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Morphological Analysis Reveals a New Species of *Passiflora* Subgenus *Decaloba* (Passifloraceae): Passiflora quimbayensis, an Endemic Species from Colombia

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Abstract—A new species of Passiflora (P. subg. Decaloba) from Colombia in the Andean region is described and illustrated in this article, using and analysis of 81 morphological descriptors. Passiflora quimbayensis is named in honor to the Pre-Columbian Quimbaya civilization which once lived in the region where the species was discovered. Its closest relative is P. magdalenae, and can be distinguished from it by its peduncle (40–55 mm), sepal (12–15 mm), and androgynophore (5–6.5 mm) lengths, by the number of laminar ocellate-nectaries (6–9, mean 7.5), biseriate corona filaments, globose ovary, and by growing under different ecological conditions (1072 to 1249 m a. s. l.). It is a new endemic species to Colombia and must be regarded as endangered because of its limited occurrence.

Keywords—Tropical Andes, biodiversity, conservation.

The genus Passiflora L., with about 577 species of vines, lianas, shrubs, and trees, is numerically and economically the most important genus of Passifloraceae Juss. ex Roussel, a botanical family with alimentary, ornamental, and pharmaceutical interest (Feuillet and MacDougal 2007; Yockteng et al. 2011). Passiflora is split into five subgenera and distributed principally in the Neotropics from coastal zones up to 4300 m above sea level in Andean slopes at the limits of páramo and puna (Ulmer and MacDougal 2004; Krosnick et al. 2009). Passiflora subgenus Decaloba (DC.) Reich. includes ca. 235 species and is divided into eight supersections (Feuillet and MacDougal 2003) with several unique features, such as extrafloral nectaries on laminas and petioles, variable leaf shape, variegation of juvenile leaves, small flowers, two or three series of the corona filaments, a plicate membranous operculum (Killip 1938; MacDougal and Feuillet 2004; Krosnick et al. 2013), a chromosome number of n 5 6, and an average genome size of 0.413 pg (Snow and MacDougal 1993; Yotoko et al. 2011). The dates of divergence/diversification ages for Passiflora subgenus Decaloba have been calculated to be ca. 37/29 MYA (Muschner et al. 2012) to ca. 24/15 MYA (Abrahamczyk et al. 2014). The centers of diversity for the subgenus are Colombia and Mexico, both with ca. 58 inventoried species. Passiflora subgenus Decaloba, with species in the United States, Mexico, Central and South America, the Caribbean, Asia, Australia, and the Pacific, has the broadest geographical distribution compared to any of the other subgenera. Pollinators include birds (short and sword-billed hummingbirds), bats, bees, and wasps, with specific suites of floral characters associated with each syndrome (Feuillet and MacDougal 2007; J. Ocampo pers. obs.). Their wide morphological variation appears to be the result of their habitat diversity as well as to their co-evolutionary relationships with many organisms, including protective ants, herbivores such as Heliconius species (Lepidoptera: Nymphalidae), pollinators, and plant communities providing them physical support and access to sunlight (Ocampo et al. 2007a; Yockteng et al. 2011). Phylogenetic analyses of DNA sequence data suggest that Passiflora subgenus Decaloba is monophyletic and contains seven major lineages that generally correspond to currently recognized supersections according to Feuillet MacDougal´s classification, with the exception of Passiflora supersections Auriculata MacDougal & Feuillet and Multiflora (Small) MacDougal & Feuillet, which are resolved as paraphyletic as originally described (Krosnick et al. 2013; Milward-de-Azevedo et al. 2014).

Colombia's location and ecosystem variety places the country as second in terms of biodiversity (MacNeely et al. 1990; Miani and Fajardo 2001). The country is divided into five main biogeographic regions, the Andean region showing a highly varied topography with three long mountain ranges separating two main inter-Andean valleys from the other regions. As a result of this habitat diversification, the Colombian flora comprises one of the world's most diverse groups of vascular plants, with more than 40,000 documented species (Myers et al. 2000; Kreft and Jetz 2007). Approximately 30% of Colombia´s native plant representatives are considered to be endemic and in a high degree of threat (Porup et al. 2009).

