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RESTREPIA RESTREPOI: A NEW SPECIES FROM THE CLOUD FORESTS OF THE COLOMBIAN WESTERN ANDES

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Abstract. A new species of *Restrepia* from the Department of Valle del Cauca, exclusively found in the montane rainforest of the Western Colombian Andes, is described and illustrated. This new species is morphologically similar to *Restrepia chrysoglossa*, another species endemic to Valle del Cauca; however, it can be distinguished by its brown-spotted sheaths, cleistogamous non-spreading flowers, oblong, attenuated, non-clavate dorsal sepal, and pyriform, when expanded, ovate lip. We discuss its morphological affinities and provide notes on its conservation status and ecology, highlighting its restricted distribution and potential threats to its habitat, along with a distribution map.

Resumen. Se describe e ilustra una nueva especie de *Restrepia* del departamento del Valle del Cauca, restringida al bosque montano lluvioso de los Andes Occidentales de Colombia. La nueva especie es morfológicamente similar a *Restrepia chrysoglossa*, otra especie restringida al Valle del Cauca; sin embargo, puede distinguirse por sus vainas con manchas marrones, sus flores cleistógamas que no abren completamente, su sépalo dorsal oblongo, atenuado y no claviforme, y su labelo ovado y piriforme cuando está expandido. Se discuten las especies morfológicamente similares y se proporcionan notas sobre su estado de conservación y ecología, destacando su distribución restringida y las posibles amenazas a su hábitat, así como un mapa de distribución.

Keywords / Palabras clave: Dapa, endemic species, especies endémicas, Orchidaceae, Pleurothallidiinae *Restrepia aberrans*, *Restrepia chrysoglossa*, *Restrepia flosculata*, taxonomía, taxonomy

Introduction. Colombia is one of the most orchid-diverse countries in the world, particularly across the three mountain ranges of the northern Andes (Karremans *et al.*, 2023; Luer & Thoerle, 2012; Pérez-Escobar *et al.*, 2022). However, deforestation, primarily driven by agricultural expansion, has diminished the natural habitat cover of Andean ecosystems. The remaining habitat exhibits signs of significant human intervention, with 78% of forest recovery being disrupted, arrested, or unsuccessful (Christmann *et al.*, 2023; Rodríguez Eraso *et al.*, 2013). This trend poses a threat to the rich diversity of many Andean orchid species (Parra-Sánchez *et al.*, 2016, 2023).

Restrepia Kunth (Orchidaceae: Pleurothallidinae) is one of the most taxonomically challenging genera due to high intra-specific variation within species (e.g., color patterns) and extremely uniform interspecific floral morphology. These factors complicate species circumscription and identification in both herbaria and living specimens (Luer, 1996). This taxonomic difficulty has persisted since the earliest collections of the genus in the late 18th and early 19th centuries (Gutiérrez

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Morales *et al.*, 2023; Luer, 1996). The genus currently comprises approximately 60 species, distributed from Mexico to the tropical Andes (Gutiérrez Morales *et al.*, 2023; Karremans *et al.*, 2023). It is monophyletic (Chumová *et al.*, 2021; Pérez-Escobar *et al.*, 2017) and can be recognized by its ramicauls, which are surrounded by imbricating, papery, distichous, laterally flattened sheaths, as well as the dorsal sepal and petals that are thickened at the apex by osmophores (Vogel, 1990). Additionally, the lip's hypochile features a pair of uncinate, capillary processes, a characteristic that is absent in *Restrepia aberrans* Luer, the sole member of the *Restrepia* subgen. *Ecmeles* Luer (Luer, 1996).

Phylogenetic studies place *Restrepia* within the *Restrepia* affinity clade (sensu Chumová *et al.*, 2021; Karremans, 2016), alongside related genera such as *Barbosella* Schltr., *Chamelophyton* Garay, *Dresslerella* Luer, *Echinosepala* Pridgeon & M.W.Chase, *Myoxanthus* Poepp. & Endl., *Pleurothallopsis* Porto & Brade, and *Restrepiella* Garay & Dunst. All these genera are characterized by exhibiting single-flowered co-florescences (Rojas-Alvarado & Karremans, 2024).

According to the IUCN criteria (2020), 75% (35 species) of assessed *Restrepia* species are threatened with global extinction due to deforestation and illegal collection (BGC, 2024; Calderón-Sáenz, 2007). This issue is exacerbated by the narrow endemism of many species, some of which are historically rare (e.g., *Restrepia chocoensis* Garay, *R. cuprea* Luer & R.Escobar, *R. chrysoglossa* Luer & R.Escobar, *R. howei* Luer). The Colombian Andes serve as the center of diversity for the genus, with 31 species, of which 19 are endemic to the country (Gutiérrez Morales *et al.*, 2023; Karremans *et al.*, 2023; Luer, 1996). However, less than 40% of the natural cover remains across the three cordilleras in Colombia (Rodríguez Eraso *et al.*, 2013), and the transformation of natural habitats further endangers the future of many orchid species (Ospina-Calderón *et al.*, 2023).

In this study, we describe and illustrate a newly discovered *Restrepia* species found during recent botanical explorations in the montane rainforests of the Department of Valle del Cauca, Colombia. This region has drawn the attention of botanists because it harbors a high level of plant species endemism, and several novel orchids from various genera have been documented in the area (e.g. Ortiz *et al.*, 2011; Reina-Rodríguez *et al.*, 2019, 2022). The new species, *R. restrepoi,* appears to be restricted to the western Andes of Colombia and is morphologically similar to the Valle del Cauca endemic *R. chrysoglossa.* Natural populations of this species have been identified in both highly fragmented and conserved forest patches. We provide a color illustration, a taxonomic description, a comparison with its morphologically similar species, and a distribution map.

