* in the Dominican Republic (Cabrera-García *et al*. 2023), *P. kraenzlinii* only grows on a subset of available phorophytes. While it shows highest preference for *Machaonia portoricensis, Coccoloba microstachya* is the least preferred phorophyte given the abundance of this tree species in the study area. Contrastingly, Otero *et al.* (2007) found that *C. microstachya* is a common phorophyte of *P. monensis* on Mona Island, Puerto Rico. Sanford (1974) suggested that the different usage of phorophytes by an orchid species in different geographical areas was indicative of the importance of the whole habitat instead of only a few factors such as phorophyte species and their characteristics. Thus, the ability of an epiphyte to germinate and develop on a certain tree species, not only depends on climate, habitat, forest structure and characteristics of phorophytes, but also on microsite conditions such as temperature, humidity, microbial symbionts, etc. Otero *et al.* (2007) noted that the relationship of *P. monensis* with its phorophyte species is site-dependent and they suggested this was due to water relations. Data for phorophyte usage of *P. kraenzlinii* in other regions of Puerto Rico are not available, but phorophyte preferences of this species, like that of other epiphytes, might change according to environmental stressors (Sanford 1974, Timsina *et al*. 2016).

Phorophyte Physical Characteristics—.Variation in WHC and WRC between trees with and without the orchid irrespective of their species, was not significant. However, we found that *Machaonia portoricensis*, the most preferred phorophyte species, has the highest WHC, but no WRC. Other species on which the orchid was commonly found, *Phyllanthus cuneifolius* and *Rondeletia inermis*, also had a high WHC and no WRC. Conversely, *C. microstachya*, the least preferred phorophyte species, has the second lowest WHC, and a higher WRC. Intermediate conditions do exist. *Psychilis kraenzlinii* is frequently found on *Ouratea littoralis*, but unlike other preferred phorophytes (*M. portoricensis*, *P. cuneifolius*, *R. inermis*), *it* has the second lowest WHC and an intermediate WRC. Nonetheless, in general, preferred phorophytes tend to have high WHC and low WRC. We hypothesize that when it rains, the preferred phorophytes have the capacity to hold more water, giving the opportunity for seeds to go through the imbibition process rapidly. Then,

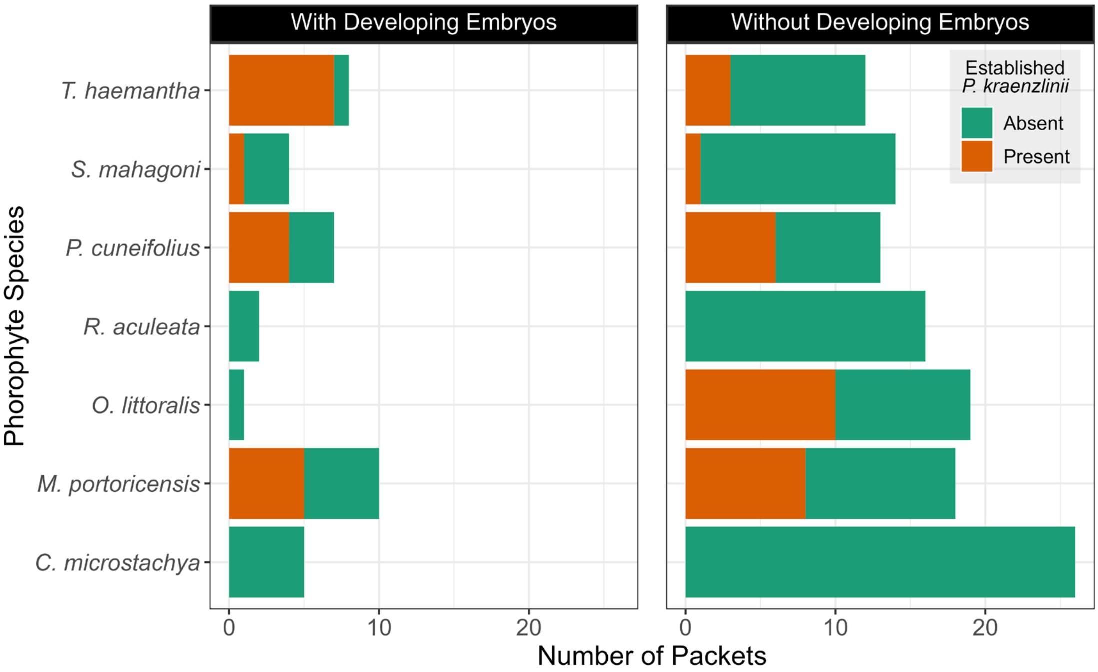


Figure 3. The number of packets with and without developing seeds on each phorophyte species and whether they were placed near an established *Psychilis kraenzlinii* or not.

these phorophytes quickly lose water (low WRC), preventing seeds from becoming waterlogged. As the imbibition process must occur before the infection of the OMF (Rasmussen, 1995), preferred phorophytes with high WHC promote rapid imbibition, resulting in ready-to-infect seeds faster than those phorophytes that have low WHC. Seeds growing on phorophytes with low WHC, but high WRC, might take longer to go through the imbibition process and become infected by their OMF, resulting in longer exposure to adverse environmental conditions, pathogens, or grazers. Although *O. littoralis* seems to share characteristics with the less common phorophytes, it has the lowest WHC. The fact that the orchid is commonly found growing on this species might be explained by the low WHC preventing the seeds from waterlogging, and its high WRC giving the seeds time to go through the imbibition process without desiccating. Wagner *et al.* (2015) mention that a low WRC might be suitable for epiphytes on a mesic habitat. Hence, in the moist forest of Susúa, low WRC might render smooth barked species good phorophytes for *P. kraenzlinii*, since water relations may be balanced.

Bark roughness may be associated with water storage capacity (Migenis & Ackerman 1993, Otero *et al.* 2007, Zarate-García *et al.* 2020). We observed a trend where species with higher WHC had lower FI (smoother bark), while those species with higher WRC had higher FI (rougher bark). Nonetheless, this association could not be statistically tested with our data. Bark roughness may also help seeds attach to the trunk of trees (Callaway *et al*. 2002, Siaz-Torres *et al*. 2020). Hence, it might explain why those phorophytes with low WHC, but high WRC, like *O. littoralis*, still harbor the orchid. Their roughness promotes attachment, and the crevices might serve as protection to give time for seeds to develop under a low but time-continuous water supplement. This hypothesis is supported by the fact that irrespective of the phorophyte species, trees on which *P. kraenzlinii* was growing had significantly rougher bark (lower FI) than those trees lacking the orchid. Furthermore, intraspecific differences in FI between trees with and without the orchid was only significant in *M. portoricensis*, where more orchids were growing on trees with rougher bark (lower FI). This relationship is also present as a non-significant

