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A NEW SPECIES OF *BEGONIA* FROM THE CHOCÓ BIOGEOGRAPHICAL REGION OF COLOMBIA

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A new cane-like begonia species, *Begonia embera* Jara & D.Franco, is described and illustrated. Morphological and molecular evidence suggest that it belongs to *Begonia* sect. *Ruizopavonia*. This species has been collected only in the Chocó Department, Colombia, growing by streams that flow into the Atrato river. We discuss its phylogenetic relationships, provide illustrations, and present the findings of an assessment of its conservation status.

Keywords. Cucurbitales, Neotropics, Western Cordillera.
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Introduction

Having 2049 currently accepted species, *Begonia* L. is one of the most species-rich genera in tropical regions. The Neotropics, where 631 species have been recorded, is the second centre of diversity for the genus after Southeast Asia (Hughes *et al.*, 2015–). A significant portion of *Begonia* diversity in the Neotropics is located in the humid montane forests of the Andes, particularly the northern region within Colombia. In that country, the most diverse *Begonia* section with cane-like species is *Begonia* sect. *Casparya* (Klotzsch) Warb., represented by 33 species. Other sections that include Colombian species having the same growth form are *Begonia* sect. *Cyathocnemis* (Klotzsch) A.DC. (three species), *Begonia* sect. *Hydristyles* A.DC. (one species), *Begonia* sect. *Lepsia* (Klotzsch) A.DC. (eight species) and *Begonia* sect. *Ruizopavonia* A.DC. (nine species) (Hughes *et al.*, 2015–).

In the sectional classification of *Begonia* proposed by Moonlight *et al.* (2018), some species previously included in *Begonia* sect. *Ruizopavonia*, according to Doorenbos *et al.* (1998), were placed in *Begonia* sects *Cyathocnemis*, *Donaldia* (Klotzsch) A.DC., *Lepsia* and *Pritzelia* (Klotzsch) A.DC.; in some cases, this was with some uncertainty due to the absence of samples in the phylogeny. Based on this revised concept of the section, *Begonia* sect. *Ruizopavonia* includes cane-like species with raised veins on the underside of leaves, elliptic or oblong anthers longer than the filaments, and fewer than five tepals in the female flower (except in *Begonia harlingii* L.B.Sm. & Wassh. and *B. tiliifolia* C.DC.).

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Ongoing research on the systematics of Colombian begonias has uncovered several taxonomic novelties. In this paper, we describe a new species that grows in the western foothills of the Colombian Cordillera Occidental, in the transition zone between the Chocó and Andean biogeographical regions. This species was first collected in the 1970s by researchers of the Colombian National Herbarium (COL), and was collected again by the authors in recent years. We present a description and discuss taxonomic relationships based on morphological similarity and a nuclear ribosomal DNA phylogeny. We complement the description with a line illustration, photographs of the live plant, a conservation assessment, and habitat notes.

Materials and methods

Expeditions to the region where a specimen of this previously unnamed species was collected for the first time in the 1970s were undertaken in May 2015 and March 2021. Specimens were collected using traditional herbarium methods, including the use of silica gel to desiccate plant material ready for DNA extraction and the preparation of spirit samples to facilitate morphological study. The collection of material of the species was in accordance with the permit issued under resolution number 1177 of 14 October 2014, by the Colombian environmental licensing agency (Autoridad Nacional de Licencias Ambientales). Material of the seven newly sequenced species was obtained from the cultivated sources listed in the **Appendix table**.

The dried material was used for measurements of vegetative structures, whereas the spirit-preserved collections were used for measurements of flowers and fruits. A digital calliper with 0.01 mm precision was used for measurements of the smaller structures (approximately < 1 cm), and a conventional ruler with 1 mm precision was used for larger structures. The qualitative and quantitative morphological characters most commonly described in the taxonomic literature for *Begonia* were recorded for the formal taxonomic description and for comparison with similar species.

DNA extraction and sequencing of the nuclear ribosomal ITS regions of the unidentified species were carried out at the Laboratory of Molecular Plant Systematics, Los Andes University, Bogotá. We used the Qiagen DNA extraction kit (Qiagen, Germantown, Maryland, USA), following the manufacturer's protocols. Each 25.2-µL PCR amplification sample contained 1 µL of template; 5 µL of QIAGEN PCR buffer; 0.75 µL of both forward and reverse primer (10 mM), using the same ITS primers used by Clement *et al.* (2004); and 0.2 µL of Phusion Taq polymerase (Thermo Fisher Scientific, Waltham, Massachusetts, USA). Finally, 11 µL of double-distilled H2O, 2.5 µL of dNTPs (2 µM) and 4 µL of TBT-PAR were added.