Colombia, with 174 reported species, is the country with the highest Passiflora richness, with the greatest diversity found in the Andean region (Ocampo et al. 2007a, 2010; Hernández et al. 2015). The largest number of species is found between 1000 and 2000 m above sea level and the most common ones thrive in disturbed habitats, such as roadsides, cultivated land, and secondary forests (Ocampo et al. 2007a). Passiflora section Decaloba DC. is represented by ca. 59 species present in Colombia where, uniquely, some members of the subgenus possess particularly long floral tubes (pink, red, or purple) presumably evolved for hummingbird pollination syndromes (J. Ocampo, pers. obs.), such as P. bicuspidata (H. Karst.) Mast., P. hyacinthiflora Planch. & Linden ex Triana & Planch., and P. trinervia (Juss.) Poir.

The quality of botanical inventories depends on the quality of the taxonomic work in this complex family. In several cases, experts may have underestimated intraspecific variation in widely distributed species or even intra-individual variation, splitting well known species into several new species only distinguished by a few quantitative or color traits (Ocampo

and Coppens d´Eeckenbrugge 2017). However, the opposite could happen, when an apparent polymorphism that has not been adequately investigated could represent multiple "cryptic" species. In Passiflora subgenus Decaloba, several morphological groups also demand great experience and caution for their identification, even in the most common species such as P. capsularis L. and P. rubra L. (5 P. cisnana Harms; Boza 2010), which can be found in the same habitats. In the most difficult cases, several species have even changed status several times. For instance, Killip (1938) first merged P. bauhiniifolia Kunth with P. andreana Mast., and later restored the former as a distinct species (Killip 1960), while Holm-Nielsen et al. (1988) merged P. bauhiniifolia with another close relative, P. alnifolia, a position that we have adopted here. Likewise, a few other species may also show very little morphological differentiation, such as P. mollis and P. cuspidifolia Harms, but differ in their altitudinal distribution, which confirms that they are distinct entities.

Morphological descriptors are a tool that can be used to solve issues between closely related taxa (Ocampo and Molinari 2017). Despite the impressive morphological diversity described among Passiflora subgenus Decaloba species, few studies have compared intra- and interspecific variation with statistical tools. A very detailed list of descriptors was used by Boza (2010) and Porter-Utley (2014) to study Passiflora supersections Cieca (Medic.) Feuillet & MacDougal and Passiflora sect. Xerogona (Raf.) Killip. The morphological cladistic analysis by Porter-Utley (2014) produced a plotting pattern that clearly supports the delimitation of the species, showing particular intraspecific morphological variation of the species complex around P. suberosa L. and P. coriacea Juss. A recent study was conducted by Ocampo and Coppens d´Eeckenbrugge (2017) on 61 species of Passiflora with special emphasis on quantitative and qualitative floral traits, showing a clear separation among Passiflora subgenera Astrophea (DC.) Mast., Decaloba, and Passiflora. The three main divisions of the classification of Feuillet and MacDougal (2003) were supported, as well as their main divisions of Passiflora subgenus Decaloba, with the exception of P. trinervia (P. section Decaloba) and P. adenopoda DC. (P. supersection Bryonioides (Harms) MacDougal & Feuillet), which form two separate branches in the tree.

In this paper we propose a new species belonging to Passiflora section Decaloba, which has been discovered in the Colombian Andes, and is strongly supported with information gathered from specimens in several herbaria, living materials, as well as descriptions from the literature. This new species is described, illustrated, and compared with its closest related species using a phenetic approach and geographical distribution analysis.