Materials and methods. We sampled natural and human-modified habitats using a randomized design in the Departments of Valle del Cauca in Colombia. Following Parra-Sánchez *et al.* (2023), we established 50 sampling points in natural habitats (37 plots) and pastures (13 plots) across an 800 m elevational range (1800–2600 m, Tadono *et al.*, 2014). Natural habitats generally support native species and represent baseline ecosystems, serving as references for understanding ecological dynamics. In contrast, human-modified habitats often display altered species compositions, which can provide valuable insights into the effects of environmental change. After the conversion of natural habitats, about 80% of orchid species are lost, while driving 90% of orchid turnover, indicating that most orchid species are confined to pristine environments (Parra-Sánchez *et al.*, 2016, 2023). Each plot covered 300 m^2 (10 × 30 m), maintaining a minimum distance of 200 m apart, and we sampled all possible substrates up to 2 m in height (i.e., phorophytes, ground, fallen branches). In addition to the randomized plot sampling, we conducted over 56 hours of random walks to enhance our sampling effort. Plants were collected under collection permits issued by the Agencia Nacional de Licencias Ambientales (ANLA n. 791), and vouchers were preserved as dried and spirit specimens for future reference at Jardín Botánico de Bogotá (JBB *sensu* Thiers, 2024).

Field images were captured using a Canon ® T3i, equipped with a Canon 100 mm f/2.8 USM macro lens. Sketches of living and preserved specimens were digitized, and the images were utilized to create a draft composite plate in Adobe Photoshop® 2020. Living and preserved specimens were examined for morphological and taxonomic comparisons in accordance with the latest taxonomic treatment (Luer, 1996) and subsequent new species descriptions (e.g., Gutiérrez

Morales, 2023). Botanical terminology adhered to the standards set by Luer (1996), Gutiérrez Morales *et al.* (2023), and Rojas-Alvarado and Karremans (2024). Environmental variables were obtained from ClimateCharts.net (Zepner *et al.*, 2020) and the Holdridge life zones (Holdridge, 1987). Maps were produced using QGis 3.16 (QGIS 2021). Plant names and authors are based on standard databases (Epidendra, 2025; IPNI, 2025; Tropicos, 2025).

Taxonomic treatment

Restrepia restrepoi E.Restrepo & E.Parra ***sp. nov.*** (Fig. 1, 4A).

TYPE: COLOMBIA. Valle del Cauca: Yumbo, Dapa. Vía a los cultivos de Té, 2200 m, 15 December 2024 (fl.), *E.Restrepo & D. Edwards 319* (holotype JBB!).

Diagnosis: reminiscent of *Restrepia chrysoglossa* (Fig. 2, 4B) in plant shape, size and flower colors, but easily distinguished by its brown-spotted sheaths (*vs.* unspotted, except the lowermost, dotted with brown), the cleistogamous, non-spreading flowers (*vs.* non-cleistogamous, spreading), the oblong, attenuated, non-clavate dorsal sepal (*vs.* narrowly ovate-triangular, clavate) and its ovate lip, pyriform when expanded, 4.8 × 2.9 cm (*vs.* oblong-ovate, 9.00 × 4.25 cm).

Plant epiphytic, caespitose, erect to sub-erect, up to 35 cm tall; *roots* slender. *Ramicauls* erect, 12–24 cm long, enclosed by 5–10 thin, whitish, brown-spotted, papery, loose, imbricating, oblique, laterally compressed, acute sheaths, the uppermost prominent, elongate, acuminate, extended to near the middle of the pseudopeduncle, acuminate. *Leaf* erect, coriaceous, ovate-elliptical, 7.2–8.1 × 2.8–3.4 cm, the apex emarginate, with the mid vein extending beneath and ending in a short mucro, the base slightly cuneate to rounded, contracted into a twisted petiole *ca.* 3 mm long. *Inflorescence* with a reduced peduncle *ca.* 2 mm long, enclosed by a 3 mm long spathe, producing single-flowered coflorescenses in succession. *Pseudopeduncle* 3.2–3.6 cm long, glabrous, subtended by a 1.0–2.5 mm long bracts, 2–3 at a time; *floral bract* thin, tubular, 3 mm long, pedicel 1.5 mm long, the remnant of the axis a filament 1 mm long, free; *ovary* 2.63 mm long; *Flower* yellow, often cleistogamous, *sepals* membranous, glabrous, not wide-spreading, the *dorsal sepal* free, oblong, attenuated at the apex, slightly thickened near the apex, 7.5 × 2.1 mm, 5-veined, the *lateral sepals* connate to each other forming a synsepal, bifid at the apex when expanded, oblong, attenuated, 7.5 × 5.4 mm, 13-veined; *petals* membranous, translucent, suffused with yellow along the margins, with a notorious midvein discontinuously suffused with purple, narrowly linear triangular, the apex minimally clavate-thickened, 7 × 0.8 mm at the base; *lip* magenta-yellow, oblong and concave in natural position, pyriform when expanded, 4.8 × 2.2 mm in natural position, 2.9 mm wide across the lateral processes expanded, 3-veined, the epichile indistinctly demarcated from the hypochile, broadly triangular, concave, smooth, rounded at the apex, the hypochile subquadrate, concave, each side with a microscopic, capillary, uncinate process, the disc featureless, the base connected to the column-foot by a short, thick, cylindrical neck; *column* greenish-white, the basal half slender, clavate, the margins of the apical half irregular 4.92 mm long, the base pedestal-like. *Pollinia* and *anther cap* not seen. *Capsule* oblong, strongly ridged, about 7.9 cm long.