For the phylogenetic analysis, we included the sequence of the unidentified species, seven new sequences of potentially related species (sequenced using protocols described by Clement *et al.*, 2004) and 22 sequences retrieved from GenBank (https://www.ncbi.nlm.

nih.gov/genbank/) (see **Appendix**). DNA sequences were aligned using MAFFT (Katoh *et al.*, 2019) and then edited manually in AliView 1.26 (Larsson, 2014). The alignment included 30 sequences and was 980 bp in length. Bayesian phylogenetic analysis was run locally in the program MrBayes 3.2.7a (Ronquist *et al.*, 2012), employing the model GTR + G + I, MCMC strategy was to run the program for 1,000,000 generations, sampling each 100 generations, and sampling every 1000 generations.

Results

Taxonomically informative characters validate the distinctiveness of a new species (see *Taxonomic treatment*). Vegetative morphological characters of this species, as well as its floral and fruit characters, were found to generally fall within the variation of *Begonia* sect. *Ruizopavonia*; an exception was the number of bracteoles.

In the **Table**, a comparison with the sections of Neotropical clade 2-ii, *sensu* Moonlight *et al.* (2018) is presented. The new species shares with other members of *Begonia* sect. *Ruizopavonia* raised veins on the underside of the leaves, elliptic or oblong anthers that are longer than the filaments, male flowers with four tepals, and female flowers with three to five tepals.

With the tree search strategy used, satisfactory search parameters were reached: standard deviation of split frequencies, < 0.01; potential scale reduction factor for all parameters of the model, close to 1.0; and effective sample size, > 100. According to the maximum clade credibility tree obtained, the new species is sister to two species in *Begonia* sect. *Ruizopavonia*, namely *B. botryoides* Moonlight & Tebbitt and *B. convallariodora* C.DC. ex Donn.Sm., and this group of three species is sister to the clade formed by *Begonia* sects *Casparya* and *Lepsia* (**Figure 1**).

Taxonomic treatment

Begonia embera Jara & D.Franco, **sp. nov.**

In *Begonia* sect. *Ruizopavonia*, *B. embera* is most similar to *B. harlingii* L.B.Sm. & Wassh. but is distinguished by its much shorter petioles (1.5–5.6 mm vs 25–75 mm), narrower leaves (1.5–2.8 cm vs 3–6 cm) and fewer secondary veins (4–6 vs 9–13). Floral differences include the smaller outer staminate tepals (2.7–4.5 × 1.4–2.5 mm vs 5–10 × c.5 mm), female flowers with 3 bracteoles (vs 2 in *B. harlingii*) and shorter styles (0.7–2.1 mm vs 4–5.5 mm). – Type: Colombia, Chocó, municipio El Carmen del Atrato, vereda El Doce, carretera Medellín-Quibdó, km 150, 700 m, 6 vi 1979, *G. Galeano & R. Bernal* 98 (holotype COL [barcode: COL000138608], isotype HUA). **Figures 2**, **3**.

Cane-like herb, to 30 cm tall, without tubers or rhizomes. *Stem* 0.7–2.7 mm in diameter, unbranching or branching near to the base, reddish green, nodes thickened, internodes 4.2–26 mm long. *Stipules* persistent, membranous, glabrous, hyaline to light green, oblong,

Table. Morphological comparison between *Begonia embera* and closely affiliated sections in the Andean cane-like group, excluding *Begonia* sect. *Casparya*, which can be easily differentiated by fruit type