Materials and Methods

Eleven expeditions of collaborative projects focused on Passifloraceae in 63 localities of 18 departments in Colombia were carried out between the years 2004 and 2015. Additionally, we examined specimens from the major herbaria in Colombia (AFP, CAUP, CDMB, CHOCO, COL, COAH, CUVC, FAUC, FMB, HUA, HUQ, JBB, JAUM, MEDEL, PSO, SURCO, TOLI, TULV, VALLE, UIS, and UPTC) and other countries (F, GH, K, LPB, MA, MO, MOL, NY, P, TEX, U, US, and USM). Dried specimens were measured or recorded and photographed (with color details) to create a species description for the new species. The database was supplemented with specimens mentioned in the species descriptions carried out by Killip (1938) and Mutis and Uribe (1955).

Data of collecting trips were recorded for each collected specimen, including locality names, elevation, and geographic coordinates. Literature, herbaria, and trip data were gathered and processed with OpenRefine (Verborgh and De Wilde 2013) to generate a dot map of the distribution, using the ArcMap 10.3 software. Conservation status was assessed according to IUCN (2014) categories and supported with geographic range data, based on the extent of occurrence (EOO) and area of occupancy (AOO), using the Geospatial Conservation Assessment Tool Geo-CAT (Bachman et al. 2011).

Morphological description was carried out in situ on living individuals, following a list of morphological descriptors of 32 quantitative and 49 qualitative vegetative and reproductive characters (Table 1). They were assessed on two wild individuals per species (P. quimbayensis and P. magdalenae), and five measures were taken for quantitative characters for each individual. Quantitative data were submitted to an analysis of variance to compare variation among species, and compared by Duncan's multiple comparison test at 95% confidence level (p # 0.05), using the

Table 1. List of 81 morphological descriptors evaluated and selected by Ocampo and Coppens d´Eeckenbrugge (2017) and used in this study. Scales for qualitative characteristics: B (binary), O (Ordinal), and N (Nominal).

Organ	Qualitative characters (49)	Quantitative characters (32)
Stem	Pubescence (N)	Diameter (cm)
	Anthocyanin (O)	Internode length (cm)
Tendril	Pubescence (N)	
	Color (N)	
	Anthocyanin (O)	
Stipule	Permanence (B)	Length (mm)
	Color (N)	Width (mm)
	Pubescence (N)	
	Shape (N)	
	Margin (N)	
	Anthocyanin (O)	
	Color (N)	
Leaf	Margin (N)	Central vein length (cm)
	Base shape (N)	Central lobe width (cm)
	Apex shape (N)	Lateral vein length (cm)
	Presence of acumen (B)	Angle between lateral veins (°)
	Sinus depth (N)	Laminar nectaries number
	Pubescence – adaxial (N)	Nectary number on leaf margin
	Pubescence – abaxial (N)	
	Anthocyanin – lamina (O)	
	Anthocyanin – nerves (O)	
	Color – adaxial (N)	
	Presence of laminar nectaries (B)	
Peduncle	Pubescence (N)	Length (mm)
	Color (N)	Diameter (mm)
	Anthocyanin (O)	Pedicel length (mm)
Bract	Permanence (B)	Length (mm)
	Pubescence (N)	Width (mm)
	Color (N)	
	Anthocyanin (O)	
	Shape (N)	
Flower	Color sepals (N)	Sepal length (mm)
	Sepal horn (B)	Sepal width (mm)
	Color petals (N)	Petal length (mm)
	Color filaments at base (N)	Petal width (mm)
	Color of filaments at apex	Hypanthium diameter (mm)
	Hypanthium pubescence (N)	Number of corona series
	Ovary shape (N)	Outer filaments length (mm)
	Ovary pubescence (N)	Staminal filaments length (mm)
	Color of ovary (N)	Ovary length (mm)
	Color of styles (N)	Styles length (mm)
	Color operculum (N)	Androgynophore length (mm)
	Color operculum at apex (N)	Operculum length (mm)
		Limen length (mm)
Fruit	Shape (N)	Length (mm)
	Color fruit unripe (N)	Diameter (mm)
	Color fruit ripe (N)	
	Pubescence (N)	
Seed	Shape seed (N)	Length (mm)
	Color of seed (N)	Width (mm)

STATISTICS 10.0 software (Hill and Lewicki 2007). Colors of the qualitative characters were compared with the Royal Horticultural Society Colour Chart (The Royal Horticultural Society 2001).

