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***PACHYGENIUM MUYSCHARUM* (SPIRANTHINAE), A NEW OVERLOOKED SPECIES FROM THE SUBXEROPHYTIC ENCLAVES FROM THE EASTERN RANGE OF COLOMBIA**

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ABSTRACT. *Pachygenium muyscharum*, a new species from Colombia, is described, illustrated, and aspects related to its distribution, ecology, conservation status, and relationships with morphologically similar species are discussed. This species is characterized by flowering without leaves, labellum 1.4–1.6 cm long, with the apex trilobulate and labellum nectar glands 0.2–0.4 cm long, subulate and uncinata. To date, this is the only species of the genus present in Colombia, being endemic to the subxerophytic enclaves of Cundinamarca.

RESUMEN. *Pachygenium muyscharum*, una especie nueva de Colombia, es descrita, ilustrada y se discuten aspectos relacionados con su ecología, estado de conservación y relaciones con especies morfológicamente similares. Esta especie se caracteriza por florecer sin hojas, labelo de 1.4–1.6 cm de longitud, de ápice trilobulado y glándulas de néctar del labelo de 0.2–0.4 cm de longitud, subuladas y uncinadas. A la fecha, esta especie es la única representante del género en Colombia y es endémica de los enclaves subxerofíticos de Cundinamarca.

KEYWORDS / PALABRAS CLAVE: flora de Bogotá, flora de Cundinamarca, flora of Bogotá, flora of Cundinamarca, high-Andean terrestrial orchids, orquídeas terrestres altoandinas, *Pelexia*

Introduction. Subtribe Spiranthinae is the most species-rich clade of terrestrial orchids in the New World, with *ca.* 40 genera and 500 species (Salazar *et al.* 2018). One of the largest genera in this subtribe is *Pelexia* Poit. ex Lindl. (Lindley 1826), which in its broad sense includes about 77 species (Chase *et al.* 2015). Schlechter (1920a) recognized five sections within *Pelexia*: *Cogniauxocharis* Schltr., *Centropellexia* Schltr., *Pachygenium* Schltr., *Pelexia*, and *Potosia* Schltr. The monotypic *Potosia* and one of the species of *Cogniauxocharis* have been shown to belong to *Sarcoglottis* C.Presl (Presl 1827) and *Pteroglossa* Schltr. (Schlechter 1920a), respectively (Salazar *et al.*

2018). In turn, the two species assigned by Schlechter to the section *Centropellexia* shared many features with the type species of *Pelexia*, *P. adnata* (Sw.) Spreng. (Sprengel 1826), and therefore, there is no way to distinguish this section from the section *Pelexia* (Salazar *et al.* 2018). The remaining two sections [“Eu-”] *Pelexia* and *Pachygenium*, have received different treatments in recent classifications, either as congeneric (Balogh 1982, Garay 1982, Salazar 2003) or as two separate genera (Rutkowski *et al.* 2008, Szlachetko *et al.* 2001, Szlachetko *et al.* 2005).

Salazar *et al.* (2018) assessed the phylogenetic relationships in Spiranthinae, analyzing nuclear and

plastid DNA markers of a nearly complete generic sample and about one-third of the species of the subtribe. Their results recovered two strongly supported clades corresponding to sections *Pelexia* and *Pachygenium*. Nevertheless, the low bootstrap support prevents knowing with certainty the relationships of these groups with *Brachystele* Schltr. (Schlechter 1920b). The authors of that article suggested a possible closer relationship between the *P.* sect. *Pachygenium* and *Brachystele*, based on their richness centered in eastern South America, their preference for open grassy habitats, and the pollination by bumblebees (*Bombus* spp.). In contrast, the diversity of *Pelexia* s.s. is widespread from the Andean region to Mexico and the Caribbean, its species inhabit forests, and the pollination is carried out by euglossine bees (G. Gerlach pers. comm.). All the above is consistent with the recognition of the sections *Pelexia* and *Pachygenium* (Schltr.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001) as distinct genera.

Morphologically, *Pachygenium* is distinguished from *Pelexia* by the presence of leaves gradually attenuating (vs. abruptly contracted into a pseudopetiole in *Pelexia*), the proportionately broad and wide lateral sepals, and the saccate nectary spur (vs. proportionately narrow, long lateral sepals and rounded or sharp spur). Other floral morphological differences indicated by Szlachetko *et al.* (2001) as distinctive, such as details of the rostellum and stigma, do not hold true as distinctive characters upon close examination (Salazar *et al.* 2018).

In their synopsis of the “spiranthoid” orchids of Colombia, Dueñas & Fernández-Alonso (2009) recorded 14 species of *Pelexia* s.l., including two assignable to *Pachygenium* sensu Szlachetko *et al.* (2001), namely *P. hirta* (Lindl.) Schltr. (Schlechter 1920b) and *P. orobanchoides* (Kraenzl.) Schltr. (Schlechter 1920b). The specimen quoted by Dueñas & Fernández-Alonso (2009) as *P. orobanchoides* (*M. Schneider 679/1*, COL!) had been designated by Szlachetko as the type of his new species, *Pelexia cundinamarcae* Szlach. (Szlachetko 1993), which appears to have been overlooked by Dueñas & Fernández-Alonso (2009). On the other hand, the specimen determined as *P. hirta* (*R. Schnetter 494*, COL!) corresponds to the new species here described as *Pachygenium muyscarum*.