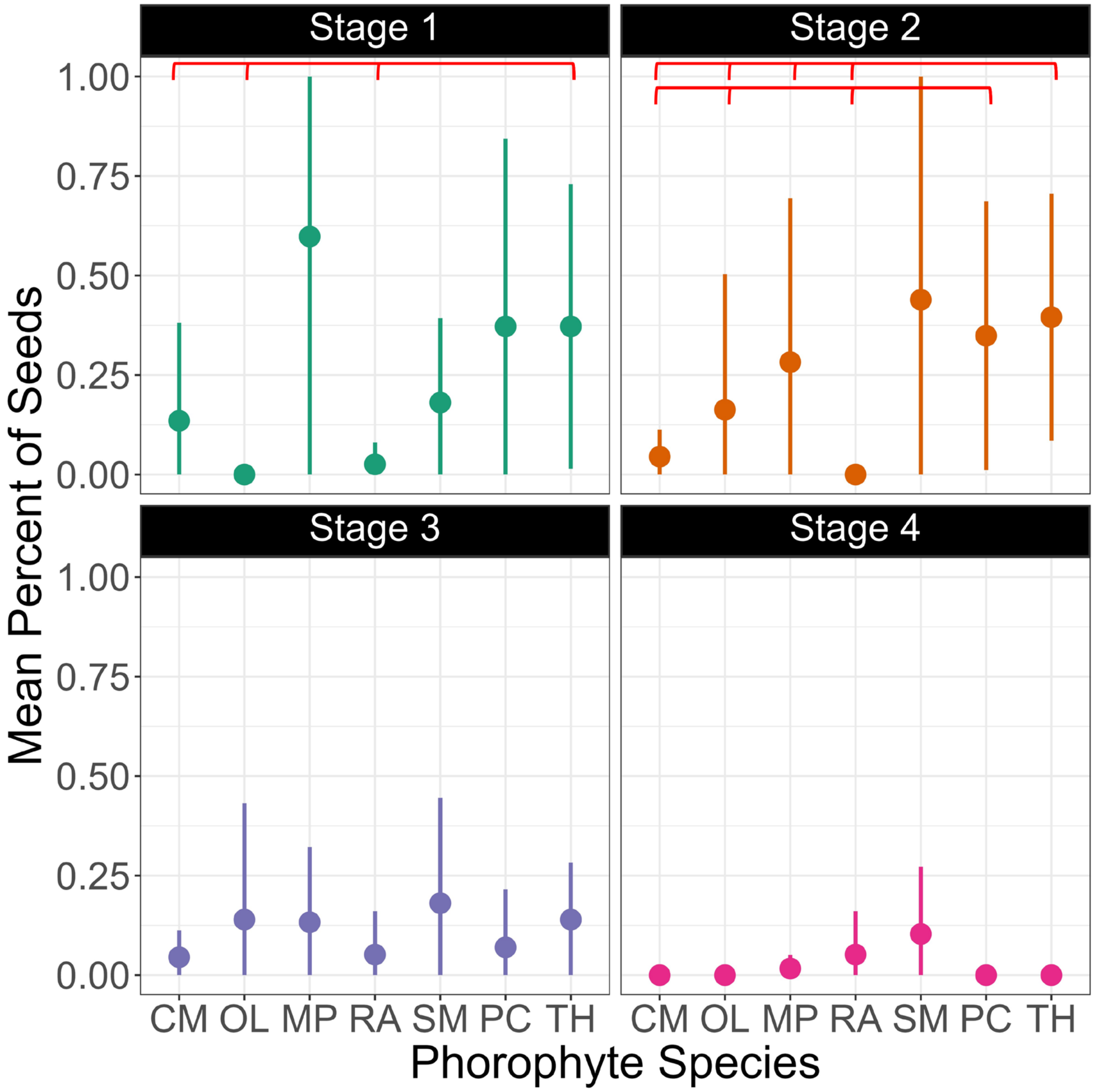


FIGURE 4. Mean percent of developing seeds per packet and their development stage on phorophytes with and without an established *Psychilis kraenzlinii*. Where Stage 1 refers to seeds with swollen embryos, Stage 2 are seeds whose embryo have swelled to the point of breaking the testa, Stage 3 the testa is gone and the protocorm is formed, and Stage 4 the protocorm has elongated. For *Ouratea littoralis*, no seeds developed near an established *P. kraenzlinii*, whereas in the case of *Coccoloba microstachya* and *Randia aculeata*, no packets were placed near and established orchid. Red lines indicate significant differences according to Conover-Iman Pairwise Comparisons (p<0.05).

trend among species with smoother bark (*R. inermis* and *P. cuneifolius)*. *Rondeletia inermis* superficially appears to have smooth bark, but microscopically the bark appears rough with numerous crevices. Nonetheless, *R. inermis* behaves as a smooth bark species (high WHC, no WRC) because its bark is thin, unlike other rough-barked species (*T. haemantha, O. littoralis, C. microstachya* and *S. mahagoni*) which all have thick spongy bark. The hypothesis that *P. kraenzlinii* prefers phorophytes with rough bark and high WRC is not supported. It appears that the contrary is true.

In fact, most *P. kraenzlinii* were found growing at the base of the tree—no higher than 0.75 m from the ground—where humidity is higher and light exposure

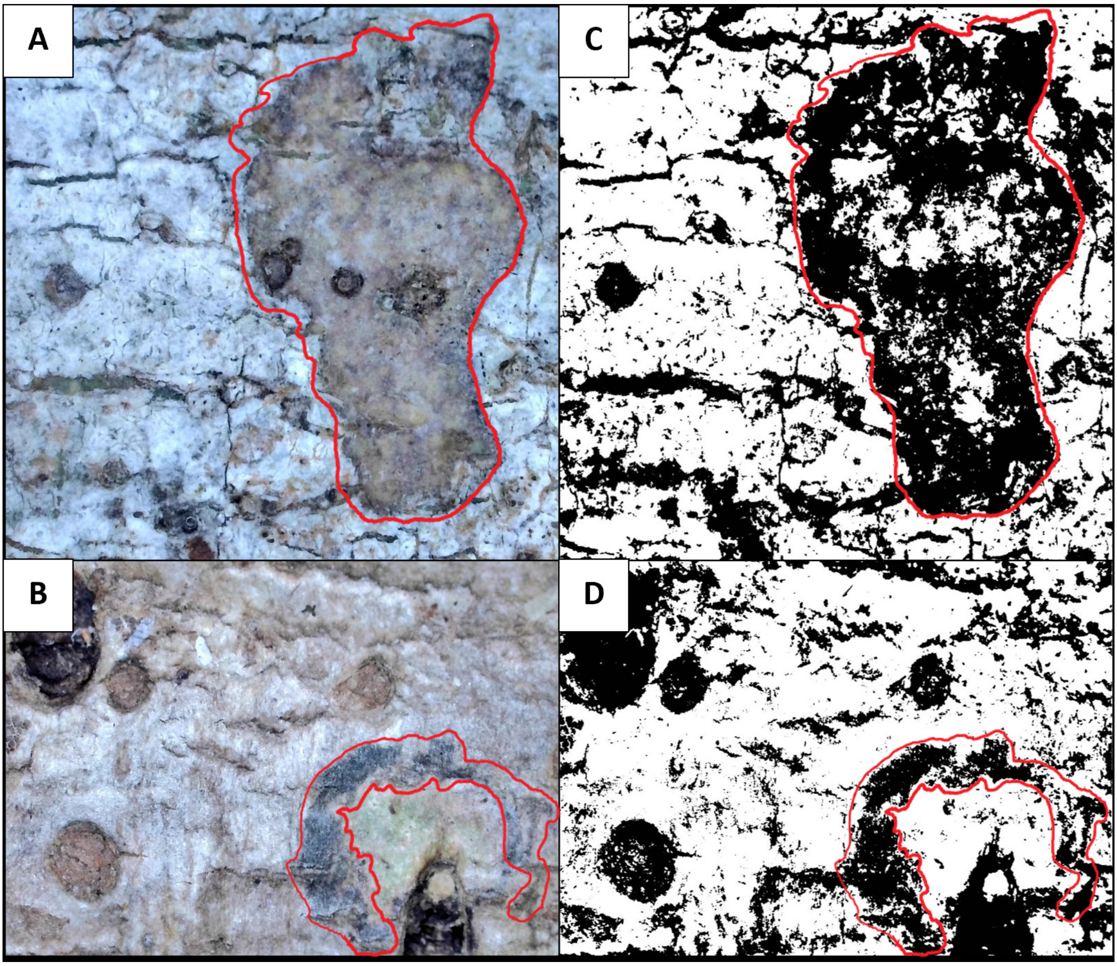


FIGURE 5. Effect of bark pigmentation on the fissuring index. **A**. Pictures of the bark surface of *Coccoloba microstachya* taken with a camera coupled to a dissecting microscope and a ring light. **B**. Pictures of the bark surface of *Phyllanthus cuneifolius* taken with a camera coupled to a dissecting microscope and a ring light. **C**. Photos converted to black and white (binary) images of *C. microstachya*. **D**. Photos converted to black and white (binary) images of *P. cuneifolius*. Enclosed in red is the area where roughness interpretation could be affected by bark pigmentation. Photos by N. González-Orellana.

is lower Petter *et al.* (2016), likely meaning more water availability. Phorophyte preferences of two dry-forest *Psychilis* species have also been studied using subjective assessments of bark roughness. Ackerman *et al.* (1989) found no preference for rough-barked species by *P. krugii* in Guánica, Puerto Rico, and Otero *et al.* (2007) discovered that *P. monensis* on Mona Island was very common on rough-barked *Phyllanthus epiphyllanthus,* but when they eliminated that phorophyte from their analysis they found no preference for other rough-barked phorophyte species.

Since trees tend to have different pigmentation patterns on their bark, the FI results must be interpreted cautiously. The bark of tree species we studied is not uniformly colored, which may affect the FI results (Fig. 5). Sections of the bark with dark colors such as green and brown could be interpreted by the algorithm as roughness, while light pigmentation like white and pink could be interpreted as smoothness. While we do not yet know whether this is a problem, staining the bark surface to cover such pigmentation may be advisable.

Psychilis kraenzlinii prefers trees with smoother bark (high FI), high WHC and a low WRC. Conversely, Zarate-García *et al*. (2020) found no clear correlation between FI of phorophytes and the presence of orchids. Furthermore, they did find phorophyte preference was inversely correlated with WHC, while positively correlated with WRC. Bark roughness preferences might be influenced by microsite conditions such as radiation exposure, humidity, and seasonality as well as by the method of attachment used in each stage of the life history of an epiphytic species (Tay *et al.* 2023). The study sites in Zarate-García *et al*. (2020), were low coastal forests in the Yucatan Peninsula, Mexico, where mean annual temperature is higher and mean annual rainfall is lower than our study site in Susúa State Forest, Puerto Rico. Environmental conditions and phorophyte phenology at these sites might affect phorophyte preferences of the orchid species studied (Zarate-García *et al*. 2020). Similarly, Ackerman, Montalvo & Vera (1989) and Otero *et al.* (2007) found no clear relationship for either *P. monensis* or *P. krugii* between phorophyte preference and bark roughness. However, subjective assessments of bark topography, such as the one used by those authors could be misleading (Tay *et al.* 2023). Guánica State Forest and Mona Island are dry environments with low, open canopies where *P. krugii* and *P. monensis* might be exposed to direct sunlight and drought. Phorophyte preferences might be governed by factors such as light exposure, rather than only by phorophyte characteristics. In contrast, the Susúa State Forest is a moist forest with a dense canopy cover that protects orchids against radiation and water evaporation. Hence, orchid germination might be influenced by higher WHC rather than WRC because it promotes rapid germination, reducing the probability of experiencing adverse conditions during early stages of development.

In Situ *Seed Germination*—. Germination of terrestrial orchids is higher near established plants, which may serve as a beacon of suitable conditions and/or a reservoir of mycorrhizal fungi (Diez 2007, McCormick *et al*. 2016). In situ germination studies of epiphytic orchids are limited, contrary to the studies of terrestrial orchids, Kartzinel *et al.* (2013) found that *Epidendrum firmum* Rchb.f. was dependent on the microclimates of large trees and closed canopies, rather than proximity of conspecific adults. Conversely, Petrolli *et al*. (2021) found a correlation between OMF community composition with epiphyte root proximity, suggesting that the bark near established orchids likely harbor their OMF. Further evidence of spatial structure was revealed when Petrolli *et al.* (2022) and Fernández *et al.* (2023) discovered that epiphytic orchid communities formed modular networks with their OMF. In addition, studies for both terrestrial (Whitman & Ackerman 2015, Jacquemyn *et. al.* 2007, Jersáková & Malinová 2007) and epiphytic species have suggested that spatial distribution of orchids may be dependent on propagule pressure which is strongest near seed sources (Ackerman *et al*. 1996).