Eponymy: Named after Eugenio Restrepo Hoyos, Colombian entrepreneur and father of the first author, who has enormously supported him in all his passions and personal aims. This species is dedicated to him as an act of gratitude.

Discussion. The infrageneric placement of *Restrepia restrepoi* (Fig. 1, 4A) remains uncertain. According to Carl Luer´s infrageneric system (Luer, 1996), the new species displays diagnostic features from both *Restrepia* subgen. *Restrepia* and the monospecific *Restrepia* subgen. *Ecmeles*. The former includes most of the species and is characterized by elliptical to ovate, petiolate leaves; clavate dorsal sepals; lateral sepals without thickened apices; and a lip hypochile that features microscopic, capillary, uncinate processes on each side (also present in *Restrepia* subgen. *pachymeles*). The latter, *Restrepia* subgen. *Ecmeles*, is distinguished by the non-clavate dorsal sepals, free lateral sepals, and a lip with obtuse, marginal, lateral lobes on the hypochile (Luer, 1996).

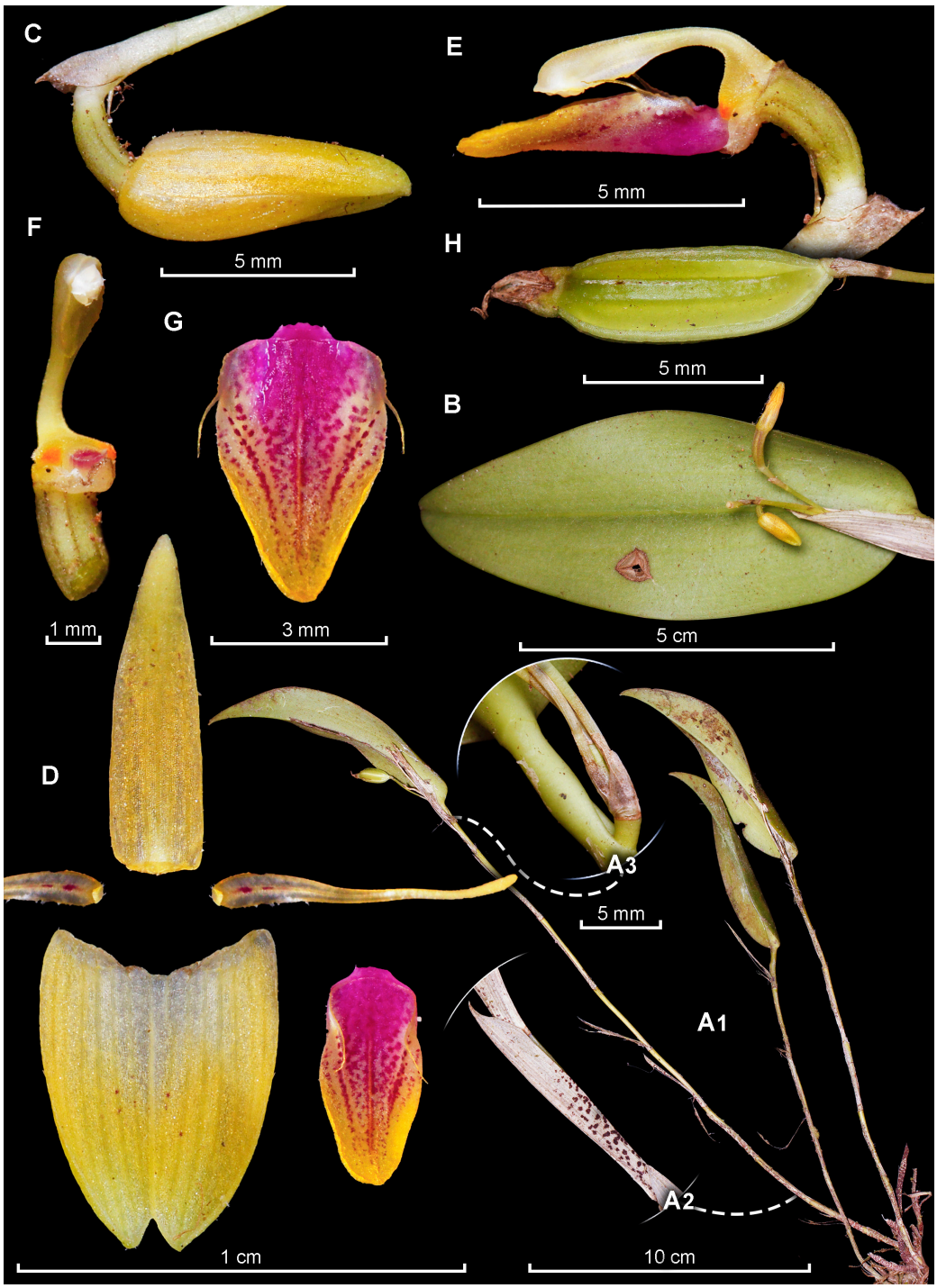

FIGURE 1. Dissection plate of *Restrepia restrepoi* E.Restrepo & E.Parra. **A1**. Plant habit. **A2**. Floral bract. **A3**. Close-up to the peduncle of the inflorescence bearing multiple single flowered co-florescences. **B**. Adaxial view of the leaf, showing the multiple inflorescences at a time. **C**. Mature bud, lateral view. **D**. Dissected perianth. **E**. Column plus lip, lateral view. **F**. Column, ¾ view. **G**. Expanded lip. **H**. Capsule, lateral view. Prepared by Eugenio Restrepo from the holotype.