Here, we propose a new species of *Pachygenium* which is described and illustrated. Its possible relation-

ships to other species are discussed on morphological grounds, and information about its distribution, ecology, and conservation status is provided.

Materials and methods. We conducted fieldwork at the Parque Ecológico Cerro Seco, Ciudad Bolívar locality, Bogotá D.C., in May–June 2019, May–June 2021, December 2021, and January–February 2022. The vouchers were deposited at JBB. To determine the generic identity of the species, we consulted the pertinent literature on the taxonomy of the subtribe Spiranthinae (Szlachetko *et al.* 2001, Dueñas Gómez & Fernández-Alonso 2007, 2009, Salazar *et al.* 2018). For the circumscription of *Pachygenium*, we followed Salazar *et al.* (2018). We followed the terminology of Balogh (1982), and for the seed coat morphology that of Molvray & Kores (1995); we measured the organs with a digital caliper and observed the specimens under a stereomicroscope Motic SMZ 168. We examined the protologues of the types deposited in JSTOR PLANTS website (<http://plants.jstor.org>), the collections of COL, HUA, HUQ, HUAZ, JBB, JAUM, MEDEL, MEXU, and the virtual collections (digital photographs) of A, BHBC, F, HBG, K, MBM, NY, RB, and U (acronyms follow Thiers 2022). We followed the morphological species concept (McDade 1995, Wiens & Servedio 2000, De Queiroz 2007). The Geospatial Conservation Assessment Tool (GeoCAT) application (<http://geocat.kew.org/>) was used to establish the conservation status, according to the categories and criteria of IUCN (2019).

TAXONOMIC TREATMENT

Pachygenium muyscarum Rinc.-González, Fonseca-Cortés & Salazar, *sp. nov.* Fig. 1–4.

TYPE: Colombia. Cundinamarca: Bogotá D.C., Ciudad Bolívar, Arborizadora Alta, Cerro Seco, 2800 m, 15 July 2021, *M. Rincón-González, A.I. Díaz & M. Pinzón 1842* (holotype: JBB!).

DIAGNOSIS: *Pachygenium muyscarum* is morphologically similar to *P. tamanduense* (Kraenzl.) Szlach., R.González & Rutk., from which it differs by flowering without leaves (vs. flowering with leaves), labellum 1.4–1.6 cm long (vs. 1.2–1.4 cm long), apical labellum

lobe trilobate (vs. entire, rounded) and labellum nectar glands 0.2–0.4 cm long (vs. up to 0.1 cm long).

Terrestrial *herb*, 3–5 cm in height without the inflorescence and 15–30 cm in height, including the inflorescence. *Roots* 10–20 × 0.5–0.8 cm, fasciculate, terete, attenuating slightly towards the apex, pale dull yellowish. *Leaves* 6–16 × 1–2 cm, 4–6 when present, elliptic-lanceolate, 5–6 parallel nerved, base attenuate, margin entire, apex acute, dark green adaxially, pale green abaxially, forming a rosette, with the leaves ascending; pseudopetioles sublinear, channeled, white adaxially, tawny abaxially. Inflorescence 15–25 cm long, racemose, erect, glabrous below the middle, becoming increasingly villose towards the apex, hairs multicellular and clavate; peduncle 12–20 cm long; sheaths 3.7–5.0 × 0.7–1.0 cm, 5–12, lanceolate, chartaceous, yellowish green at the base, green on the rest, glabrous; *floral bracts* 1.8–2.5 × 0.6–0.8 cm, elliptic-lanceolate, concave, cuneate, 3–4 veined, olive green, tomentose with multicellular, clavate, caducous hairs, margins irregularly ciliate and becoming papillose near the apex. *Flowers* 0.8–1.4 cm long, ascending, resupinate, dorsal sepal green, lateral sepals green with the margins white, tomentose abaxially, glabrous adaxially, petals green with the apex white, labellum green at the base, white in the middle at the apex, with greenish dorsal vein. *Dorsal sepal* 8–1.2 × 0.4–0.6 cm, ovate-lanceolate, concave, 3–5 veined. *Lateral sepals* 1.2–1.4 × 0.3–0.5 cm, lanceolate-falcate, concave, 3–5 veined, base fused into a saccate nectary. *Petals* 1.0–1.2 × 0.2–0.3 cm, oblong, spatulate, 3–5 veined, fused internally at the base with the dorsal sepal, apex acute, external margin irregularly papillose above the middle. *Labellum* 1.4–1.6 × 0.4–0.6 cm, panduriform, with 3–9 veins, base provided at each side with one subulate, uncinata nectar gland, 0.2–0.4 × to 0.1 cm, apical lobe 0.4–0.6 × 0.4–0.6 cm, rounded. *Column* 0.8–1.2 × 0.1–0.2 cm, terete, papillose, canaliculate; anther 0.2–0.4 cm long, ellipsoid; rostellum 0.1–0.3 cm long, triangular; ovary 1.3–1.6 × 0.3–0.5 cm, fusiform, cylindrical, green, tomentose; stigma concave, slightly bilobed. *Pollinarium* 4.0–4.1 × 1.9–2.0 mm, wishbone-shaped, with two creamy-white pollinia; pollinia 3.0–3.2 × 0.8–1.0 mm, ellipsoid, creamy-white, viscidium 0.3–0.5 × to 0.1 cm, rhomboid, grey.