A higher frequency of seeds in process of germinating was obtained near established orchids. Still, the model (negative binomial GLM) that best explains the data did not include the variable of presence of an established *P. kraenzlinii* as a predictor. We hypothesized that germination would be higher near established orchids because of a higher propagule pressure, higher probability of OMF availability and appropriate microsite conditions. Our results suggest that germination is more probable near established orchids, supporting our hypothesis, but that the phorophyte species has a stronger effect on the percentage of developing seeds. According to the model, *P. kraenzlinii* has a significantly higher probability of developing on *M. portoricensis*, and a significantly lower probability of developing on *C. microstachya.* Hence, the patterns of *P. kraenzlinii* seeds that are ready to undergo germination tend to mirror that of the distribution of established orchids in the study site.

Germination development stages reached by seeds in packets on different phorophyte species varied. The percentage of non-germinated seeds (Stage 0) was highest on *O. littoralis* and *R. aculeata.* Those that reached Stages 1 and 2 were more common on *T. haemantha* and *P. cuneifolius*. Nonetheless, the later stages (Stage 3 and 4) showed no difference among phorophyte species so that early-stage success is not necessarily indicative of success in reaching later stages. In fact, we found no significant difference among phorophyte species in the presence of OMF. Remarkably, the highest probability of having OMF (as evidenced by germination to at least stage 4) was *S. mahagoni*, a species where established orchids are rare to find. Furthermore, *R. aculeata*, a species largely unoccupied by *P. kraenzlinii* was one of the few species where seeds reached protocorm stages during *in situ* germination experiments. On the contrary, *P. kraenzlinii* grew on 21% of the *R. inermis* within our plots, but no embryo development was observed on this phorophyte species. Thus, population dynamics of orchids can be context dependent where best sites for one life history stage are not necessarily best for another stage. Indeed, we found that best sites for germination are not always the same as sites where plants can develop and survive, as observed by Crain *et al.* (2022) for epiphytic *Lepanthes caritensis* in the Carite State Forest in Puerto Rico, Whitman & Ackerman (2015) for terrestrial *Prescottia stachyodes* in El Yunque, Puerto Rico, and by Jacquemyn *et al*. (2007) for *Orchis purpurea* in Belgium (see also Gowland *et al*. 2011 and Jersáková & Malinová 2007). Moreover, Otero *et al.* (2007) found that the best sites for germination of *P. monensis* are different from those sites with high pollination, suggesting that the major production of seeds may occur far from suitable germination sites. Which is why, when developing conservation strategies for orchids, the environmental conditions in which an established population exists should not be assumed to be good for germination and establishment, unless recruitment is observed (Rasmussen *et al*. 2015). Another factor that needs to be considered is that of OMF usage throughout the life cycle of an orchid. Ontogenic turnover of OMF species exists in some orchids, suggesting that the OMF that trigger seed germination is not necessarily the best for later development (Otero *et al.* 2005, Bidartondo & Read 2008, Meng *et al.* 2019a, 2019b, Fernández *et al.* 2023).

Conclusion. *Psychilis kraenzlinii* was shown to prefer a subset of available phorophytes as well as higher probability of developing near established orchids. The orchid was found more often on substrates with a high WHC and lower FI (smoother bark). These results are not entirely consistent with similar studies of other orchids done under different climatic regimes and vegetation types, including closely related *P. monensis*, suggesting that preferences for certain substrate conditions may be context dependent. *Psychilis kraenzlinii* is the most widespread member of the genus, so comparative studies of different populations might reveal how environmental conditions affect phorophyte preferences. The results described here lay the foundation to develop informed conservation and management strategies for *P. kraenzlinii* and other species of the genus. However, various unknowns must be clarified: (1) pollinator identity and visitation frequency; (2) the OMF that triggers seed germination and development; (3) distribution of the orchid and how it relates to the distribution of its pollinators and OMF; (4) abiotic factors affecting the distribution of this orchid and its symbionts. Nonetheless, the population studied here is unusually large and apparently robust having evidence of fruit production and germination success which may be viewed generally as an indicator of a healthy population (Pierce & Belotti 2011). Still, this is a population near the edge of the Forest Reserve and should be monitored for any incursions and adjacent development which may affect critical ecosystem functions. The phorophyte that *P. kraenzlinii* prefers in the Susúa State Forest, *M. portoricensis*, is an endemic and rare shrub found in the southwest of Puerto Rico (Axelrod 2011). The protection and monitoring of this tree species might also be beneficial for *P. kraenzlinii*. It cannot be overstated, orchid conservation needs to target whole ecosystems, particularly in biodiversity hotspots of which the Caribbean is one (Fay 2018, Myers *et al*. 2000, Phillips *et al.* 2020).

ACKNOWLEDGEMENTS. NGO dearly thanks her grandmother, Maria M. Navarro Roldán, for making the plankton net seed packets used for her *in situ* seed germination experiment; Frank Axelrod and Steve Maldonado-Silvestrini for helping with phorophyte identification; Jamilys Rivera-Rodríguez, Elif Kardas, Carlos Cifuentes, Sergio L. Alicea Román, Armando Canchani, Angel M. Duran De Leon and Yalmarie Numan for their support during data collection and/or analysis; Dr. Paul Bayman, for making his lab available, we would have not been able to complete our experiments otherwise, for his comments and critiques along the way, and revision of the manuscript; to NGO thesis committee members, who shed the light to the correct path when she doubted; Puerto Rico Louis Stokes Alliance for Minority Participation Bridge to the Doctorate program (National Science Foundation HRD-1906130) and the American Orchid Society Conservation Committee for the financial support that made this research possible. Permits for this research were provided by the Department of Natural and Environmental Resources of Puerto Rico (Permit numbers: 2020-EPE-032 and 2021-EPE-041).

Appendix 1. Number of samples per tree for the assessment of water storage capacity.

Tree Species	Tree ID	***Psychilis kraenzlinii***	
		Absent	**Present**
Coccoloba microstachya	1	4	4
Coccoloba microstachya	2	4	0
Coccoloba microstachya	3	4	0
Coccoloba microstachya	4	4	0
Machaonia portoricensis	1	3	2
Machaonia portoricensis	2	4	2
Machaonia portoricensis	3	3	4
Machaonia portoricensis	4	4	3
Ouratea littoralis	1	3	4
Ouratea littoralis	2	4	4
Ouratea littoralis	3	4	4
Ouratea littoralis	4	4	4
Randia aculeata	1	2	3
Randia aculeata	2	3	2
Randia aculeata	3	4	0
Randia aculeata	4	4	0
Rondeletia inermis	1	4	3
Rondeletia inermis	2	1	3
Rondeletia inermis	3	4	0
Phyllanthus cuneifolius	1	4	4
Phyllanthus cuneifolius	2	4	4
Phyllanthus cuneifolius	3	3	4
Phyllanthus cuneifolius	4	4	4
Swietenia mahagoni	1	3	0
Swietenia mahagoni	2	4	0
Swietenia mahagoni	3	4	0
Swietenia mahagoni	4	4	0
Tabebuia haemantha	1	4	4
Tabebuia haemantha	2	4	4
Tabebuia haemantha	3	4	4
Tabebuia haemantha	4	4	4

Appendix 2. Number of samples per tree for the fissuring index.

Tree Species	Tree ID	***Psychilis kraenzlinii***	
		Absent	**Present**
Coccoloba microstachya	1	4	4
Coccoloba microstachya	2	4	4
Coccoloba microstachya	3	4	0
Coccoloba microstachya	4	4	0
Ouratea littoralis	1	4	4
Ouratea littoralis	2	3	4
Ouratea littoralis	3	4	4
Ouratea littoralis	4	4	4
Machaonia portoricensis	1	4	4
Machaonia portoricensis	2	4	4
Machaonia portoricensis	3	4	4
Machaonia portoricensis	4	4	4
Randia aculeata	1	3	0
Rondeletia inermis	1	1	4
Rondeletia inermis	2	4	4
Rondeletia inermis	3	4	4
Rondeletia inermis	4	4	0
Swietenia mahagoni	1	4	0
Swietenia mahagoni	2	4	0
Swietenia mahagoni	3	4	0
Swietenia mahagoni	4	4	0
Phyllanthus cuneifolius	1	4	3
Phyllanthus cuneifolius	2	4	0
Phyllanthus cuneifolius	3	4	4
Phyllanthus cuneifolius	4	4	4
Phyllanthus cuneifolius	5	0	4
Tabebuia haemantha	1	4	4
Tabebuia haemantha	2	4	4
Tabebuia haemantha	3	4	4
Tabebuia haemantha	4	4	4

Appendix 3. Number of seed packets placed *in situ* per phorophyte species.

Phorophyte Species	**Seed Packets**	
	On trees orchid-free	**Near established orchid**
Coccoloba microstachya	31	0
Machaonia portoricensis	15	13
Ouratea littoralis	10	10
Randia aculeata	18	0
Rondeletia inermis	13	6
Phyllanthus cuneifolius	10	10
Swietenia mahagoni	16	2
Tabebuia haemantha	10	10

Appendix 4. Conover-Iman Pairwise Comparisons among phorophyte species for Water Holding Capacity (WHC), Water Retention Capacity (WRC) and Fissuring Index (FI).