Results

A total of thirteen individuals belonging to Passiflora quimbayensis and P. magdalenae were observed during the collecting trips, growing very commonly in disturbed habitats such as road borders and secondary forest margins. Among the specimens collected, six belong to P. quimbayensis and are located in the departments of Caldas, Quindío, Risaralda, and north of Valle del Cauca between 1072 to 1249 m above sea level on the eastern flank of the Central Cordillera in the Andean region. The specimens of P. magdalenae were found in the departments of Caldas, Cundinamarca, and Tolima on the western flank of the Central Cordillera and the eastern flank of the Cordillera Oriental between 203 to 998 m above sea level (Upper Magdalena Valley). Of these, only two living individuals per species were found in different localities in a fertile status with more than five flowers and fruits each (P. quimbayensis: Quindío and Risaralda; P. magdalenae: Caldas and Tolima). Herbaria and literature data were recorded from 26 dried specimens of P. quimbayensis (1) and of P. magdalenae (25) dated between 1844 and 2014. A dot map of the spatial distribution of our final dataset of 42 records from field collections, herbaria specimen information, and literature reviews of P. quimbayensis and its closest relative is shown in Fig. 1.

Morphological characterization was performed in situ on fertile living material following a list of 81 descriptors. Twenty-two quantitative descriptors showed significant differences according to Duncan's multiple comparison test (Table 2). The mean coefficient of variation of the descriptors was highest in P. quimbayensis (CV 5 11.3%) and is related with the dimensions of the right and central lobe (CV . 24%). We retained seven qualitative descriptors on the basis of their potential to discriminate between the two species, mainly those associated with the number of series of coronal filaments, staminal filaments, and style color. These morphological traits were applied to compared herbarium specimens for provisional species assignments to create better species description accuracy.

Taxonomic Treatment

Passiflora quimbayensis Ocampo & Forero, sp. nov. TYPE: COLOMBIA. Risaralda: Mpio. Pereira, kilómetro 7 vía a Cerritos, entrada por vivero Pavas, Hacienda Malabar (75.80864°W, 4.81654°N), 1249 m, 4 March 2004, J. Ocampo & M.T. Restrepo 19 (holotype: VALLE!).

Herbaceous vine. Stem angulate, 8 to 10 mm in diam, internodes 3.3–5.6 cm long, pubescent, the younger parts finely pubescent, green. Tendrils green, purple and pubescent when young. Stipules setaceous, 4–6 mm long, 1–1.5 mm wide, purple at the base, deciduous. Petioles slender, 2.6 to 3.8 cm long, glands absent, finely pubescent. Leaves 3 lobed-obovate, the central vein length slightly longer than the lateral lobes (3–9.5 long 3 1.1–6.4 wide cm), angle between lateral lobes 57–70°, lateral vein length 2.9–8.5 cm, sinus only slightly deep, rounded or truncate at apex, mucronulate, margin entire, laminar ocellate-nectaries (6 to 9, mean 7.5) in a V-shaped pattern between the primary veins, glabrous, membranous, not variegated. Peduncles solitary or in pairs, 40.0–55.0 long 3 1.2–1.5 mm wide,