Capsule 1.6–1.7 cm long × 0.6–0.7 cm wide, elliptic, tomentose, with 3 longitudinal keels, perianth persistent, brown. *Seeds* 0.5–0.8 × 0.15–0.20 mm, seed coat spiranthoid type, with 12–15 cells in length and 5–7 in width, cells rectangular with one of both ends arched and prominent, embryo 0.25–0.30 mm, ovoid.

ETYMOLOGY: The specific epithet “muyscarum” commemorates the indigenous ethnic group Muysca, who inhabit the Cundinamarca-Boyacá highlands where this species grows.

DISTRIBUTION AND HABITAT: To the date, *P. muyscarum* only has been found in four localities of Cundinamarca, located in subxerophytic enclaves between 2600–2800 m a.s.l. (Fig. 6). This species grows on hills with slopes with an inclination of 15–20° and well-drained soils, with an A or A/E horizon formed from the root activity within a well-drained, silty sand, thick eluviated horizon (originally formed from altered volcanic ash), which became enriched in quartz (>70%), feldspars, hornblende, and cristobalite, with some remnant (about 10%) of halloysite clay. It exhibits a pH close to 6, about 2% organic carbon, base saturation close to 60%, and low K and P contents. Below this horizon, a sequence of intercalated clayey and silty horizons with variable thickness follows, which are richer in K and P (León Linares *et al.* unpubl. data). *Pachygenium muyscarum* grows under the shadow of *Dodonaea viscosa* Jacq. (Jacquin 1760) or exposed to the sun besides *Anthoxanthum odoratum* L. (Linnaeus 1753), *Bidens andicola* Kunth (Kunth 1818), *Cuphea ciliata* Ruiz & Pav. (Ruiz & Pavón 1794), *Desmodium molliculum* (Kunth) DC. (De Candolle 1825), *Echeandia flavescens* (Schult. & Schult.f.) Cruden (Cruden 1981), *Euphorbia orbiculata* Kunth (Kunth 1817), *Evolvulus bogotensis* Ooststr. (Ooststroom 1934), *Hypericum brevistylum* Choisy (Choisy 1821), *Jarava ichu* Ruiz & Pav. (Ruiz & Pavon 1798), *Laennechia gnaphalioides* (Kunth) Cass. (Cassini 1822), *Myriopteris myriophylla* (Desv.) J.Sm. (Smith 1854), *Nassella mucronata* (Kunth) R.W.Pohl (Pohl 1990), *Pombalia parviflora* (L.f.) Paula-Souza (Paula-Souza & Ballard 2014), *Rhynchospora nervosa* (Vahl) Boeckeler (Boeckeler 1869), *Selaginella sellowii* Hieron. (Hieronymus 1900), and *Stenandrium dulce* (Cav.) Nees (De Candolle 1847).