Comparison	**WHC**		**WRC**		**FI**	
	Z	***P***	***Z***	***P***	***Z***	***P***
Coccoloba microstachya - Ouratea littoralis	3.56	**<0.01***	-0.51	0.6	-0.25	0.8
Coccoloba microstachya - Machaonia portoricensis	-5.55	**<0.01***	3.52	**<0.01***	-1.39	0.17
Coccoloba microstachya - Randia aculeata	-0.95	0.34	2.3	**0.02***	-1.22	0.22
Coccoloba microstachya - Rondeletia inermis	-2.99	**<0.01***	3.09	**<0.01***	0.47	0.64
Coccoloba microstachya - Swietenia mahagoni	2.8	**0.01***	-2.35	**0.02***	-0.76	0.45
Coccoloba microstachya - Phyllanthus cuneifolius	-1.87	0.06	0.94	0.35	-2.8	**0.01***
Coccoloba microstachya - Tabebuia haemantha	1.24	0.21	0.21	0.84	-0.64	0.53
Ouratea littoralis - Machaonia portoricensis	-9.99	**<0.01***	4.47	**<0.01***	-1.21	0.23
Ouratea littoralis - Randia aculeata	-4.49	**<0.01***	3.01	**<0.01***	-1.06	0.29
Ouratea littoralis - Rondeletia inermis	-6.5	**<0.01***	3.82	**<0.01***	0.77	0.45
Ouratea littoralis - Swietenia mahagoni	-0.2	0.84	-2.08	**0.04***	-0.57	0.57
Ouratea littoralis - Phyllanthus cuneifolius	-6.13	**<0.01***	1.64	0.11	-2.73	**0.01***
Ouratea littoralis - Tabebuia haemantha	-2.64	**0.01***	0.82	0.42	-0.41	0.68
Machaonia portoricensis - Randia aculeata	4.38	**<0.01***	-1.18	0.24	0.09	0.92
Machaonia portoricensis - Rondeletia inermis	1.96	0.05	0.18	085	1.95	0.05
Machaonia portoricensis - Swietenia mahagoni	8.03	**<0.01***	-5.68	**<0.01***	0.42	0.67
Machaonia portoricensis - Phyllanthus cuneifolius	4.19	**<0.01***	-2.92	**<0.01***	-1.54	0.13
Machaonia portoricensis - Tabebuia haemantha	7.56	**<0.01***	-3.73	**<0.01***	0.81	0.42
Randia aculeata - Rondeletia inermis	-2.04	**0.04***	0.88	0.38	1.67	0.10
Randia aculeata - Swietenia mahagoni	3.63	**<0.01***	-4.43	**<0.01***	0.44	0.66
Randia aculeata - Phyllanthus cuneifolius	-0.77	0.44	-1.61	0.11	-1.14	0.25
Randia aculeata - Tabebuia haemantha	2.25	**0.03***	-2.33	**0.02***	0.74	0.46
Rondeletia inermis - Swietenia mahagoni	5.42	**<0.01***	-5.08	**<0.01***	-1.2	0.23
Rondeletia inermis - Phyllanthus cuneifolius	1.55	0.12	-2.5	**0.01***	-3.42	**<0.01***
Rondeletia inermis - Tabebuia haemantha	4.4	**<0.01***	-3.18	**<0.01***	-1.17	0.24

Appendix 4. *continues...*

Swietenia mahagoni - Phyllanthus cuneifolius	-4.75		3.4	**<0.01***	-1.68	0.10
Swietenia mahagoni - Tabebuia haemantha	-1.93		2.75	**<0.01***	0.24	0.81
Phyllanthus cuneifolius - Tabebuia haemantha	3.53		-0.84	0.41	2.34	**0.02***

Appendix 5. Intraspecific differences in water holding capacity (WHC) and water retention capacity (WRC) between trees with and without *Psychilis kraenzlinii*. Mann-Whitney U test.

Phorophyte Species	**WHC**		**WRC**	
	U	***p***	***U***	***p***
Coccoloba microstachya	59	**0.01**	17	0.13
Machaonia portoricensis	129	**<0.01**	NA	NA
Ouratea littoralis	105	0.57	101.5	0.46
Randia aculeata	39	0.57	37.5	0.42
Rondeletia inermis	27	1	NA	NA
Phyllanthus cuneifolius	116	0.89	148.5	0.17
Tabebuia haemantha	71	**0.03**	149	0.39

Appendix 6. Conover-Iman Pairwise Comparisons for the percentage of seeds at Stage 0, 1 and 2 among phorophyte species. Values in bold indicate significant results.

Comparison	**Stage 0**		**Stage 1**		**Stage 2**	
	Z	**P**	**Z**	**P**	**Z**	**P**
Coccoloba microstachya - Ouratea littoralis	-0.55	0.29	0.66	0.26	0.06	0.48
Coccoloba microstachya - Machaonia portoricensis	1.48	0.07	-1.4	0.08	-1.2	0.12
Coccoloba microstachya - Randia aculeata	-0.53	0.3	0.15	0.44	0.59	0.29
Coccoloba microstachya - Swietenia mahagoni	1.02	0.15	-1	0.16	-1.52	0.07
Coccoloba microstachya - Phyllanthus cuneifolius	1.83	**0.03***	-1.41	0.08	-2.29	**0.01***
Coccoloba microstachya - Tabebuia haemantha	2.44	**0.01***	-2.77	**<0.01***	-3.22	**<0.01***
Ouratea littoralis - Machaonia portoricensis	1.85	**0.03***	-1.89	**0.03***	-1.13	0.13
Ouratea littoralis - Randia aculeata	0	0.5	-0.45	0.33	0.48	0.31
Ouratea littoralis - Swietenia mahagoni	1.42	0.08	-1.5	0.07	-1.44	0.08
Ouratea littoralis - Phyllanthus cuneifolius	2.16	**0.02***	-1.9	**0.03***	-2.13	**0.02***
Ouratea littoralis - Tabebuia haemantha	2.72	**<0.01***	-3.11	**<0.01***	-2.97	**<0.01***
Machaonia portoricensis - Randia aculeata	-1.8	**0.04***	1.35	0.09	1.62	0.05
Machaonia portoricensis - Swietenia mahagoni	-0.27	0.39	0.22	0.41	-0.45	0.33
Machaonia portoricensis - Phyllanthus cuneifolius	0.48	0.32	-0.14	0.45	-1.17	0.12
Machaonia portoricensis - Tabebuia haemantha	1.08	0.14	-1.47	0.07	-2.08	**0.02***
Randia aculeata - Swietenia mahagoni	1.38	0.08	1.02	0.15	-1.87	**0.03***
Randia aculeata - Phyllanthus cuneifolius	2.1	**0.02***	-1.38	0.09	-2.56	**0.01***
Randia aculeata - Tabebuia haemantha	2.64	**<0.01***	-2.58	**0.01***	-3.38	**<0.01***
Swietenia mahagoni - Phyllanthus cuneifolius	0.68	0.25	-0.33	0.38	-0.64	0.26
Swietenia mahagoni - Tabebuia haemantha	1.22	0.11	-1.53	0.06	-1.45	0.07
Phyllanthus cuneifolius - Tabebuia haemantha	0.55	0.29	-1.23	0.11	-0.84	0.2

Appendix 7. Do not bother…

As part of this project other experiments took place without much success. We tried isolating the orchid mycorrhizal fungi (OMF) that triggers the germination of *Psychilis kraenzlinii*. We tried isolating the OMF from both adult roots and protocorms. To isolate the OMF from the roots we first confirmed the presence of pelotons and then put both a thin cross-sectional slice of the root and the peloton already isolated, in cultivation media. We used water agar (WA) and Potato Dextrose Agar (PDA); the media was both poured over the tissue and already set on the plate. Although several strains grew, none were Rhizoctonia-like fungi. To isolate the OMF from protocorms that resulted from the *in-situ* germination experiment we used WA and PDA, both poured over the pelotons and already set. Again, several strains grew, none of them *Rhizoctonia*-like. Although we paid some attention to two strains that were likely to be *Fusarium* and *Xylaria*. With these strains we did germination assays to see if either would promote germination. Although the seeds swelled, some to the point of breaking the seed coat (testa), there was no further development. It is worth noting that Otero *et al*. (2002) attempted OMF isolation from *Psychilis monensis* using PDA and did not find an obvious OMF strain. We would suggest that, if the reader intends to conduct research on the OMF of *P. kraenzlinii* or a *Psychilis* spp., then they should try other fungi cultivation media.

As part of the phorophyte characterization phase of my research we followed the methodology described by Callaway *et al*. (2002) to measure bark stability. This methodology consists of painting dots with oil paint on the bark of phorophytes and checking them after a pre-determined time (in my case a year) to see if the dots have disappeared or changed. Changes on the dots suggest that the bark is shedding, and it can be used as a proxy for stability. The study site for Callaway *et al*. (2002) was the subtropical Sapelo Island in Georgia (USA), and phorophyte composition was mostly pines and oaks which shed their bark in pieces. A much different scenario than where we did our work: a secondary forest of the tropical moist Susúa State Forest in Puerto Rico, where the oil dots stayed through the length of this study (2 years). We also followed the methodology described by Zarate-Garcia *et al.* (2020) for rhytidome texture characterization. Here, one uses scanning electron microscopy (SEM) to closely look at the bark texture and porosity. After looking at the images closely, the methodology appeared too subjective. The rhytidome classification was too variable and without patterns among phorophyte species. As for the pores, we are not convinced that the so-called pores are, in fact, pores. They seem to be cells. Hence, the data was archived and not used for publication.

With this section our hope is not to avert the reader to conduct research on these topics, but rather to give some input so they can develop a methodology with a higher probability of being successful.