Character	*B. embera*	*§ Begonia*	*§ Cyathocnemis*	*§ Doratometra*	*§ Ephemera*	*§ Hydristyles*	*§ Lepsia*	*§ Ruizopavonia*
No. tepals in staminate flowers	4	4	2	2 or 4	2 or 4	2 (4 in *B. ophiogyna* L.B.Sm. & B.G.Schub., of doubtful circumscription)	4	4
No. tepals in pistillate flowers	5	5	2 (rarely, in species of doubtful circumscription, 3 or 5)	4 or 5	5	5 (or 6)	5	3–5
Wing relative size	Wings subequal	Usually one wing longer than other two	One wing longer than other two (rarely subequal)	Usually one wing longer than other two	Wings subequal or one wing longer than other two	One wing longer than other two	One wing longer than other two	One wing longer than other two
Relative length of anther to filament	Longer	Longer	Longer or shorter	Longer or shorter	Longer	Usually longer	Shorter (except *B. foliosa* Kunth)	Longer
Style division	Bifid	Bifid	Bifid or multifid	Bifid, or rarely multifid	Bifid	Forked more than once	Bifid, or multifid in *B. guaduensis* Kunth	Bifid
Veins on the underside of the leaves	Conspicuous	Conspicuous	Conspicuous	Conspicuous	Conspicuous	Conspicuous	Indistinct	Conspicuous
Number of bracteoles in female flowers	3	2 (or 3)	Usually 2 (3 in *B. magdalenae* L.B.Sm. & B.G.Schub.)	2 or 3	2 or 3	2 (or none)	2	2

§, Section.

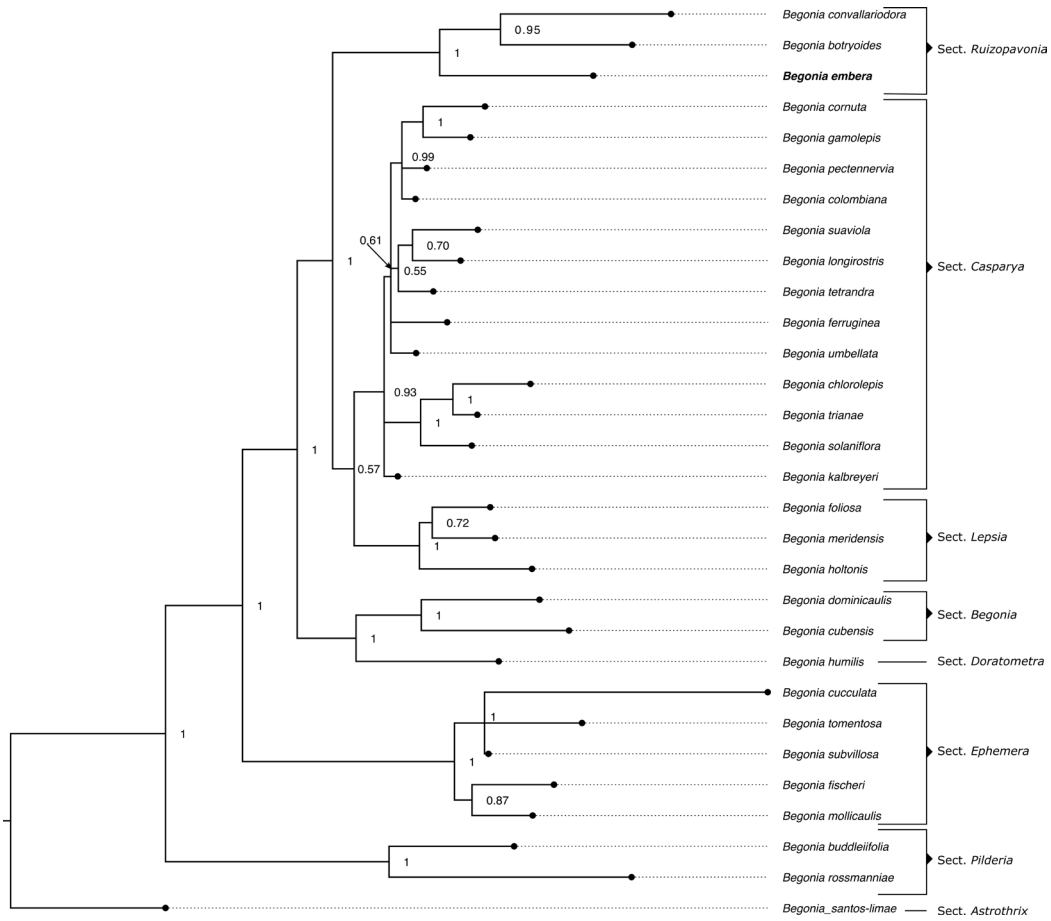

Figure 1. A 50% majority rule consensus tree for species in the cane-like sections of Neotropical clade 2, *sensu* Moonlight *et al.* (2018). Posterior probability support values are shown at the bases of the branches.