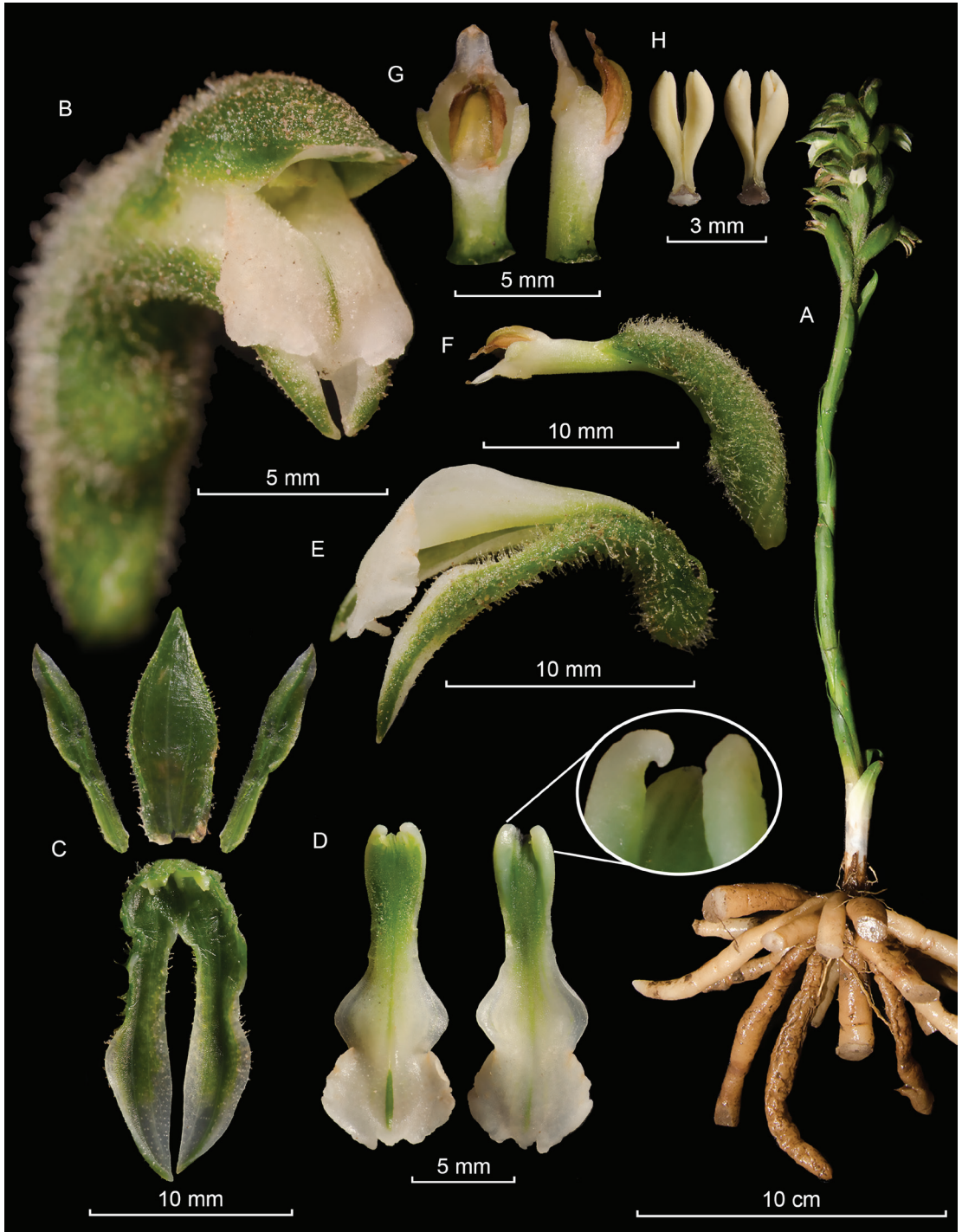


FIGURE 1. Lankester Composite Dissection Plate (LCDP) of *P. muyscarum*. A. Habit when flowering. B. Detail of the flower. C. Sepals and petals. D. Abaxial and adaxial view of the labellum, showing the falcate subulate nectary spurs. E. Labelium and sepal in lateral view. F. Column and ovary. G. Column in dorsal and lateral view. H. Pollinarium. Photographs and elaboration by Milton Rincón-González.