However, free lateral sepals cannot be used to diagnose the subgenus itself, as they have proven inconsistent across populations of its only member, *R. aberrans* (Fernández *et al.*, 2014; Luer, 1996). Since the new species presents a non-clavate dorsal sepal, lateral sepals connate into a synsepal, and the typical uncinate, capillary processes on the lip hypochile, we believe this species should be classified as "*incertae sedis*" until further phylogenetic studies on the infrageneric relationships of the genus are conducted. Thus, the new species further provides evidence that groups within the genus need to be reconsidered.

Restrepia restrepoi (Fig. 1, 4A) can be distinguished from other species in the genus by its ramicauls, which are enclosed by dark-spotted sheaths, entirely light yellow, unspotted cleistogamous flowers, the oblong, non-clavate dorsal sepal that is attenuated and slightly thickened at the apex, the 13-veined synsepal, and its lip, which is intense rose at the base and pyriform when expanded, featuring basal, capillary, uncinate processes.

The species that are morphologically most similar to *R. restrepoi* are *R. chrysoglossa* (Fig. 2, 4B) and *R. flosculata* Luer (Fig. 3, 4C). Both are yellow-flowered species from the Western Colombian Andes in Valle del Cauca's department. The former is known only from its type locality and is endemic to the department, while the latter, which is also found in northwestern Ecuador, exhibits various color forms across populations, ranging from purple-dotted or striped to entirely yellow (as shown in Fig. 3; Luer, 1996). All three species exhibit similar overall plant size, short pseudopedunculate coflorescences, and almost entirely yellow flowers.

As discussed in the diagnosis, *R. restrepoi* is distinguished from *R. chrysoglossa*, by its brown-spotted sheaths (*vs.* unspotted, except for the lowermost, dotted with brown), the cleistogamous, non-spreading flowers (*vs.* non-cleistogamous, spreading), the oblong, attenuated, non-clavate dorsal sepal (*vs.* narrowly ovate-triangular, clavate) and its ovate lip, pyriform when expanded, 4.8 × 2.9 (*vs.* oblong-ovate, 9.0 × 4.25 cm). In addition to those characteristics, the new species exhibits shorter sepals, *ca.* 7.5 mm long (*vs.* up to 20 mm long), and unstripped synsepal (*vs.* striped with red below the middle).

The new species can be easily distinguished from *Restrepia flosculata* by its brown-spotted sheaths all along the ramicaul (*vs.* the lowermost brown spotted), the uppermost sheath elongate, acuminate (*vs.* oblique, acute), the cleistogamous, non-spreading flowers (*vs.* non-cleistogamous, spreading), the shorter sepals, *ca.* 7.5 mm long (*vs.* to 14 mm long), the oblong, attenauted, non-clavate dorsal sepal (*vs.* narrowly triangular below the middle, attenuate above, clavate), straight petals (*vs.* decurved), and attenuated lip, pyriform when expanded, with rounded apex, 4.8 × 2.9 (*vs.* broadly oblong lip with retuse apex, 7 × 3.75 cm).

Finally, the new species resembles *R. aberrans* (Fig. 4D), which is restricted to Costa Rica and Panama. Both species show autogamous plants with non-clavate dorsal sepals, but the new species presents larger ramicauls, 12.3–23.4 cm long (*vs.* 7.5–11.5 cm long), enclosed by brown-spotted sheaths (*vs.* 1.5–3.5 cm long, unspotted sheaths), lateral sepals connate to each other forming a synsepal, bifid at the apex when expanded, oblong, attenuate, 7.5 × 5.4 mm, 6–7 veined each (*vs.* often free or slightly adherent, oblique, oblong-acute, 10.0 × 1.5 mm, 5-veined each) and the lip shape and dimensions, pyriform when expanded, 4.8 × 2.9 mm, rounded at the apex, the hypochile with two lateral, capillary, uncinate processes (*vs.* oblong-trilobed when expanded, 3.0 × 2.0 mm; the hypochile with two lateral, oblique, erect lobes, and two inner erect blades). The differences among the new species and its morphological affinities are shown in Table 1.

Habitat and ecology: The remaining forests on the eastern flank of Colombia's western cordillera are often highly fragmented, primarily due to extensive conversion of forested areas to pastures (Rodríguez Eraso *et al.*, 2013). *Restrepia restrepoi* is exclusively known from three localities located 9.2 km apart (Fig. 5). Individuals grow epiphytically on branches of tree canopies and young trees, near roads or trails (Fig. 6), alongside other *Restrepia* species (*R. brachypus* Rchb.f.) and several members of the Orchidaceae family, including *Dracula chimaera* (Rchb.f.) Luer, *Dichaea andina* Alomía & Sambin, *Lepanthes trimerinx* Luer, *L. sanjuanensis* Bogarín & Karremans, *L. stellaris* Luer & Hirtz, and *Telipogon mayoi* Reina-Rodr. & C.Martel, among others.