4.5–12.2 mm long, margin entire, apex acuminate. *Leaves* distichous, c.6 per stem; *petiole* glabrous, 1.5–5.6 mm long; *leaf blade* straight to the petiole, dark green above, pale green below, hairs only on the midvein above and on the margin, slightly asymmetrical, narrowly oblong-obovate, 4.3–10 × 1.5–2.8 cm, apex acuminate, base acute, truncate, or shallowly cordate, with one side connecting to the petiole c.2 mm above the other, margin biserrate with a seta at the end of each tooth, venation pinnate, 4–6 secondary veins per side. *Inflorescence*: 1–3 per plant, axillary, cymose, with 3 male flowers and 1 female flower per inflorescence, protandrous; *peduncle* erect, reddish white, glabrous, 1.3–4 cm long; *bracts* persistent, hyaline, elliptic, 4–7.5 × 1.7–2.8 mm, apex acute, margin fimbriate. *Staminate flowers*: pedicels white, glabrous, 4.5–7 mm long; *tepals* spread

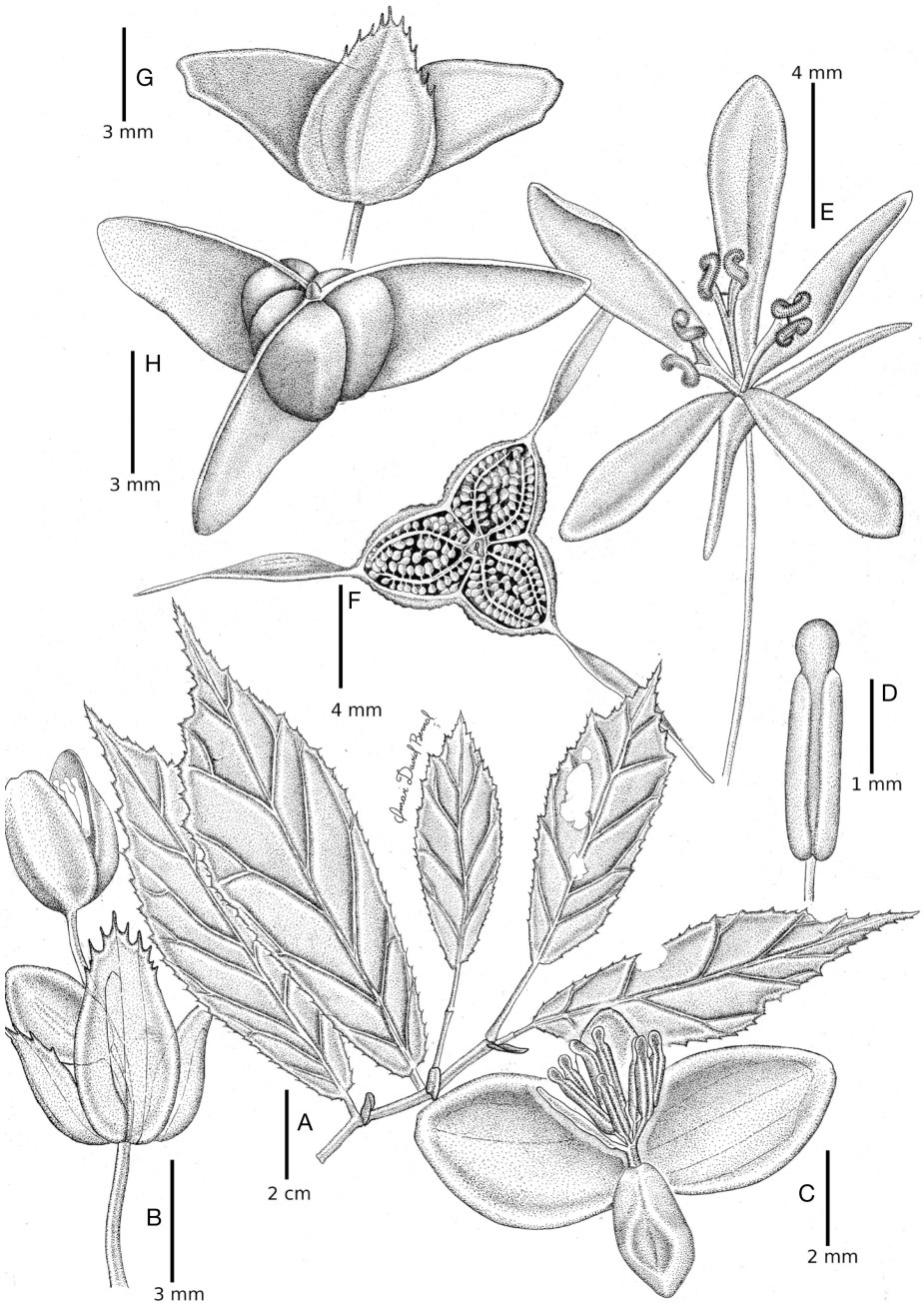

Figure 2. *Begonia embera* Jara & D.Franco, sp. nov. A, Sterile branch; B, detail of the inflorescence; C, staminate flower; D, detail of one stamen; E, pistillate flower; F, transverse section of the ovary; G, young fruit with bracteole; H, fruit without bracteoles. Drawn from *G. Galeano & R. Bernal* 98 (the type specimen), *A. Jara & D. White* 2796 and *A. Jara & D. White* 2799, by Omar Bernal.

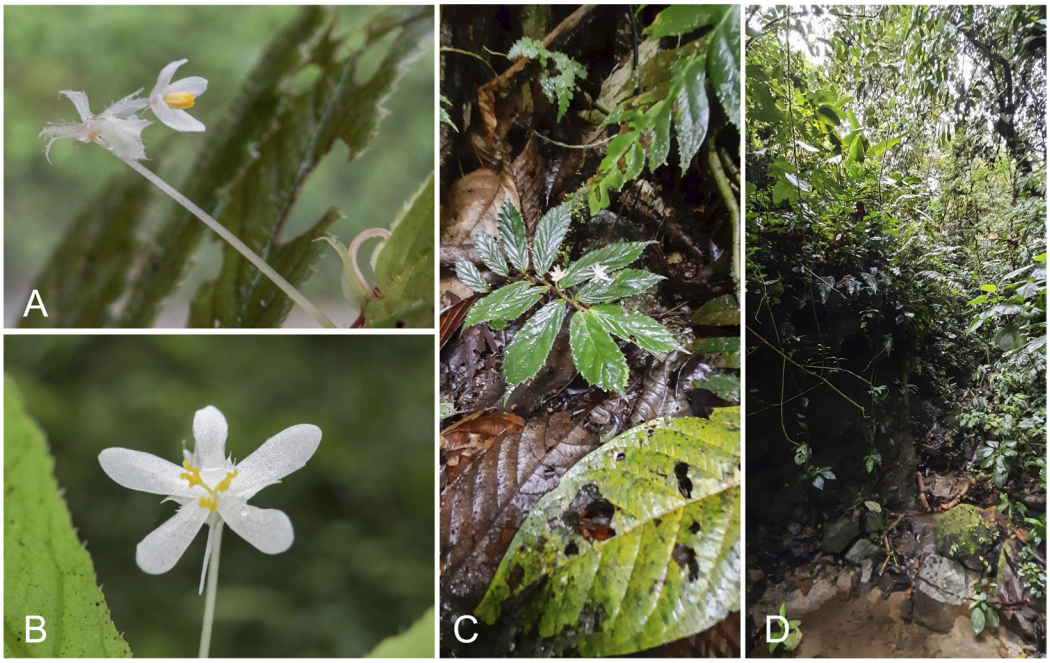

Figure 3. *Begonia embera* Jara & D.Franco, sp. nov. A, Staminate flower; B, pistillate flower; C, plant habit; D, habitat of the species. Photographs of *A. Jara & D. White* 2796, taken by Angela Sanchez.