Literature cited

Ackerman, J. D. (1986). Coping with the epiphytic existence: pollination strategies. *Selbyana*, 9(1), 52–60.

Ackerman, J. D. & Collaborators. (2014). *Orchid flora of the Greater Antilles*. Memoirs of the New York Botanical Garden, 105.

Ackerman, J. D., Montalvo, A. M. & Vera, A. M. (1989). Epiphyte host specificity of *Encyclia krugii*, a Puerto Rican endemic orchid. *Lindleyana*, 4(2), 74–77.

Ackerman, J. D., Sabat, A. & Zimmerman, J. K. (1996). Seedling establishment in an epiphytic orchid: an experimental study of seed limitation. *Oecologia*, 106(2), 192–198. doi: 10.1007/BF00328598

Adhikari, Y. P. & Fischer, A. (2011). Distribution pattern of the epiphytic orchid *Rhynchostylis retusa* under strong human influence in Kathmandu valley, Nepal. *Botanica Orientalis: Journal of Plant Science*, 8, 90–99. doi: 10.3126/botor.v8i0.5956

Aragón, S. & Ackerman, J. D. (2004). Does flower color variation matter in deception pollinated *Psychilis monensis* (Orchidaceae)? *Oecologia*, 138(3), 405–413. doi: 10.1007/s00442-003-1443-9

Arditti, J. (1992). *Fundamentals of orchid biology*. Wiley.

Axelrod, F. S. (2011). *A systematic vandemecum to the vascular plants of Puerto Rico*. Brit Press, 34.

Barthelme, S. (2023). imager: Image processing library based on 'CImg' (R package version 0.45.2). Retrieved from https://CRAN.R-project.org/package=imager

Benzing, D. H. (1979). Alternative interpretations for the evidence that certain orchids and bromeliads act as shoot parasites. *Selbyana* 5(2), 135–144.

Benzing, D. H. (1990). *Vascular epiphytes. General biology and related biota*. Cambridge University Press.

Benzing, D. H. (2004). Vascular epiphytes. In: D. M. Lowman & H. B. Rinker (2nd Ed.), *Forest canopies* (2nd Ed.) (pp. 175–211). Elsevier.

Bidartondo, M. I. (2005). The evolutionary ecology of myco-heterotrophy. *New Phytologist*, 167(2), 335–352. doi: 10.1111/j.1469-8137.2005.01429.x

Bidartondo, M. I. & Read, D. J. (2008). Fungal specificity bottlenecks during orchid germination and development. *Molecular Ecology*, 17(16), 3707–3716. doi: 10.1111/j.1365-294X.2008.03848.x

Brandner, S. (2005). An assessment of the fungal specificity of the orchid sub-tribe *Pterostylis*. *Centre for Australian National Biodiversity Research and Australian National Herbarium*. Retrieved from https://www.cpbr.gov.au/cpbr/summer-scholarship/2005-projects/brandner-susan-orchids/index.html

Cabrera-García, B., Guerrero, A., Folgado, R., Jimenez, F. & Serra, C. (2023) Biología reproductiva de *Psychilis truncata* (Orchidaceae) en Arroyo Corral, Partido, Dajabón, República Dominicana. *Moscosoa*, 21, 99–114.

Callaway, R. M., Reinhart, K. O., Moore, G. W., Moore, D. J. & Pennings, S. C. (2002). Epiphyte host preferences and host traits: mechanisms for species-specific interactions. *Oecologia*, 132(2), 221–230. doi: 10.1007/s00442-002-0943-3

Crain, B. J., Sánchez-Cuervo, A. M. & Deren, V. (2022). Mixed evidence of a commensal relationship between a rare epiphytic orchid and cohabiting bryophytes. *Botanical Journal of the Linnean Society*, 201(4), pp. doi: https://doi.org/10.1093/botlinnean/boac049

Departamento de Recursos Naturales. (2015). El Bosque Estatal de Susua. Retrieved from http://drna.pr.gov/wp-content/uploads/2015/04/El-Bosque-Estatal-de-Susúa.pdf

Diez, J. M. (2007). Hierarchical patterns of symbiotic orchid germination linked to adult proximity and environmental gradients. *Journal of Ecology*, 95(1), 159–170.10.1111/j.1365-2745.2006.01194.x

Fay, M. F. (2018). Orchid conservation: how can we meet the challenges in the twenty-first century? *Botanical Studies*, 59(16), 1–6. doi: 10.1186/s40529-018-0232-z

Fernández, M., Kaur, J. & Sharma, J. (2023). Co-occurring epiphytic orchids have specialized mycorrhizal fungal niches that are also linked to ontogeny. *Mycorrhiza*, 33(1–2), 1–19. doi: 10.1007/s00572-022-01099-w

Frei, S. J. K. (1973). Effect of bark substrate on germination and early growth of *Encyclia tampensis* seeds. *American Orchid Society Bulletin*, 42(8), 701–708.

Frei, S. J. K. & Dodson, C. H. (1972). The chemical effect of certain bark substrates on the germination and early growth of epiphytic orchids. *Bulletin of the Torrey Botanical Club*, 99(6), 301–307. doi: https://doi.org/10.2307/2997072

Gentry, A. H. & Dodson, C. H. (1987). Diversity and biogeography of neotropical vascular epiphytes. *Annual Missouri Botanical Garden,* 74(2), 205–233. doi: https://doi.org/10.2307/2399395

González-Orellana, N., Salazar-Mendoza, A., Numan, Y. & Ackerman, J. D. (2022). Understanding orchid conservation, one species at a time. *Orchids*, 91(12), 914–919.

Gowland, K. M., Wood, J., Clements, M. A. & Nicotra, A. B. (2011). Significant phorophyte (substrate) bias is not explained by fitness benefits in three epiphytic orchid species. *American Journal of Botany*, 98(2), 197–206. Doi: 10.3732/ajb.1000241

Gravendeel, B., Smithson, A., Slik, F. J. W. & Schuiteman, A. (2004). Epiphytism and pollinator specialization: drivers for orchid diversity? *Philosophical Transactions of the Royal Society London B*, 359, 1523–1535.

Hietz, P. & Hietz-Seifert, U. (1995). Composition and ecology of vascular epiphyte communities along an altitudinal gradient in central Veracruz, Mexico. *Journal of Vegetation Science*, 6(4), 487–498. Doi: https://doi.org/10.2307/3236347

Izuddin, M., Srivathsan, A., Lee, A. L., Yam, T. W. & Webb, E. L. (2019a). Availability of orchid mycorrhizal fungi on roadside trees in a tropical urban landscape. *Scientific Reports*, 9(1), 1–12. Doi: 10.1038/s41598-019-56049-y

Izuddin, M., Yam, T. W. & Webb, E. L. (2019b). Germination niches and seed persistence of tropical epiphytic orchids in an urban landscape. *Journal of Plant Research*, 132(3), 383–394. Doi: 10.1007/s10265-019-01110-0

Jacquemyn, H., Brys, R., Vandepitte, K., Honnay, O., Roldán-Ruiz, I. & Wiegand, T. (2007). A spatially explicit analysis of seedling recruitment in the terrestrial orchid *Orchis purpurea*. *New Phytologist*, 176(2), 448–459. Doi: 10.1111/j.1469-8137.2007.02179.x

Jersáková, J. & Malinová, T. (2007). Spatial aspects of seed dispersal and seedling recruitment in orchids. *New Phytologist*, 176(2), 237–241. Doi: 10.1111/j.1469-8137.2007.02223.x

Khamchatra, N. M., Dixon, K., Chayamarit, K., Apisitwanich, S. & Tantiwiwat, S. (2016). Using in situ seed baiting technique to isolate and identify endophytic and mycorrhizal fungi from seeds of a threatened epiphytic orchid, *Dendrobium friedericksianum* Rchb.f. (Orchidaceae). *Agriculture and Natural Resources*, 50(1), 8–13. doi: https://doi.org/10.1016/j.anres.2016.01.002

Kartzinel, T. R., Trapnell, D. W. & Shefferson, R. P. (2013). Highly diverse and spatially heterogeneous mycorrhizal symbiosis in a rare epiphyte is unrelated to broad biogeographic or environmental features. *Molecular Ecology*, 22(23), 5949–5961. doi: 10.1111/mec.12536

Laube, S. & Zotz, G. (2006). Neither host-specific nor random: vascular epiphytes on three tree species in a Panamanian lowland forest. *Annals of Botany*, 97(6), 1103–1114. doi: 10.1093/aob/mcl067

McCormick, M. K., Taylor, D. L., Whigham, D. F. & Burnett Jr, R. K. (2016). Germination patterns in three terrestrial orchids relate to abundance of mycorrhizal fungi. *Journal of Ecology*, 104(3), 744–754. doi: https://doi.org/10.1111/1365-2745.12556

Meng, Y. Y., Fan, X. L., Zhou, L. R., Shao, S. C., Liu, Q., Selosse, M. A. & Gao, J. Y. (2019a). Symbiotic fungi undergo a taxonomic and functional bottleneck during orchid seeds germination: a case study on *Dendrobium moniliforme*. *Symbiosis*, 79, 205–212. doi: 10.1007/s13199-019-00647-x

Meng, Y. Y., Zhang, W. L., Selosse, M. A. & Gao, J. Y. (2019b). Are fungi from adult orchid roots the best symbionts at germination? A case study. *Mycorrhiza*, 29(5), 541–547. doi: 10.1007/s00572-019-00907-0

Migenis, L. E. & Ackerman, J. D. (1993). Orchid—phorophyte relationships in a forest watershed in Puerto Rico. *Journal of Tropical Ecology*, 9(2), 231–240. doi: 10.1017/S0266467400007227