Flowering has been observed in the wild from February to May (Haelterman, pers comm.). Several indi-

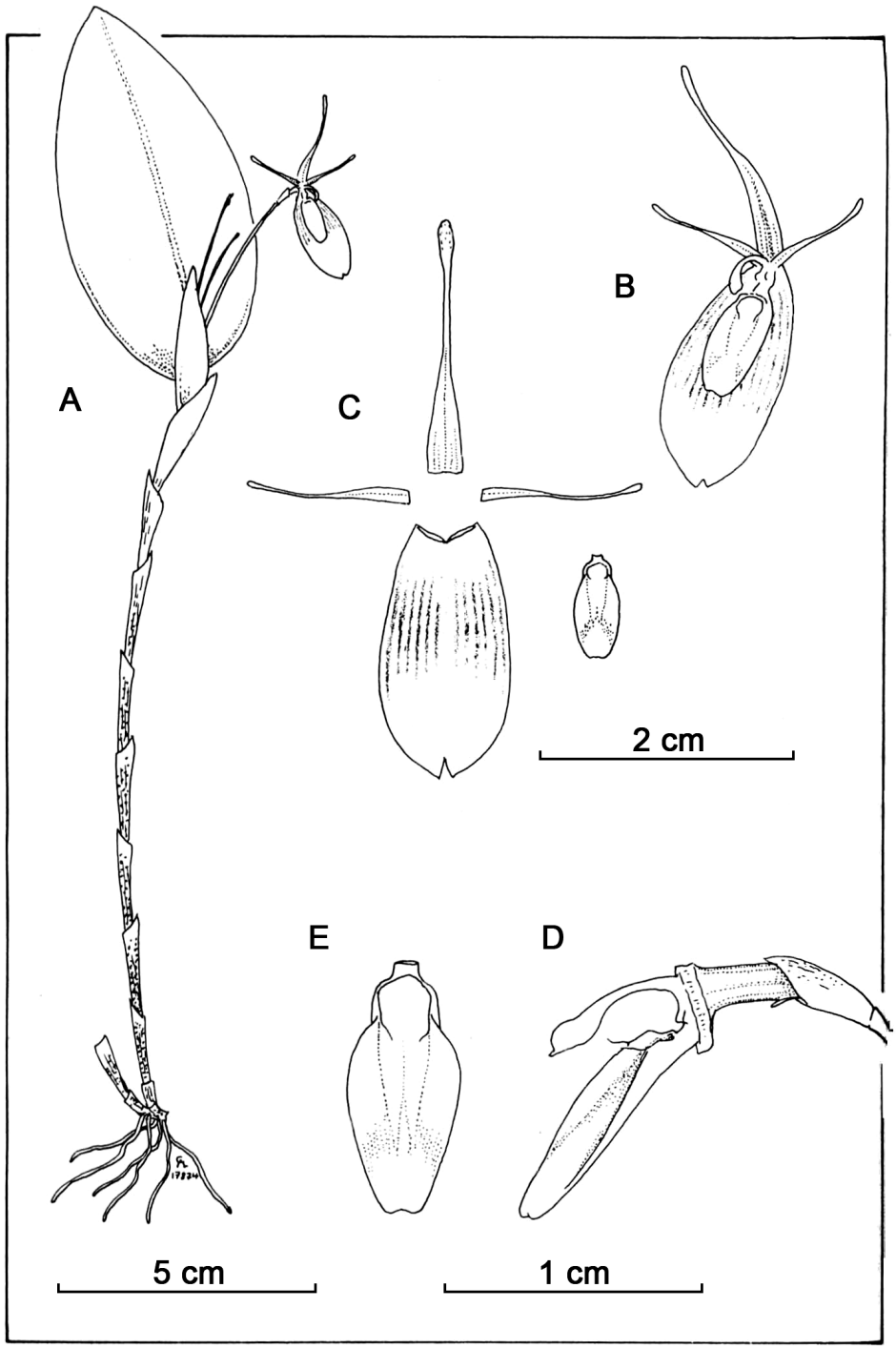

FIGURE 2. Type illustration of *Restrepia chrysoglossa* Luer & R.Escobar. **A**. Plant habit. **B**. Flower, ¾ view. **C**. Dissected perianth. **D**. Column and lip, lateral view. **E**. Lip, frontal view. Illustration by Carlyle A. Luer, featured in the Monographs in Systematic Botany from the Missouri Botanical Garden, Vol. 59, p. 43, Plate 10 (Luer, 1996). Reproduced with permission from the Missouri Botanical Garden Press.