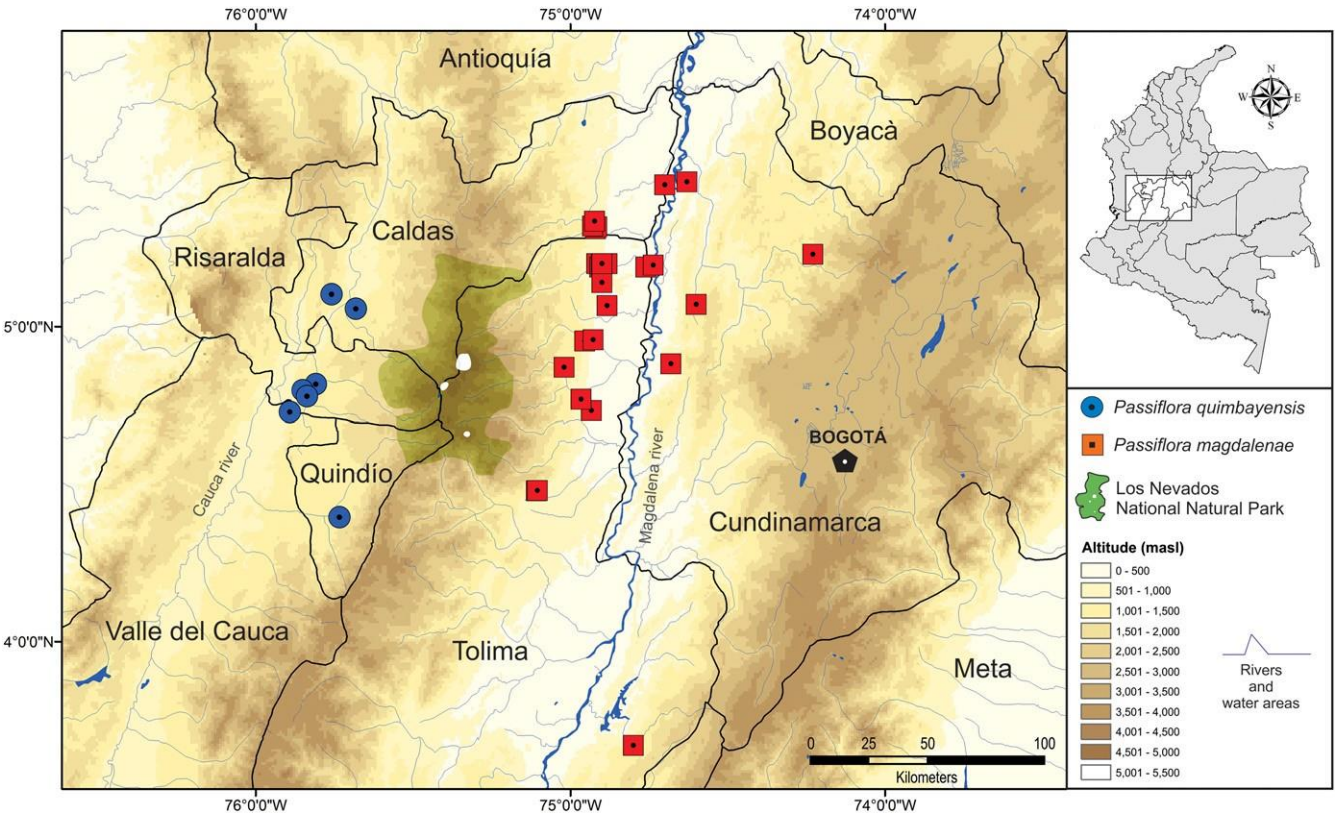


Fig. 1. Geographical distribution of P. quimbayensis (blue circles) and its closest relative P. magdalenae (red squares) in Colombia`s Andean region.

Table 2. Summary and comparison of morphological characters between P. quimbayensis (Pq) and P. magdalenae (Pm).