Miller, J. S., Krupnick, G. A., Stevens, H., Porter-Morgan, H., Boom, B., Acevedo-Rodríguez, P., Ackerman, J. D., Kolterman, D., Santiago, E., Torres, C. & Velez, J. (2013). Toward Target 2 of the Global Strategy for Plant Conservation: An Expert Analysis of the Puerto Rican Flora to Validate New Streamlined Methods for Assessing Conservation Status. *Annals of the Missouri Botanical Garden*, 99(2), 199–205. doi: https://doi.org/10.3417/2011121

Miller, G., & Lugo, A. E. (2009). *Guide to the ecological systems of Puerto Rico*. USDA, IITF-GTR-35.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, 403(6772), 853–858. doi: https://doi.org/10.1038/35002501

Otero, J. T., Ackerman, J. D. & Bayman, P. (2002). Diversity and host specificity of endophytic *Rhizoctonia-like* fungi from tropical orchids. *American Journal of Botany*, *89*(11), 1852-1858. doi: 10.3732/ajb.89.11.1852

Otero, J. T., Aragón, S. & Ackerman, J. D. (2007). Site variation in spatial aggregation and phorophyte preference in *Psychilis monensis* (Orchidaceae). *Biotropica*, 39(2), 227–231. doi: 10.1111/j.1744-7429.2006.00258.x

Otero, J. T., Bayman, P. & Ackerman, J. D. (2005). Variation in mycorrhizal performance in the epiphytic orchid *Tolumnia variegata* in vitro: the potential for natural selection. *Evolutionary Ecology*, 19, 29–43. doi: 10.1007/s10682-004-5441-0

Otero, J. T. & Flanagan, N. S. (2006). Orchid diversity – beyond deception. *Trends in Ecology and Evolution*, 21(2), 64–65. doi: https://doi.org/10.1016/j.tree.2005.11.016

Petrolli, R., Augusto Vieira, C., Jakalski, M., Bocayuva, M. F., Vallé, C., Cruz, E. D. S., Selosse, M., Martos, F. & Kasuya, M. C. M. (2021). A fine-scale spatial analysis of fungal communities on tropical tree bark unveils the epiphytic rhizosphere in orchids. *New Phytologist*, 231(5), 2002–2014. doi: 10.1111/nph.17459

Petrolli, R., Zinger, L., Perez-Lamarque, B., Collobert, G., Griveau, C., Pailler, T., Selosse, M. & Martos, F. (2022). Spatial turnover of fungi and partner choice shape mycorrhizal networks in epiphytic orchids. *Journal of Ecology*, 110(11), 2568–2584. doi: https://doi.org/10.1111/1365-2745.13986

Petter, G., Wagner, K., Wanek, W., Sánchez Delgado, E. J., Zotz, G., Cabral, J. S. & Kreft, H. (2016). Functional leaf traits of vascular epiphytes: vertical trends within the forest, intra- and interspecific trait variability, and taxonomic signals. *Functional Ecology*, 30(2), 188–198. doi: https://doi.org/10.1111/1365-2435.12490

Phillips, R. D., Reiter, N. & Peakall, R. (2020). Orchid conservation: from theory to practice. *Annals of Botany*, 126(3), 345–362. doi: https://doi.org/10.1093/aob/mcaa093

Pierce, S. & Belotti, J. (2011). *The Conservation of Terrestrial Orchids from the Alps to the Po Plain Lombardy*. Parco delle Orobie Bergamasche and Centro Flora Autoctona della Regione Lombardia. Italy: Galbiate LC.

Rasmussen, H. N. (1995). *Terrestrial orchids: from seed to mycotrophic plant*. United Kingdom: Cambridge University Press.

Rasmussen, H. N., Dixon, K.W., Jersáková, J. & Těsĭtelová, T. (2015). Germination and seedling establishment in orchids: a complex of requirements. *Annals of Botany*, 116(3), 391–402. doi: 10.1093/aob/mcv087

Rasmussen, H. N. & Rasmussen, F. N. (2018). The epiphytic habitat on a living host: reflections on the orchid-tree relationship. *Botanical Journal of the Linnean Society*, 186(4), 456–472. https://doi.org/10.1093/botlinnean/box085

Sanford, W. W. (1974). The Ecology of Orchids (pp. 1–100). In: C. L. Withner (1st Ed.), *The orchids scientific studies*.

Sauleda, R. P. (1988). A revision of the genus *Psychilis* Rafinesque (Orchidaceae). *Phytologia*, 65, 1–33.

Sáyago, R., Lopezaraiza-Mikel, M., Quesada, M., Álvarez-Añorve, M. Y., Cascante-Marín, A. & Bastida, J. M. (2013). Evaluating factors that predict the structure of a commensalistic epiphyte–phorophyte network. *Proceedings of the Royal Society B*, 280(1756), 20122821. doi:https://doi.org/10.1098/rspb.2012.2821

Siaz-Torres, S. S., Mora-Olivo, A., Arellano-Méndez, L. U., Vanoye-Eligio, V., Flores-Rivas, J. & de la Rosa-Manzano, E. (2021). Contribution of peeling host for epiphyte abundance in two tropical dry forests in the "El Cielo Biosphere Reserve", Mexico. *Plant Species Biology*, 36(2), 269–283. doi: https://doi.org/10.1111/1442-1984.12317

Stenberg, M. L. & Kane, M. E. (1998). In vitro seed germination and greenhouse cultivation of *Encyclia boothiana* var. erythronioides, an endangered Florida orchid. *Lindleyana*, 13(2), 101–112. doi: https://doi.org/10.1016/j.anres.2016.01.002

Sulit, M. D. (1950). Field observations on tree hosts of orchids in the Philippines. *Philippines Orchid Review*, 3, 3–8.

Sulit, M. D. (1953). Field observations on tree hosts of orchids in Palawan. *Philippines Orchid Review*, 5, 16.

Szumilas, M. (2010). Explaining odds ratios. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 19(3), 227–229.

Tay, J. Y., Zotz, G. & Einzmann, H. J. (2023). Smoothing out the misconceptions of the role of bark roughness in vascular epiphyte attachment. *New Phytologist*, 238(3), 983–994. doi: https://doi.org/10.1111/nph.18811

Timsina, B., Rokaya, M. B., Münzbergová, Z., Kindlmann, P., Shrestha, B., Bhattarai, B. & Raskoti, B. B. (2016). Diversity, distribution, and host-species associations of epiphytic orchids in Nepal. *Biodiversity and Conservation*, 25(13), 2803–2819. doi: 10.1007/s10531-016-1205-8

Trapnell, D. W., & Hamrick, J. L. (2006). Variety of phorophyte species colonized by the neotropical epiphyte, *Laelia rubescens* (Orchidaceae). *Selbyana*, 27(1), 60–64. doi: 10.2307/41760261

Tremblay, R. L. (1997). Distribution and Dispersion Patterns of Individuals in Nine Species of *Lepanthes* (Orchidaceae). *Biotropica*, 29(1), 38–45.

Tremblay, R. L., Meléndez-Ackerman, E. J. & Kapan, D. (2006). Do epiphytic orchids behave as metapopulations? Evidence from colonization, extinction rates and asynchronous population dynamics. *Biological Conservation*, 129(1), 70–81. doi: 10.1016/j.biocon.2005.11.017

Tremblay, R. L., Zimmerman, J. K., Lebrón, L., Bayman, P., Sastre, I., Axelrod, F. & Alers-García, J. (1998). Host specificity and low reproductive success in the rare endemic Puerto Rican orchid *Lepanthes caritensis*. *Biological Conservation*, 85(3), 297–304.

Wagner, K., Mendieta-Leiva, G. & Zotz, G. (2015). Host specificity in vascular epiphytes: a review of methodology, empirical evidence and potential mechanisms. *AoB plants*, 7, plu092. doi: https://doi.org/10.1093/aobpla/plu092

Whitman, M. & Ackerman, J. D. (2015). Terrestrial orchids in a tropical forest: best sites for abundance differ from those for reproduction. *Ecology*, 96(3), 693–704. doi: https://doi.org/10.1890/14-0104.1

Zarate-García, A. M., Noguera-Savelli, E., Andrade-Canto, S. B., Zavaleta-Mancera, H. A., Gauthier, A. & Alatorre-Cobos, F. (2020). Bark water storage capacity influences epiphytic orchid preference for host trees. *American Journal of Botany*, 107(5), 1–9. doi: 10.1002/ajb2.1470

Zi, X. M., Sheng, C. L., Goodale, U. M., Shao, S. C. & Gao, J. Y. (2014). *In situ* seed baiting to isolate germination-enhancing fungi for an epiphytic orchid, *Dendrobium aphyllum* (Orchidaceae). *Mycorrhiza*, 24(7), 487–499. doi: 10.1007/s00572-014-0565-8

Zotz, G., Hietz, P. & Einzmann, R. (2021). Functional ecology of vascular epiphytes. *Annual Plant Reviews*, 4(4), 869–906. doi: 10.1002/9781119312994.apr0777

LANKESTERIANA 24(1): 115–116. 2024. doi: http://dx.doi.org/10.15517/lank.v24i1.59619

SARCOGLOTTIS WERNERHERZOGII (SPIRANTHINAE), A NEW SPECIES FROM CUSCO, PERU: ADDENDA

BENJAMÍN COLLANTES[1], JOSÉ D. EDQUÉN[2], FELICIANO INCAHUAMÁN[3]
& GERARDO A. SALAZAR[4,5]

[1]Inkaterra, Calle Andalucía 174, Lima 15074, Perú.
[2]Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas, Chachapoyas, Amazonas, Perú.
[3]Maranura Alto s/n, La Convención, Maranura 08730, Quillabamba, Cusco, Perú.
[4]Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, 04510 Ciudad de México, México.
[5]Author for correspondence: gasc@ib.unam.mx

ABSTRACT. A comparative table between *Sarcoglottis wernerherzogii*, *S. fasciculata*, and other species of the genus present in Peru, is included.