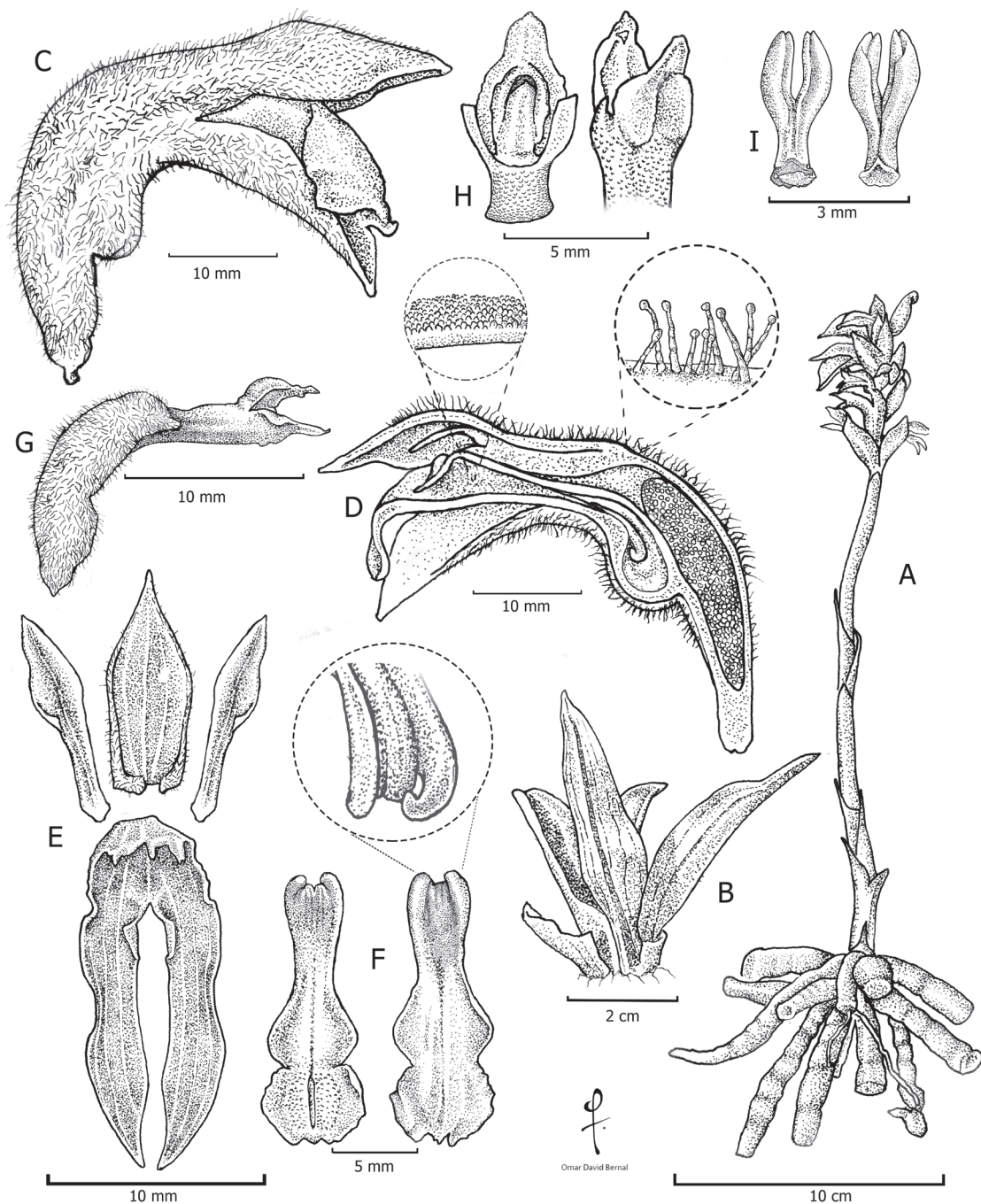


FIGURE 2. Illustration of *P. muyscarum*. A. Plant with inflorescence. B. Leaf rosette. C. Flower in lateral view. D. Longitudinal view of flower with details in the surface and trichomes. E. Sepals and superior petals. F. Abaxial and adaxial view of the labellum showing the falcate subulate nectary spurs. G. Column and ovary. H. Column in dorsal and lateral view. I. Pollinarium. Illustration based on Milton Rincón-González *et al.* 1842 (JBB). Elaborated by Omar David Bernal.