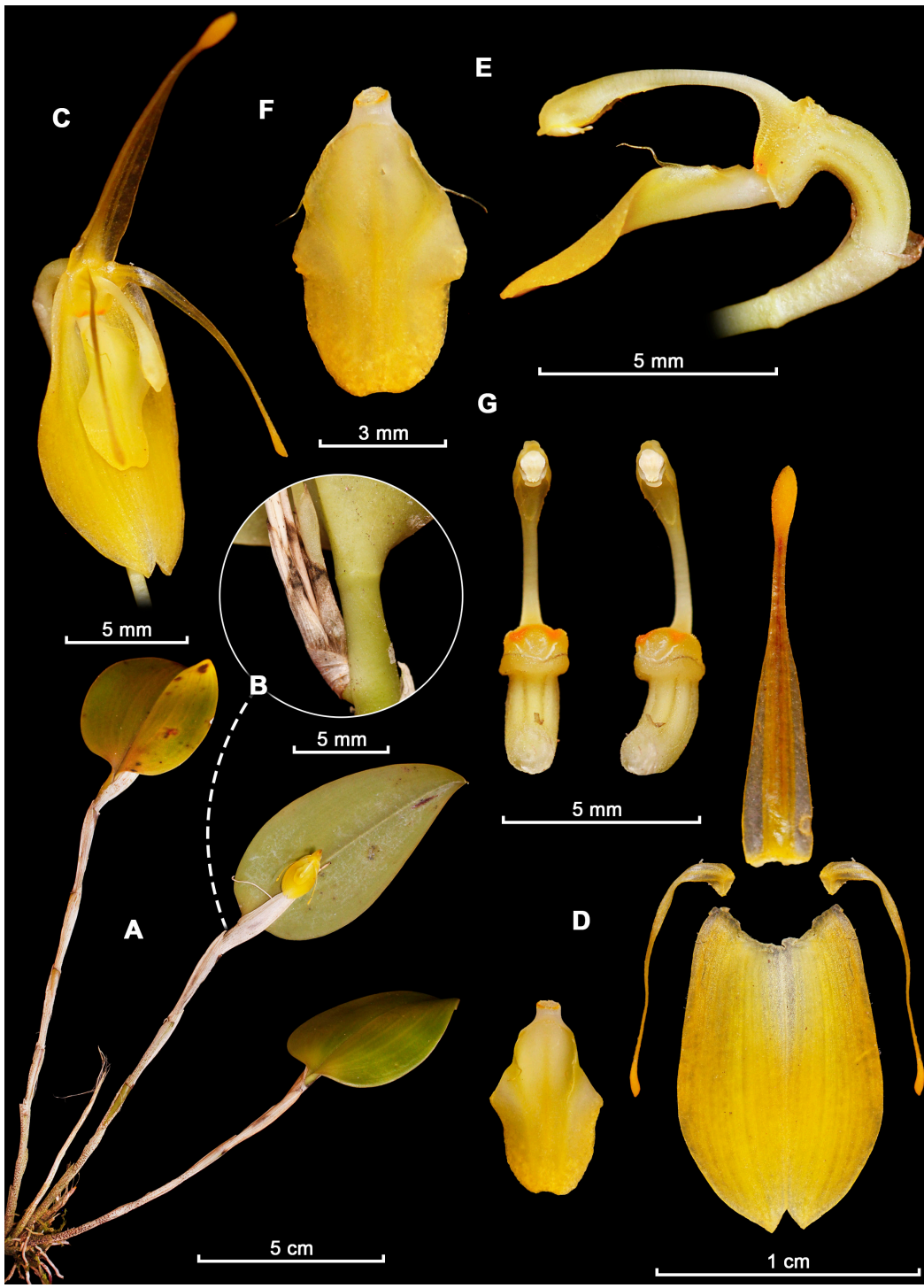

Figure 3. Dissection plate of *Restrepia flosculata* f. *xanthina.* **A**. Plant habit. **B**. Close-up to the peduncle of the inflorescence bearing multiple single flowered coflorescences. **C**. Flower, **¾ view**. **D**. Dissected perianth. **E**. Column and lip, lateral view. **F**. Expanded lip. **G**. Column, ventral and ¾ views. Prepared by Eugenio Restrepo.