RESUMEN. Se incluye una tabla comparativa entre *Sarcoglottis wernerherzogii*, *S. fasciculata* y otras especies del género presentes en Perú.

KEYWORDS / PALABRAS CLAVE: Cordillera Oriental de los Andes, Eastern Andean Cordillera, Machupicchu Historical Sanctuary, Santuario Histórico de Machupicchu, *Sarcoglottis fasciculata*

Introduction. In the publication of *Sarcoglottis wernerherzogii* Collantes, Edquén & Salazar (Collantes *et al*. 2023), the authors and editors inadvertently omitted a comparative table between *Sarcoglottis wernerherzogii* and other confirmed species of *Sarcoglottis* in Peru. Here, we present the comparative Table 1.

TABLE 1. Comparison of *Sarcoglottis wernerherzogii* with *S. fasciculata* and species of the genus verified as present in Peru (see Collantes *et al.* 2023).

Species/ feature	***S. wernerherzogii* Collantes, Edquén & Salazar**	***S. fasciculata* (Vell.) Schltr.**	***S. micrantha* Christenson**	***S. neillii* Salazar & Tobar**	***S. portillae* Christenson**	***S. speciosa* C.Presl**
Habitat	High-Andean cloud forest	Atlantic rain forest	Lowland Amazonian rainforest	Lowland Amazonian rainforest and lower montane rain forest	Lowland Amazonian rainforest	Lower and upper montane rainforest
Phenology of flowering	After the shedding of the leaves	With functional leaves	With functional leaves	With functional leaves	With functional leaves	With functional leaves
Flower coloration	Homogeneous dull green or yellow	Pale green or rosy-green with contrasting reddish veins, especially on the epichile of the labellum	Yellowish	Sepals reddish-brown with greenish base, petals white with 3 brownish-pink veins, labellum pale green becoming white distally, with 7 faint, pinkish veins on the epichile	Flesh-colored while opening, the lateral sepals and the epichile of the labellum turning golden yellow within 1-2 days	Sepals and petals pale green to bronzy, lip white with pale green epichile provided with darker green veins

ORCID of the Author: BC, JDE, FI, GAS
Received 5 April 2023; accepted for publication 16 April 2023. First published online: 25 April 2024.

Hypochile	Strongly cymbiform in natural position, when spread our obovate, as wide as long	Channeled in natural position, when spread out oblanceolate, about two times longer than wide or longer	Channeled in natural position, when spread out oblanceolate, about two times longer than wide or longer	Channeled in natural position, when spread out oblanceolate, about two times longer than wide or longer	Channeled in natural position, when spread out oblanceolate, four to five times longer than wide	Channeled in natural position, when spread out oblanceolate, four to five times longer than wide
Epichile	Ovate, strongly deflexed, with a central longitudinal thickening reaching its apex	Triangular, erect or gently arching, thin	5-lobulate, semiglobose, thin	Obreniform to broadly triangular, strongly revolute with two basal, papillose, convergent thickenings separated by a central groove	Obreniform to broadly triangular, strongly revolute with two basal, papillose, convergent thickenings separated by a central groove	Obreniform, gently recurved with two basal, convergent thickenings separated by a central groove
Ventral surface of column	Deeply and narrowly canaliculate, the channel limited at each side by a round longitudinal keel, column foot lacking the channel	Deeply and narrowly canaliculate, the channel limited at each side by a round longitudinal keel, column foot lacking the channel	Unknown	Broadly and shallowly channeled including the columm foot	Broadly and shallowly channeled including the columm foot	Broadly and shallowly channeled including the columm foot
Beak of the anther	Truncate	Rounded	Unknown	Rounded	Rounded	Rounded

LITERATURE CITED

Collantes, B., Edquén, J. D., Incahuamán, F. & Salazar, G. A. (2023). *Sarcoglottis wernerherzogii* (Spiranthinae): a new species from Cusco, Peru. *Lankesteriana*, 23(3), 623–632. doi: http://dx.doi.org/10.15517/lank.v23i3.58135

LANKESTERIANA

AUTHOR INSTRUCTIONS

LANKESTERIANA is a peer-reviewed journal. Each manuscript will be critically evaluated by two or more external reviewers under the double-blind model. An Editor in charge is assigned to each manuscript, who performs editorial tasks to improve the accordance of the manuscript to the general style of the journal, and follows the editorial process from the submission to the final decision, to ensure the quality of every publication.

Please read the following Instructions carefully and check the appropriate items to be sure your manuscript is formatted according to the journal style. Manuscripts that do not conform to the Instructions, both in format and contents, will be sent back to the authors for formatting prior to the reviewing process. This would represent a significant delay in the times required to eventually publish your manuscript.

General Instructions

- Type manuscript in Word (or Word compatible word processor) on 8.5” by 11” document with at least 1” (2.5 cm) margin on all sides.
- Use Times New Roman 12- point type, double-space throughout, including tables, figure legends, and literature cited. Do not justify the right margin. Authors are responsible for diacritical marks.
- Assemble in this order: 1) Title, Author(s) and affiliation(s) page; 2) abstract [+ optional abstract in the second language], key words and running title page; 3) Text, 4) Acknowledgments, 5) Literature cited, 6) Tables, 7) Appendices, 8) Figure legends, 9) Figures.
- Authors not fluent in written English should have their manuscripts carefully checked for correct language use before submission.
- If the paper includes newly described taxa, they must be illustrated, preferably by line drawings. Gray-scale drawings are difficult to be correctly reproduced by the printer and may result difficult to understand, and they are generally not accepted for publication.
- Include the collect permits and the corresponding institution that granted them in the cases of newly described taxa.

Title, Running title, Addresses, Abstract [+ optional Abstract in second language] & Key Words

- Title is flush left, in upper and lower case letters.
- Below Title, author(s) name(s) are on one line, flush left, in upper and lower case letters. Author(s) name(s) are in the following order: First Name (complete spelling), Second Name (initial), Surname. Indicate by superscript number after author’s name any current address. Addresses include Institution, Street, City, State, Postal Code, Country. Indicate with asterisk (*) the name of the correspondent author; indicate with asterisk, after the addresses, the email of the correspondent author.
- Abstract begins on new page, is flush left, in upper and lower case letters. Abstract must be one paragraph and not indented. Do not cite references or use abbreviations in the abstract. Abstract is intended for quick understanding of the article content and must include short but full reference to paper results. In the case of newly described taxa, diagnostic characters must be shortly stated. Optional abstract in a second language should follow in separate paragraph in same format.
- Key Words: give up to 6 keywords arranged alphabetically, preceding text as follows: Key Words: ... Keywords should reflect the main content of the manuscript, avoiding to repeat words already mentioned in the title.
- Spanish speaking authors are required to always include a second abstract in Spanish. No translation services are provided by the editorial staff.
- Below Key Words, Running title is on one line, flush left, in upper and lower case letters. The running title includes the author(s) surname(s) and a short title. The total number of characters must not exceed 50.

Text

- Begin on a new page.
- Main headings are flush left in upper- and lower-case letters and in boldface on a separate line. Secondary headings are flush left in upper and lower case letters and in italics, followed by a period, dash, and the paragraph text. Tertiary headings are flush left in upper and lower case letters and underlined, followed by a period, dash, and the paragraph text.
- All figures and tables must be cited in the text and must be cited consecutively in numerical order.
- Each reference cited in the text must be in the Literature Cited section, and vice versa.
- Cite literature in the text as follows:
    1. One author: Nobody (1991) or (Nobody 1991).
    2. Two authors: Nobody and Somebody (1991) or (Nobody & Somebody 1991).
    3. More than two authors:
       The first time you cite it: Nobody, Somebody & Someother (1991) or (Nobody, Somebody & Someother 1991).
       Subsequent citations: Nobody *et al*. (1991) or (Nobody *et al.* 1991).
    4. More than six authors: Nobody *et al.* (1991) or (Nobody *et al.* 1991).
    5. Manuscripts accepted for publication but not yet published: Nobody (in press) or (Nobody in press).
    6. Unpublished materials: S. Nobody (unpubl. data) or (S. Nobody pers. comm. Year).
    7. Within parentheses, use a comma to separate different citations (Nobody 1991, Somebody 1991). Citations should be listed in the order they appear in the reference list (alphabetically, then chronologically).
    8. Use a, b, c, and so forth, for two or more papers by same author(s) in one year (e.g., Nobody 1990a,b, Boom 1985b).
- Cite authors of all names at rank of genus and below where first used in text. Do not repeat author citations after the first name's use. Refer to Authors of Plant Names (Brummitt & Powell 1992) for correct abbreviations.
- Italicize all scientific names at the generic level or below.
- Spell out genus and species the first time used in a paragraph and abbreviate generic name by first initial thereafter in that paragraph. Do not abbreviate genus name at the beginning of a sentence.
- Use *Index Herbariorum* (*Regnum Veg.* Vol. 120. 1990; http://www.nybg.org/bsci/ih/) abbreviations to designate herbaria. It is not necessary to cite this publication.
- Do not use footnotes.
- Numbers. Write out one through nine, unless a measurement or in a description. Use comma with more than four digits (1000 but 10,000); 0.5 instead of .5; "%" instead of "percent." Use 8.0–8.5 and not 8–8.5.
- Abbreviate units of measurements without a period, e.g., km, mm, ft, mi, and so forth; temperatures are as follows: 20°C.
- Write out other abbreviations the first time used in the text and abbreviate thereafter: "Trichome morphology was examined using scanning electron microscopy (SEM)."
- If keys are included, they should be dichotomous and indented. Couplets should be numbered, not lettered, and the numbers followed by periods. Authors of taxa are not included and species are not numbered in the key.
- Specimen citation should include: locality, latitude and longitude when available, elevation, collection date, collector ("*et al.*" when more than two), collector's number, and herbarium(a) of deposit (using abbreviations in *Index Herbariorum*). Countries are cited from north to south; political subdivisions are in alphabetical order within countries; collectors are in alphabetical order within subdivisions.
- Acknowledgments should be brief and to the point.
- Manuscripts dealing exclusively with new geographic records and range extensions of previously known taxa are not of primary interest for the journal. They will be nevertheless considered for publication in a special section of LANKESTERIANA under the collective heading of "New records and range extensions", according to the availability of space and the phytogeographic significance of the proposed records. Regional extensions within-country are seldom considered for publication in the journal unless of particular relevance.