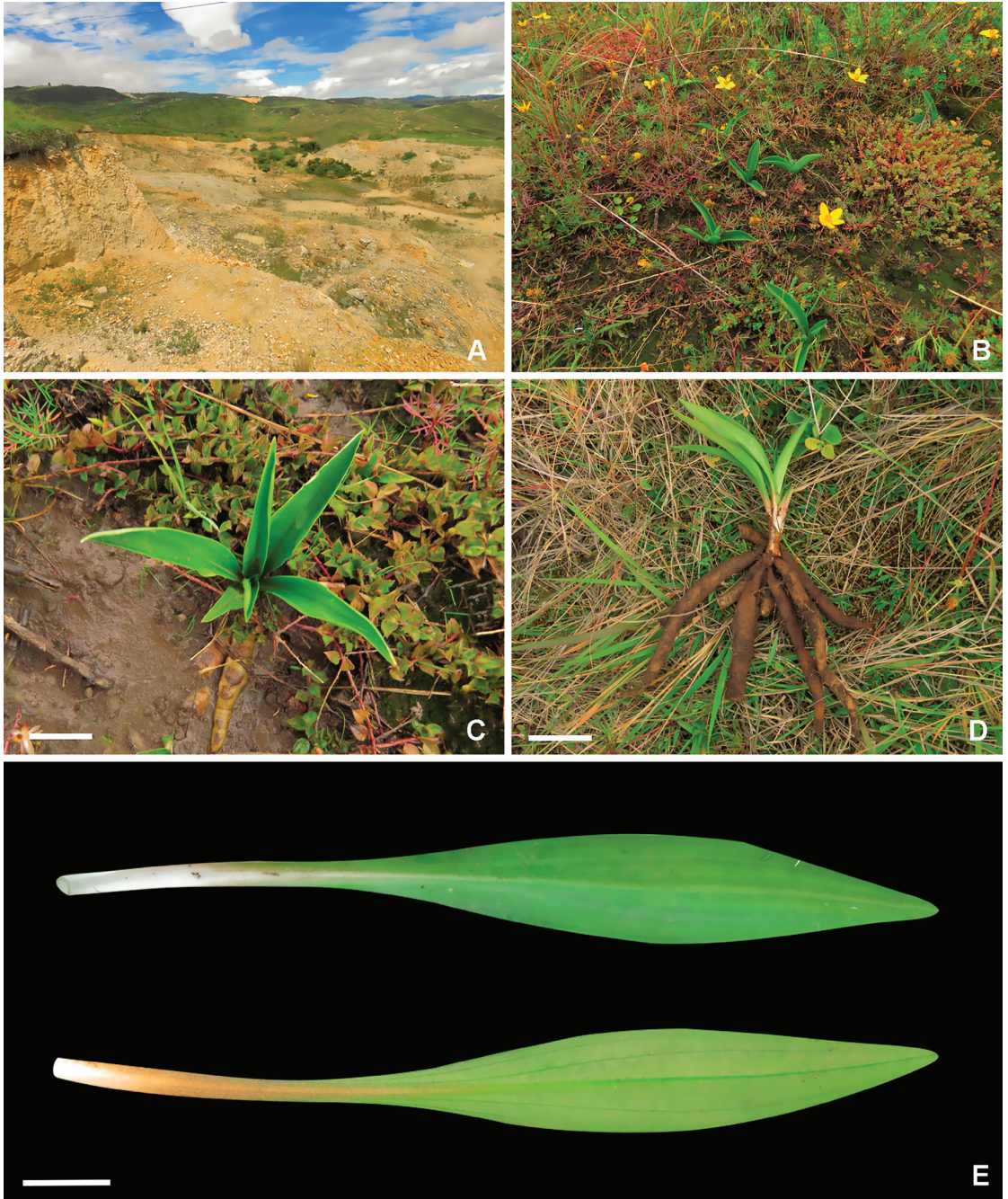


FIGURE 3. Habitat and vegetative parts of *P. myuscarum*. **A.** Habitat degraded by quarry extraction. **B.** Conserved habitat. **C.** Habit. **D.** Roots. **E.** Leaves, upper one on the adaxial surface, lower one on the abaxial surface. Scales: C-D: 2 cm, E: 1 cm. Photographs and elaboration: Andrés Fonseca-Cortés.

CONSERVATION STATUS: The extent of occurrence (EOO) is 916.306 km², and the area of occupancy (AOO) is

20 km²; hence, *P. myuscarum* meets the requirements under criterion B for threatened species (AOO < 2000



FIGURE 4. Reproductive parts of *P. myscarum*. A. Inflorescence. B. Bracts. D. Flower in front view. E. Flower in lateral view. F. Longitudinal cut of the flower showing the ovary, the subulate nectary spur, and the nectary chamber. Scales: A=1 cm, B=1.5 cm, D–E=0.5 cm. Photographs by: Andrés Fonseca-Cortés.

km). Additionally, it is only known from four localities, the populations are declining due to the presence of goats, cattle, and horses, quarrying, adventure sports (ATV and motorcycle tracks), and establishment of invasive neighborhoods. In this sense, the Endangered (EN) category is proposed (B2aiii) (IUCN 2019).

ADDITIONAL SPECIMENS EXAMINED: Colombia. Cundinamarca: Bogotá D.C. Ciudad Bolívar, Parque Ecológico Cerro Seco, 2800 m, 26 V 2021, *B. Villanueva et al.* 6022, JBB! municipio Nemocón, vereda Moguá, 2650 m, 31 July 2007, *S.P. Cortés* 4970 (JBB!); municipio Madrid, Hacienda Casa Blanca, cúspide del cerro, fr-