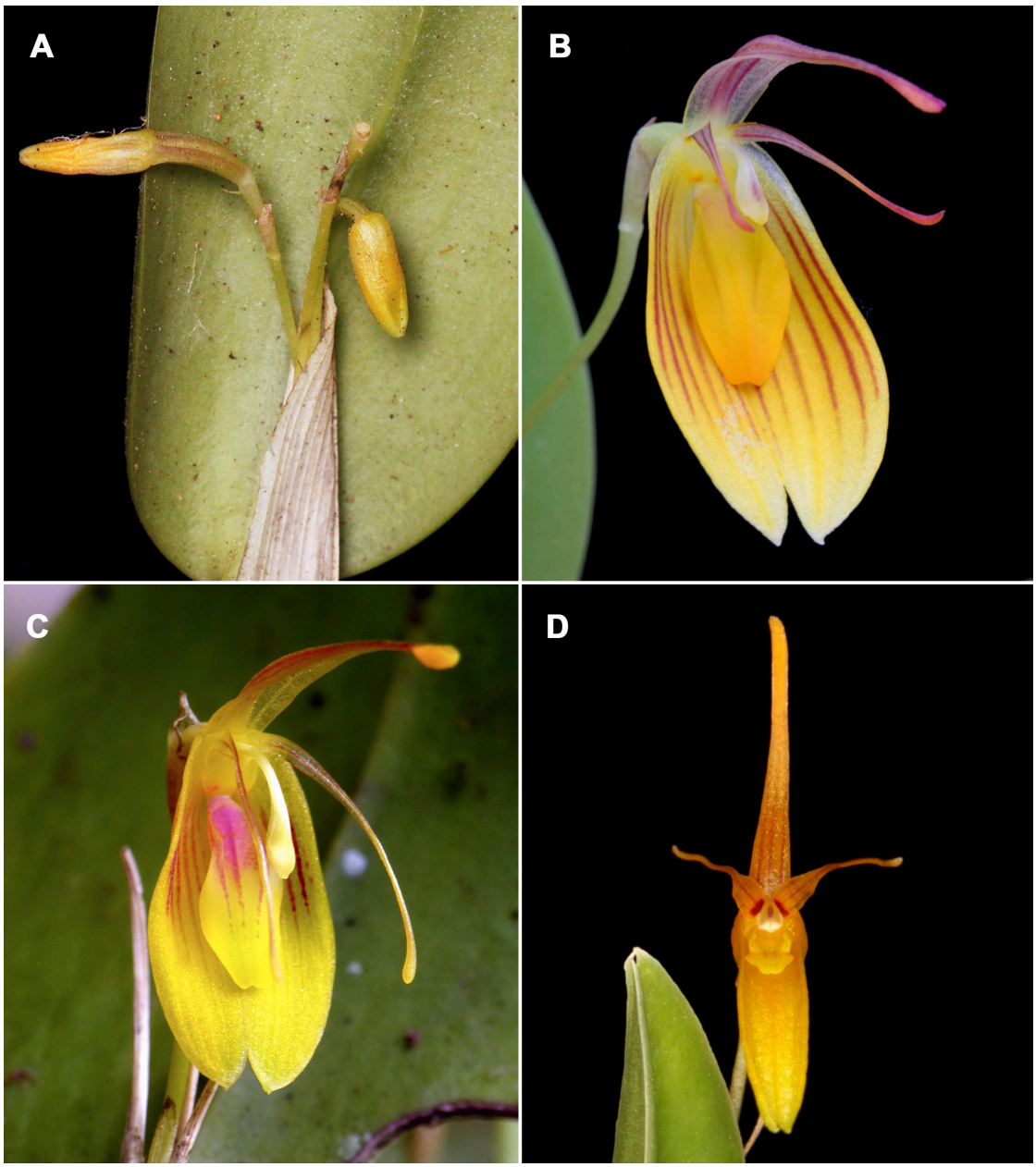

FIGURE 4. Species comparison. **A**. *Restrepia restrepoi* E.Restrepo & E.Parra. **B**. *R. chrysoglossa* Luer. **C**. *R. flosculata* Luer, type form. **D**. *R. aberrans* Luer. Photographs by Eugenio Restrepo (A), Wiel Driessen (B, D), and Andreas Kay (C).

viduals were found with capsules at different stages of development from flowers, leading us to hypothesize, *a priori*, that this species may be autogamous. However, further field observations and experimental treatments are needed to better understand its pollination syndrome and ecological interactions.

CONSERVATION STATUS: The species may be classified as Data Deficient (DD) according to IUCN criteria (IUCN, 2020). However, our data suggests that conservation actions are necessary for the populations. The species is currently known from three sites that are located 9.2 km apart within a narrow elevation-

Table 1. Comparison among *Restrepia restrepoi* E.Restrepo & E.Parra and its closest morphological affinities.

Traits	*R. aberrans*	*R. chrysoglossa*	*R. flosculata*	*R. restrepoi*
Distributional and abiotic conditions				
Distributional range	Atlantic basin, premontane wet forest	Cauca river basin, montane wet forest	Cauca river basin, premontane rain forest	Cauca river basin, Montane rain forest
Habitat	Primary cloud forest	Secondary cloud forest	Primary cloud forest	Primary and secondary cloud forest
Elevation range (m a.s.l.)	350–790	2164	2122	1910–2100
Mean annual rainfall (mm)	3040	2934.5	1682.3	1900–2100
Annual mean temperature (°C)	23	23.7	21	15–17
Morphological and phenological conditions				
Ramicauls length (cm)	1.5–3.5	9–20	15–20	12.3–23.4
Leaf blade size (cm)	6.0–8.0 × 3.0–4.0	6–8 × 3–4	8–10 × 3.5–4.5	7.9–8.1 × 3.2–3.4
Lateral sepals	5-veined	6-veined	7–8-veined	6–7-veined
Dorsal sepal	Narrowly linear-triangular	Narrowly ovate-triangular, clavate, thickened at the apex	Narrowly ovate-triangular, clavate, thickened at the apex	Oblong, attenuated, slightly thickened at the apex
Dorsal sepal lenght (mm)	10	20	14	7.5
Lip shape (expanded)	Oblong-trilobed	Oblong-ovate	Oblong	Ovate, Pyriform
Expanded lip dimensions (mm)	3.0 × 2.0	9.00 × 4.25	7.00 × 3.75	4.8 × 2.9
Lip hypochile	Broadly concave above the subtruncate base, bearing two lateral, oblique, erect lobes, and two inner, erect blades	Subquadrate, concave, with a microscopic, capillary, uncinate processes	Rounded, concave with thin, erect margins, each side with a capillary, uncinate process	Subquadrate, concave, with a microscopic, capillary, uncinate processes
Lip epichile (mm)	Oblong, 3-veined, rounded at the apex	Ovate, thickened, smooth, subtruncate	Oblong, smooth, the apex subtruncate-retuse	Broadly triangular, concave, smooth, rounded at the apex

al band (between 1900 and 2200 m in elevation). We encountered only four mature individuals and two juveniles, which indicates a small population size. Additionally, no individuals were found in 50 randomized sampling plots, despite significant sampling efforts involving two experienced orchidologists working eight hours a day for nine days near the type locality of *R. restrepoi*. Therefore, we will refrain from collecting any more individuals until further populations are discovered. The species inhabits a fragmented landscape where population dynamics are disrupted (Ospina-Calderón *et al.*, 2023), and natural forests experience edge effects that may reduce habitat availability (Parra Sánchez *et al.*, 2016).