apart, 4 in two series, white, glabrous, outer two broadly ovate, 2.7–4.5 × 1.4–2.5 mm, apex rounded, base obtuse, margin entire, inner two elliptic, 2.5–3.2 × 1–1.8 mm, base obtuse, apex rounded, margin entire; *stamens* 10–15, on a short torus, filaments white, glabrous, 0.2–1 mm long, anthers linear-oblong, longer than the filaments, 1.2–2 mm long, dehiscence longitudinal by lateral slits, connective projecting 0.2–0.4 mm long, with a rounded tip. *Pistillate flowers*: pedicels white, glabrous, 0.7–2 mm long; *bracteoles* 3, on the base of the ovary, subpersistent, hyaline, elliptic, 4.3–8 × 2.7–4.7 mm, margin ciliate, apex acute; *ovary* glabrous, body fusiform, 2.8–3.9 × 2.4–3.9 mm, wings asymmetrically triangular, with the short side distal, perpendicular to the axis, and the long side proximal and roughly at 45° to the axis, subequal or the adaxial wing slightly longer, apex obtuse, 3-locular; *placentation* axillary, placentas bilamellate, with ovules on both sides; *tepals* 5, deciduous in fruit, spread apart, white, oblanceolate, 6.5–9.3 × 2.5–3.3 mm; *styles* 3, free, 0.7–2.1 mm long, bifid, stigmatic papillae twisted. *Fruiting peduncle* erect above the branches, mature fruit at c.90° to the peduncle, the body shape and wings similar to the ovary, wings 6.1–8.4 mm long.

Habitat and distribution. *Begonia embera* is endemic to the Chocó Department, in the western foothills of the Colombian Cordillera Occidental, in the transition between the Chocó and

Andean biogeographical regions (Figure 4). The plants were observed growing in humid and shady places, always near or in streams, on substrate formed mainly by gabbro rocks, or on sandy soil. The plants are not grouped into dense populations, and are accompanied in the same strata of the forest mainly by species of Gesneriaceae, Piperaceae and Urticaceae.

Etymology. The new species is named in honour of the Emberá, the groups of indigenous peoples who reside in the Pacific Coast of Colombia, Panama and Ecuador. The Emberá Katío and Chamí peoples share their territory with the new *Begonia* species, and both are critically threatened by external factors.