Literature Cited

- Use hanging indentation.
- Continue page number sequence.
- "In press" citations must have been accepted for publication; give the name of the journal (and volume number if known) or the publisher.
- Insert a space after each initial of an author's name.
- Insert the year of the publication in parenthesis.
- Do not abbreviate journal names.
- Titles of books are written in lower case except the first word and proper nouns and as required in original language of titles.
- Italicize title of journal and book titles.
- Italicize scientific names in the title of articles.
- Cite literature as follows:
  1. One author: Nobody, A. B. (1991).
  2. Two authors: Nobody, A. B. & Somebody, C. D. (1991).
  3. More than two authors: Nobody, A. B., Somebody, C. D. & Someother, E. F. (1991).
  4. Book chapter: Nobody, A. B. (1991). The effect of light on growth. In: C. D. Somebody (Ed.), *Light and growth* (pp. 209–291). London: Light Press. – or – Nobody, A. B. (1991). The effect of light on growth. In: C. D. Somebody & E. F. Someother (Eds.), *Light and growth* (pp. 209–291). London: Light Press.
  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.
  6. Manuscripts accepted for publication but not yet published: Nobody, A. B. (In press). Name of the journal or publisher. The name of the journal where the paper was accepted must be indicated, the volume number should be included if known.
- Please refer to the 6th Edition of APA Formatting and Style Guide for more examples of cited literature.

Tables

- Continue page number sequence.
- Each table must start on a separate page and must be double-spaced. Tables can be printed landscape or portrait. Do not reduce type size of tables. If necessary, continue table on additional pages.
- Portrait tables can be prepared to be printed 1- or 2-column width; plan accordingly.
- The title of the table should be flushed left, preceded on the same line by the word "Table" and an arabic numeral.
- Items on each row must be separated by a single tab.
- Superscripts referring to footnotes should be lowercase letters, not numbers.
- Footnotes should be placed as separate paragraphs at end of table.
- References cited in tables must be included in the Literature Cited.

Figure Legends

- Begin a new page; continue page number sequence.
- All figures (maps, photos, line illustrations) should be in a single sequence, consecutively numbered. Tables are in a separate, consecutively numbered sequence.
- Double-space the legends and group them according to figure arrangements. Do not use a separate page for each group.
- Number figures consecutively with arabic numerals.
- Type legends in paragraph format, e.g.: Figure 1. *Pleurothallis inedita*. A. Habitat. B. Flower. C. Flower dissection. D. 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 figure ("A") should be in upper case and match that on legend. Italicize collector's name and number.

- The specimen(s) on which the illustrations are based must be noted.
- The author(s) of the illustration must be credited in the figure legend.
- Do not include non-alphanumeric symbols (lines, dots, stars, etc.) in legends; label them on the figure itself or refer to them by name in the legend.

Preparation and submission of illustrations

- Illustrations should be submitted digitally as TIF files (or, exceptionally, in any format that is Adobe Photoshop compatible). Do not submit original artworks. Illustrations in “native application” file formats (e.g., PageMaker, Quark, Excel, Word, WordPerfect, etc.) will not be accepted. Photographs should be scanned at a resolution of 600 dpi; line art, 600 to 1200 dpi. All digital illustrations must be complete, with letters, scale bars, and any other labeling; label figures by press-on letters or symbols or by other mechanical lettering process; labels produced on a typewriter, dot matrix, or inkjet are unacceptable. No modifications of incomplete illustrations or illustration enhancement are provided by the editorial staff.
- Parts of a plate are labeled A, B, C, etc. Letters will be black on a white or light background; white on dark background. They are not placed over a rectangular, contrasting background, but directly on the photograph or the drawing itself, without any frame. Letters will be in Helvetica, Arial, or other san serifs fonts.
- All original artwork from which digital illustrations are derived MUST be signed; unsigned digital illustrations will not be accepted. The artist must also be cited in the Acknowledgments.
- For all illustrations, color and black-and-white photographs, the electronic files print size should be as close as possible to final published size. Print size may be reduced without loss of quality, but small files cannot be altered to fit larger dimensions.
- The journal publishes black and white illustrations (pen and ink or computer-generated), color photographs and black-and-white photographs. Halftones images generated by electronic manipulation of original photographs are not allowed for publication, due to the difficulty of their typographic reproduction and their interpretation by the readers.
- Length of an illustration or plate as published is 8” (205 mm). Allow space in that 8” for the printed caption to appear below the figure. Two widths are possible as published: 1-column is 2.8” (71 mm); full page is 5.75” (146 mm). Final resolution of all the images cannot be less than 300 dpi.
- Do not combine photographs and line art.
- When preparing composite illustrations, do not include empty space between the components. Place numbers or letters on the illustration itself, not in the margins.
- Magnifications must be indicated by means of scale bars placed directly on the illustrations. Magnifications in the figure legend are not acceptable, and such figures will be returned to the author for scale bars.
- Maps should have a border, an indication of latitude and longitude, and should not have an undue amount of unused area. Distributions of several species with non-overlapping ranges can be placed on one map by using different symbols.
- Illustrations of a new species should clearly show the characteristics that distinguish it.

Conditions for publication

- Authors are not requested to pay page charges.
- In consideration of the publication of the article, authors grant to Jardín Botánico Lankester, Universidad de Costa Rica, all rights in the article.
- Authors warrant that their contribution is an original work not published elsewhere in whole or in part, except in abstract form, and that the article contains no matter which invades the right of privacy or which infringes any proprietary right.
- Authors will receive no royalty or other monetary compensation for the assignment set forth in this agreement.
- Jardín Botánico Lankester, Universidad de Costa Rica, in turn, grants to authors the royalty free right of re-publication in any book of which they are the authors or editors, subject to the express condition that lawful notice of claim of copyright be given.

What to submit

- A working version of the manuscript, including text and low resolution images (210 dpi JPEGs) must be submitted by e-mail to the Editors at: diego.bogarin@ucr.ac.cr, franco.pupulin@ucr.ac.cr, melissa.diaz_m@ucr.ac.cr, noelia.belfort@ucr.ac.cr and lankesteriana@ucr.ac.cr, pending the submission of a e-link for high-resolution images downloading (i.e., Dropbox or WeTransfer links). Submissions can also be made through a CD or DVD via regular mail (see address above).
- CD or DVD must be Macinthosh and PC compatible, and must include two copies of manuscript and two copies of illustrations. Priority mail from abroad usually comes to Jardín Botánico Lankester, Universidad de Costa Rica, within 10 days since sent.
- Please double check in your computer the CD or DVD is readable.
- Include in the package a letter with any special instructions, any change of address during the next several months, any phone, fax, e-mail numbers for the corresponding author. Indicate which author of a multiauthored paper (if not the first) should receive the proofs.
- Immediately notify the Editor-in-chief (diego.bogarin@ucr.ac.cr), the Associate Editors (franco.pupulin@ucr.ac.cr, melissa.diaz_m@ucr.ac.cr) or the Technical Editor (noelia.belfort@ucr.ac.cr) by e-mail after sending your package.

When to submit

- The deadlines to receive manuscripts to be included in the three yearly issues of LANKESTERIANA (April, August and December) are January 1, May 1 and September 1, respectively. Pending the judgment of reviewers and the time to correspond with authors, the editorial staff of LANKESTERIANA is committed to reduce to a minimum the time for articles publication.

Submit to

- Diego Bogarín
  Editor-in-Chief, LANKESTERIANA
  Universidad de Costa Rica
  Jardín Botánico Lankester
  P.O. Box 302-7050 Cartago
  Costa Rica
  E-mail: diego.bogarin@ucr.ac.cr

- Noelia Belfort Oconitrillo
  Technical Editor, LANKESTERIANA
  Universidad de Costa Rica
  Jardín Botánico Lankester
  P.O. Box 302-7050 Cartago
  Costa Rica
  E-mail: noelia.belfort@ucr.ac.cr

- Melissa Díaz-Morales
  Associate Editor, LANKESTERIANA
  Universidad de Costa Rica
  Jardín Botánico Lankester
  P.O. Box 302-7050 Cartago
  Costa Rica
  E-mail: melissa.diaz_m@ucr.ac.cr

- Franco Pupulin
  Associate Editor, LANKESTERIANA
  Universidad de Costa Rica
  Jardín Botánico Lankester
  P.O. Box 302-7050 Cartago
  Costa Rica
  E-mail: franco.pupulin@ucr.ac.cr

Questions about LANKESTERIANA should be addressed to lankesteriana@ucr.ac.cr

LANKESTERIANA

INVITED PAPERS FROM THE
50th ANNIVERSARY OF THE LANKESTER BOTANICAL GARDEN

(*continues in the internal pages of the journal*)

EDITORIAL
UCR