Our study provides evidence that the species is geographically rare, characterized by a small population size and highly specialized habitat requirements (Rabinowitz, 1981). Two key conservation actions are necessary. First, additional field surveys should be conducted to search for the species in adjacent areas, potentially expanding its known range. Second, the

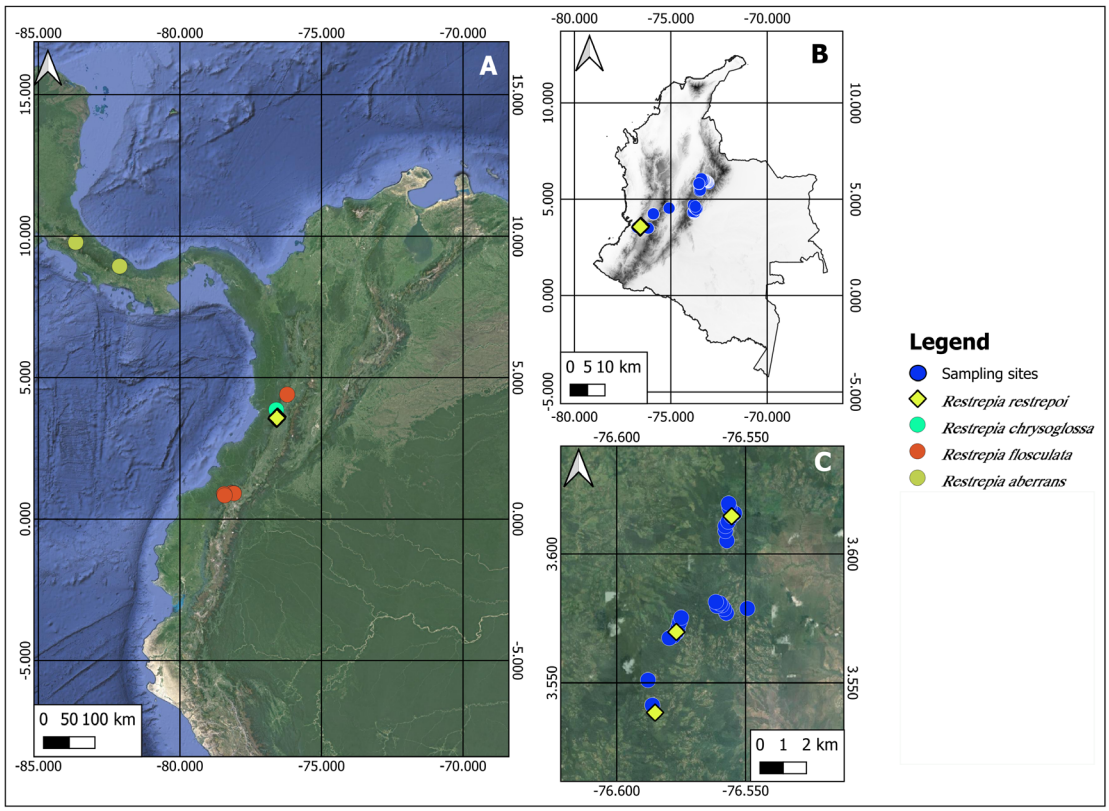

FIGURE 5. Distribution map of *Restrepia restrepoi* E.Restrepo & E.Parra, related species, and the study area in the Western, Central and Eastern Cordilleras of the Colombian Andes. **A**. Distribution of *R. restrepoi* E.Restrepo & E.Parra. (yellow triangles), *R. chrysoglossa* Luer & R.Escobar (cyan dots), *R. flosculata* Luer (red dots), and *R. aberrans* Luer (green dots). **B**. Study area within Colombia (black silhouette), along with sampling plots (blue dots) and elevation data (digital elevation model from Tadono *et al.*, 2014). **C**. Landscape across sampling sites and the localities where *R. restrepoi* was found. Map created by Edicson Parra using QGIS 3.24.1.

protection of the species' habitat and surrounding forests must be prioritized to ensure habitat conservation. This approach would likely facilitate seed dispersal from existing mother plants and promote the regeneration of more extensive secondary forest areas within the species' distribution.

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AUTHOR CONTRIBUTIONS. ER: Writing – original draft, review and editing; taxonomic treatment; discussion; taxonomic comments; visualization and design of figures; and fieldwork. EPS: Writing – original draft, review and editing; visualization; GIS software usage; sampling methodology; data curation; conceptualization; and fieldwork. DPE: Conceptualization; writing – review and editing; supervision; resources; funding acquisition; and fieldwork.

PERMITS. Plants were collected under collection permits issued by the Agencia Nacional de Licencias Ambientales (ANLA n. 791).

Figure 6. Mature and juvenile plants of *Restrepia restrepoi* E.Restrepo & E.Parra growing *in situ*. **A**. Mature plant growing on medium-sized branches of a fallen tree. **B**. A juvenile plant growing on thin branches. **C**. Mature individual seen from the underside, along with other *Lepanthes* spp. Photographs by Eugenio Restrepo (A, B) and David Edwards (C). Prepared by Eugenio Restrepo.

Conflict of interest. The authors declare no competing financial interests or personal relationships that could have influenced the work presented in this paper.

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