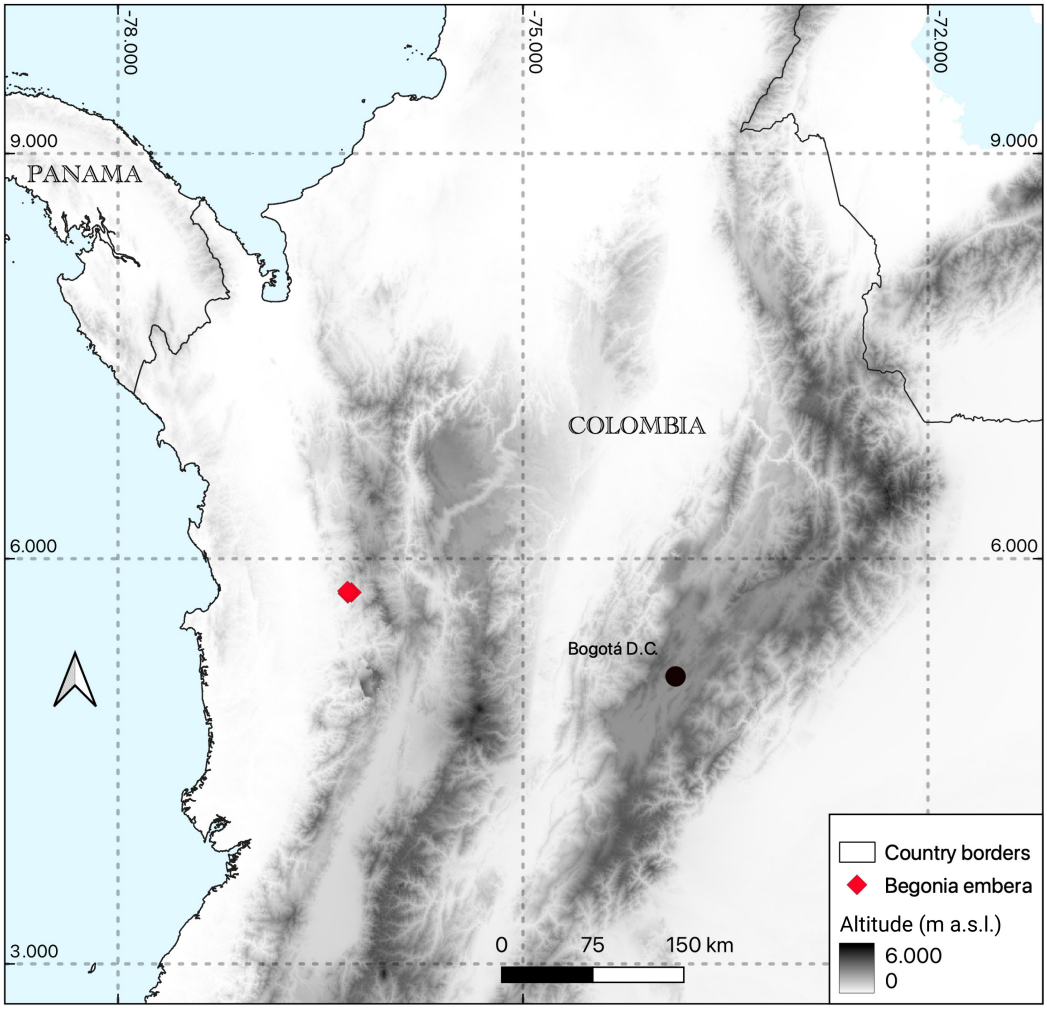

Figure 4. Distribution map for *Begonia embera* (red diamonds).

Proposed IUCN conservation category. After recognition of this taxonomic novelty, two expeditions to the area were carried out to find more populations. Despite the additional fieldwork, we found live plants in only one small area. The area of occupancy is less than 10 km^2, and the extent of occurrence is less than 100 km^2. During the second expedition, we observed an increase in settlements in the vicinity of the type locality, as well as maintenance and expansion work on the Medellín–Quibdó road, along the sides of which individuals were found. We observe from live material cultivated in a greenhouse that the new species requires high relative humidity and low light levels. These observations provide insights into the habitat requirements of the species, which is probably restricted to narrow basins under dense canopy. In light of the considerations above, according to IUCN criteria (IUCN Standards and Petitions Committee, 2022), *Begonia embera* is categorised as Critically Endangered [CR B1ab(iii) + 2ab(iii)].

Additional specimens examined. Colombia. **Chocó**: municipio El Carmen del Atrato, carretera entre Ciudad Bolivar y Quibdó, 500 m, 2 v 2015, *A. Jara & D. White* 2796 (ANDES); municipio El Carmen del Atrato, carretera entre Ciudad Bolivar y Quibdó, 545 m altitude, 5.74513°N, 76.29838°W, 2 v 2015, *A. Jara & D. White* 2799 (ANDES).

Discussion

Within *Begonia* sect. *Ruizopavonia*, morphological data suggest that *B. embera* is a member of the *B. tiliifolia* group, comprising *B. boreoharlingii* Moonlight & Tebbitt, *B. botryoides*, *B. harlingii* and *B. tiliifolia* (Tebbitt *et al.*, 2017). This group is characterised by its five female tepals, vs fewer than five in the other species of *Begonia* sect. *Ruizopavonia*.

The species in this group most similar to *Begonia embera* is *B. harlingii*. Both have five tepals in the female flowers, fewer than 20 stamens, ovary wings triangular, and bract margins fimbriate; however, *Begonia embera* can be easily distinguished by the numerous characters listed in the diagnosis (see *Taxonomic treatment*). Both species grow in similar habitats but are not sympatric; *Begonia harlingii* is found in the wet premontane forest on the west of the Andes Cordillera in Ecuador. In the species key of the Smith & Schubert (1946) treatment of the Colombian begonias, *Begonia embera* would fall close to species now in *Begonia* sects *Doranometra* and *Ephemera*, and differs from species in *Begonia* sect. *Ruizopavonia* by its small size with soft bases and probably annual habit, vs perennial in most *Ruizopavonia* species.

Phylogenetic relationships of the new species within *Begonia* sect. *Ruizopavonia* could not be clarified in the present study, because only a few species from this section were sampled. Although morphological data suggest an affinity between *Begonia embera* and the *B. tiliifolia* group, as defined by Tebbitt *et al.* (2017), our ITS phylogeny seems to contradict this (see **Figure 1**). In the topology presented by Moonlight *et al.* (2018), based on three chloroplast markers, *Begonia botryoides* is placed as sister to *B. tiliifolia*, and then sister to two species outside the *B. tiliifolia* group: *B. seemanniana* A.DC. and *B. convallariodora*.