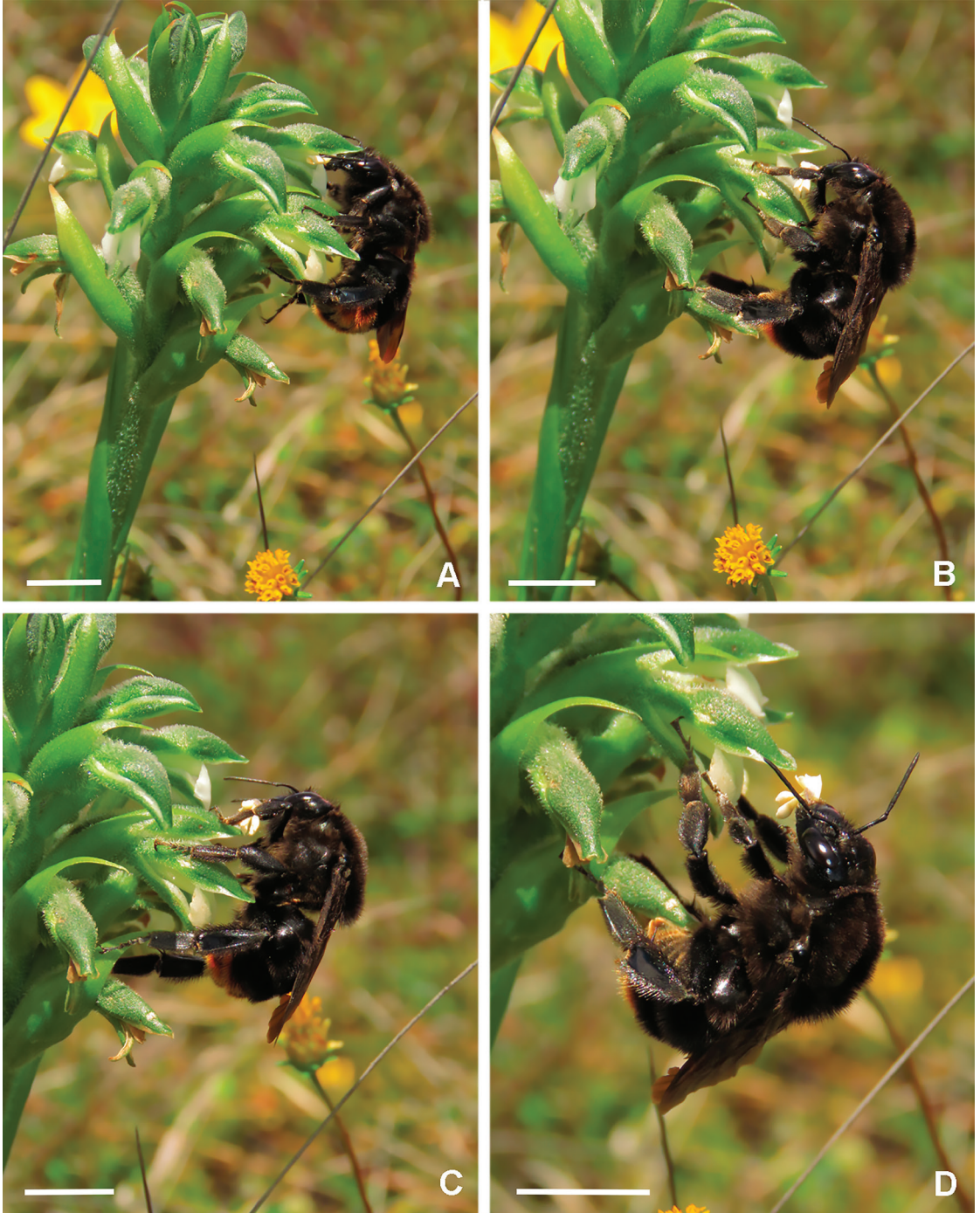


FIGURE 5. *Bombus atratus* visiting *P. muscarum*. A–D. sequence of visiting for nectar and consequent pollinarium removal. Scales: A–C: 1 cm, D: 2 cm. Photographs and elaboration by Andrés Fonseca-Cortés.

ente a la casa principal, 11 July 1999, Y.A. Mora & R. Sánchez 155 (COL!); municipio de Mosquera, zona

xerofítica de la laguna de la Herrera, 22 June 1972, R. Schnetter 494 (COL!).

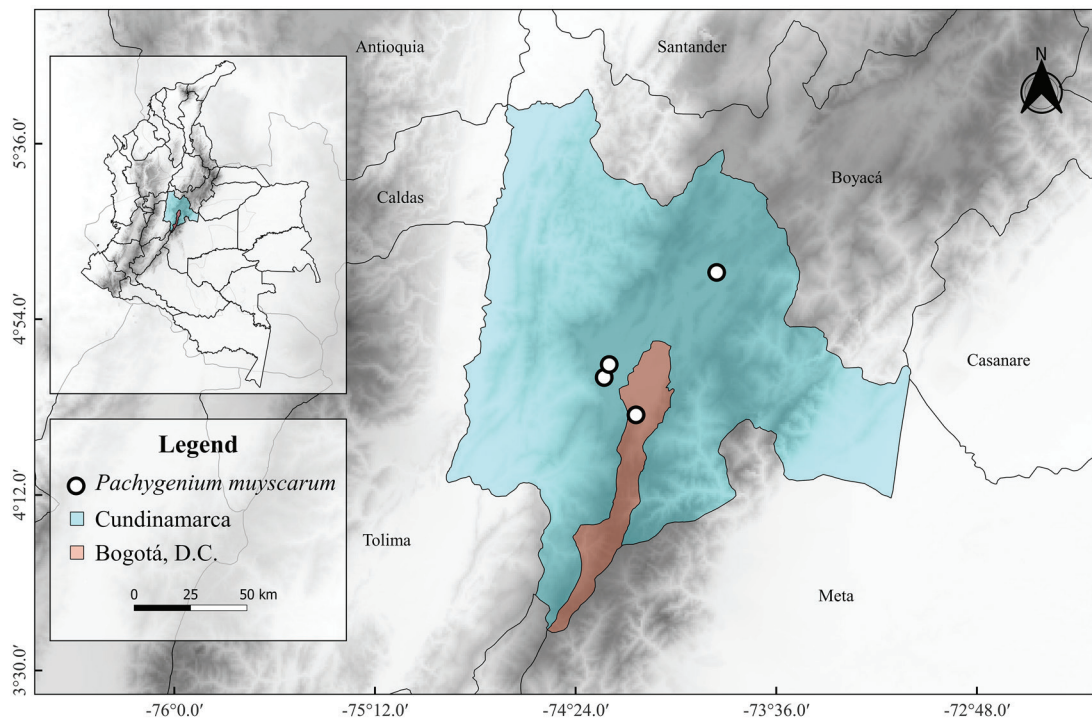


FIGURE 6. Distribution map of *Pachygenium muyscarum*. Elaborated by Camila Castellanos.

ECOLOGY: The places in which this species grows have a bimodal precipitation pattern, with the dry seasons usually occurring in December–March and July–September and the humid seasons in October–November and April–June. *Pachygenium muyscarum* produces leaves and flowers in the humid seasons, whereas during the dry seasons most individuals lose the leaves. The plants have a strong radicular system (Fig. 1D) which probably stores starch and allows this species to survive the dry season. We recorded *Bombus atratus* Franklin (1913) pollinating the flowers of *P. muyscarum* (Fig 3); when the bee visits the flower, it introduces its mouth parts deeply into the flower to reach the nectar, and the pollinarium attaches to the bee's labrum (Fig. 5D).