It is not possible to directly compare the congruence between the two tree topologies (ITS- and cpDNA-based), because only two species are shared (*Begonia botryoides* and *B. convallariodora*) and our analysis lacks several species included in the chloroplast phylogeny.

It is possible that *Begonia embera* is, in fact, not part of the *B. tiliifolia* group. This would not be entirely surprising considering the morphology of the new species, which diverges from any other species of *Begonia* sect. *Ruizopavonia* known until now. It is probable that the characters shared between *Begonia embera* and the *B. tiliifolia* group are convergent or plesiomorphic, and therefore do not reflect the new species' relationships. Inclusion in the phylogeny of more species from *Begonia* sect. *Ruizopavonia*, along with comparison of nuclear and plastid regions, is necessary to more finely resolve the position of *B. embera* within the section.

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Appendix

Appendix table. GenBank accession numbers and voucher information for the *Begonia* specimens used in the phylogenetic analysis

Species	GenBank accession no.	Voucher information
Begonia botryoides Moonlight & Tebbitt	MH559553	*A. Jara* 2650-A (QCA)
Begonia buddleiifolia A.DC.	MH559556	*A. Jara* 2599 (ANDES)
Begonia chlorolepis L.B.Sm. & B.G.Schub.	MH559538	*A. Jara* 2327 (ANDES)
Begonia colombiana L.B.Sm. & B.G.Schub.	MH559539	*D. Cardenas* 43980 (COAH)
Begonia convallariodora C.DC. ex Donn.Sm.	–	Cultivated Royal Botanic Gardens, Kew, *M.W. Chase* 943 (K)
Begonia cornuta L.B.Sm. & B.G.Schub.	MH559535	*A. Jara* 2764 (ANDES)
Begonia cubensis Hassk.	AF485169	*M. Tebbitt* 66 (BKL)
Begonia cucullata Ruiz ex A.DC.	–	Cultivated Glasgow Botanic Garden, *M.C. Tebbit*t 134 (BKL)
Begonia dominicalis A.DC.	–	Cultivated Glasgow Botanic Garden, M.C. Tebbitt 123 (BKL)
Begonia embera Jara & D.Franco	–	*A. Jara & D. White* 2796 (ANDES)
Begonia ferruginea L.f.	MH559540	*A. Jara* 2739 (ANDES)
Begonia fischeri Schrank	MH559537	*A. Jara* 2650 (ANDES)
Begonia foliosa Kunth	MH559555	19480286 (CFG)

Begonia gamolepis L.B.Sm. & B.G.Schub.	MH559541	*A. Jara* 2616 (ANDES)
Begonia holtonis A.DC.	MH559558	*A. Jara* 2382 (ANDES)
Begonia humilis Aiton	–	Cultivated Montreal Botanic Garden, accession number 00203091
Begonia kalbreyeri (Oliv.) L.B.Sm. & B.G.Schub.	MH559560	*A. Jara* 2765 (ANDES)
Begonia longirostris Benth.	MH559536	*A. Jara* 2657 (QCA)
Begonia meridensis A.DC.	MH559559	*A. Jara* 2730 (ANDES)
Begonia mollicaulis Irmsch.	–	Cultivated Montreal Botanic Garden, accession no. 000681-56
Begonia pectennervia L.B.Sm. & Wassh.	MH559542	*A. Jara* 2637 (QCA)
Begonia rossmanniae A.DC.	MH559557	150070 (LBG)
Begonia santos-limae Brade	MH559554	P21320 (HAST)
Begonia solaniflora Jara	MH559547	*A. Jara* 2564 (ANDES)
Begonia suaviola Jara	MH559561	*A. Jara* 2397 (ANDES)
Begonia subvillosa Klotzsch (= *Begonia schmidtiana* Regel)	–	Cultivated New York Botanical Garden, *M.C. Tebbitt, S.M. Swensen & J. Yeadon* 16 (BKL)
Begonia tetrandra Irmsch.	MH559549	*A. Jara* 2652 (QCA)
Begonia tomentosa Schott	–	Cultivated Glasgow Botanic Garden, M.C. Tebbitt 143 (BKL)
Begonia trianae (A.DC.) Warb.	MH559551	*A. Jara* 2668 (ANDES)
Begonia umbellata Kunth	MH559552	*A. Jara* 2762 (ANDES)

NA, not available; §, section.