This bumblebee species has been reported as a pollinator of *Pachygenium oestriiferum* (Rchb.f. & Warm.) Szlach., R.González & Rutk. in a similar manner to *P. muyscarum* (Singer & Sazima 1999).

Discussion. *Pachygenium muyscarum* is similar to *P. ekmani* (Kraenzl.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001), *P. longibracteatum* (Pabst) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001), *P. tamanduense* (Kraenzl.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001) and *P. ventricosum* (Cogn.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001), but it is clearly distinguished from them by the characters listed in Table 1.

TABLE 1. Differences among *P. muyscarum* and morphologically similar species.

Characters	<i>P. ekmani</i>	<i>P. longibracteatum</i>	<i>P. muyscarum</i>	<i>P. tamanduense</i>	<i>P. ventricosum</i>
Leaves present at flowering	Yes	Yes	No	Yes	No
Length of labellum (cm)	1.4–1.6	1.0–1.2	1.4–1.6	1.2–1.4	1.2–1.4
Apex of the labellum apical lobe	Entire	Entire	Trilobate	Entire	Entire
Length of the labellum spur (cm)	0.2–0.3	0.1–0.2	0.2–0.4	to 0.1	to 0.1
Distribution	Brazil	Brazil	Colombia	Brazil	Paraguay

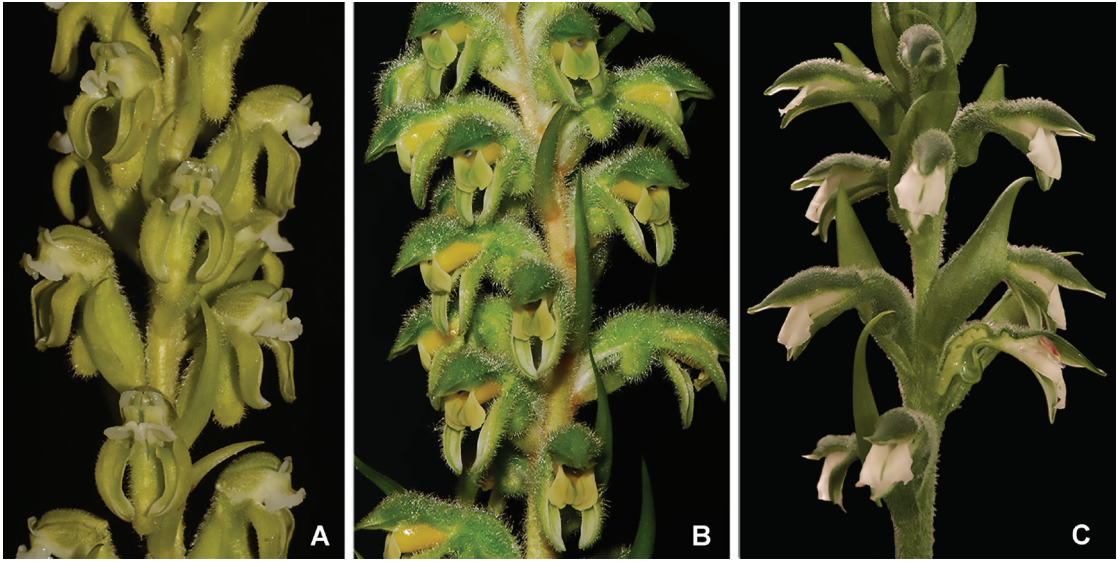


FIGURE 7. Comparison between the flowers of *P. orobanchoides* (A; Brazil, J.A.N Batista 2403), *P. hirtum* (B; Ecuador, F. Tobar s.n.) and *P. muyscarum* (C; Colombia, M. Rincón-González 1842). Photographs by João Aguiar Nogueira Batista (A), Francisco Tobar (B), and Andrés Fonseca-Cortés (C). Plate preparation: Andrés Fonseca-Cortés.

In their synopsis of the Colombian Spiranthoideae, Dueñas Gómez and Fernández-Alonso (2009) recorded 14 species of *Pelexia*, without considering the combinations in *Pachygenium* done by Szlachetko *et al.* (2001). Of those species, only two are now included in *Pachygenium*, *P. hirtum*, and *P. orobanchoides*. *Pachygenium hirtum* was recorded based on the specimen Mora & Sánchez 155 (COL!) and *P. orobanchoides* on the specimen Schneider 679/1 (COL!). Close study of those specimens allowed us to determine that Mora & Sánchez 155 corresponds to the species described here as *P. muyscarum*. At the same time, Schneider 679/1 is the holotype of *Pelexia cundinamarcae*, a species described in 1993 by Szlachetko but not reported by Dueñas Gómez and Fernández-Alonso (2007). Therefore, the only species of *Pachygenium* present in Colombia is

P. muyscarum. Photographs of flowers of the three species are presented above (Fig. 7) because *P. hirtum*, *P. orobanchoides*, and *P. muyscarum* could be confused, and the former two were attributed to Colombia by Dueñas and Fernández-Alonso (2009).

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