				Mean		Standard Deviation		Coefficient Variation (%)		Duncan's test (p#0.05)	
Organ	Descriptors	P. quimbayensis (Pq)	P. magdalenae (Pm)	Pq	Pm	Pq	Pm	Pq	Pm	Pq	Pm
Stipule	Stipule length (mm)	4.0–6.0	3.2–3.8	5.0	3.5	0.7	0.2	14.4	5.6	a	b
Leaf	Petiole length (cm)	2.6–3.8	3.4–4.5	3.2	4.0	0.4	0.4	13.6	11.1	a	b
	Central vein length (cm)	3.0–9.5	5.4–6.3	4.5	5.9	1.5	0.3	35.1	5.6	a	b
	Central lobe width (cm)	1.1–6.4	2.4–3.1	2.3	2.8	0.8	0.2	37.4	7.1	a	b
	Lateral vein length (cm)	2.9–8.5	5.3–6.2	4.4	5.8	0.9	0.4	24.5	6.6	a	b
	Sinus in leaves juveniles	slightly deep	very deep								
	Number of leaf ocelli	6 to 9	2 to 9	7.5	4.8	0.7	0.8	10.0	13.1	a	b
Flower	Peduncle length (mm)	40–55	29–35	45	32	0.3	0.2	5.0	7.6	a	b
	Bract length (mm)	2.5–2.8	2.9–4.5	2.7	3.7	0.1	0.6	3.2	16.9	a	b
	Sepal length (mm)	12.0–15.0	22–23	13.5	22.5	1.1	0.3	7.8	1.5	a	b
	Sepal width (mm)	4.0–5.0	4.5–5.5	4.5	5.0	0.4	0.5	10.2	11.4	a	b
	Petal length (mm)	8.0–10.1	12–13.3	9.1	12.8	0.7	0.5	7.8	4.1	a	b
	Petal width (mm)	2.9–3.5	3.5–4.2	3.2	3.9	0.2	0.3	5.9	7.9	a	b
	Outer filament length (mm)	9.5–10.5	11.5–13.5	10.0	12.5	0.3	0.8	3.2	6.2	a	b
	Number of corona series	2	3	2.0	3.0	0.0	0.0	0.0	0.0	a	b
	Hypanthium diameter (mm)	7.5–7.7	8.4–8.6	7.6	8.5	0.4	0.3	5.7	3.9	a	b
	Operculum length (mm)	2.0–2.2	2.2–3.1	2.1	2.7	0.1	0.4	2.6	16.5	a	b
	Operculum color	yellow-green	white								
	Operculum margin color	light violet 5.0–	deep violet 8.9–								
	Androgynophore length (mm)	6.5	10.1	5.4	8.6	0.2	0.5	7.3	5.3	a	b
	Ovary length (mm)	3.6–3.8	2.5–3.0	3.7	2.8	0.1	0.2	2.9	9.0	a	b
	Ovary shape	globose	subglobose								
	Staminal filaments length (mm)	4.0–5.0	4.1–6.0	4.5	5.1	0.5	0.6	12.5	10.8	a	b
	Staminal filaments color	green (rarely light violet)	violet								
	Styles length (mm)	4.5–5.5	5.0–7.8	5	6.4	0.4	1.1	1.5	15.5	a	b
	Styles color	green (rarely light violet)	violet								

pedicel 2.7–3.8 mm long, pubescent. Bracts setaceous, 2.5–2.8 long × 0.5 mm wide, finely pubescent, green, deciduous. Flowers 3.0–3.8 cm in diam; hypanthium concave-conical at attachment, glabrous, 7.5–7.7 mm in diam, light green; sepals lanceolate, 12–15 long × 4–5 mm wide, light green beneath, purplish white above; petals lanceolate, 8.0–10.1 long × 2.9–3.5 mm wide, shorter than sepals, purplish white above and beneath, awn at the apex, 1 mm long, light green; corona filaments in 2 series, filaments of outer series filiform, spreading outward horizontally and slightly reflexed, slightly tortuous near apex, 9.5–10.5 mm long, white, filaments of inner series shorter than the outer filaments, 5 to 8 mm long, vertical, white; operculum plicate, lobulated at the margin, 2.0–2.2 mm long, translucent whitish, with yellow nectary tissue, margin light violet; limen saucer-shaped, 1.5 mm long, margin entire; androgynophore 5.0–6.5 mm long, purple-violet; ovary globose, pubescent, 3.6–3.8 mm long; styles 4.5–5.5 mm long, green, rarely light violet; staminal filaments 4–5 mm long, green, rarely light violet; fruit a berry, 8–12 mm long, 8–11 mm in diam, globose, unripe green, ripe purplish black, skin waxy, unpleasant odor, pubescent; seeds elliptical, 2.5–3.0 long × 1.5–2.0 mm wide, acute at apex; testa with 5 to 6 transversal grooves, the ridges rugulose, black, 38–40 seeds per fruit, surrounded by a translucent whitish aril. Figures 2, 3.

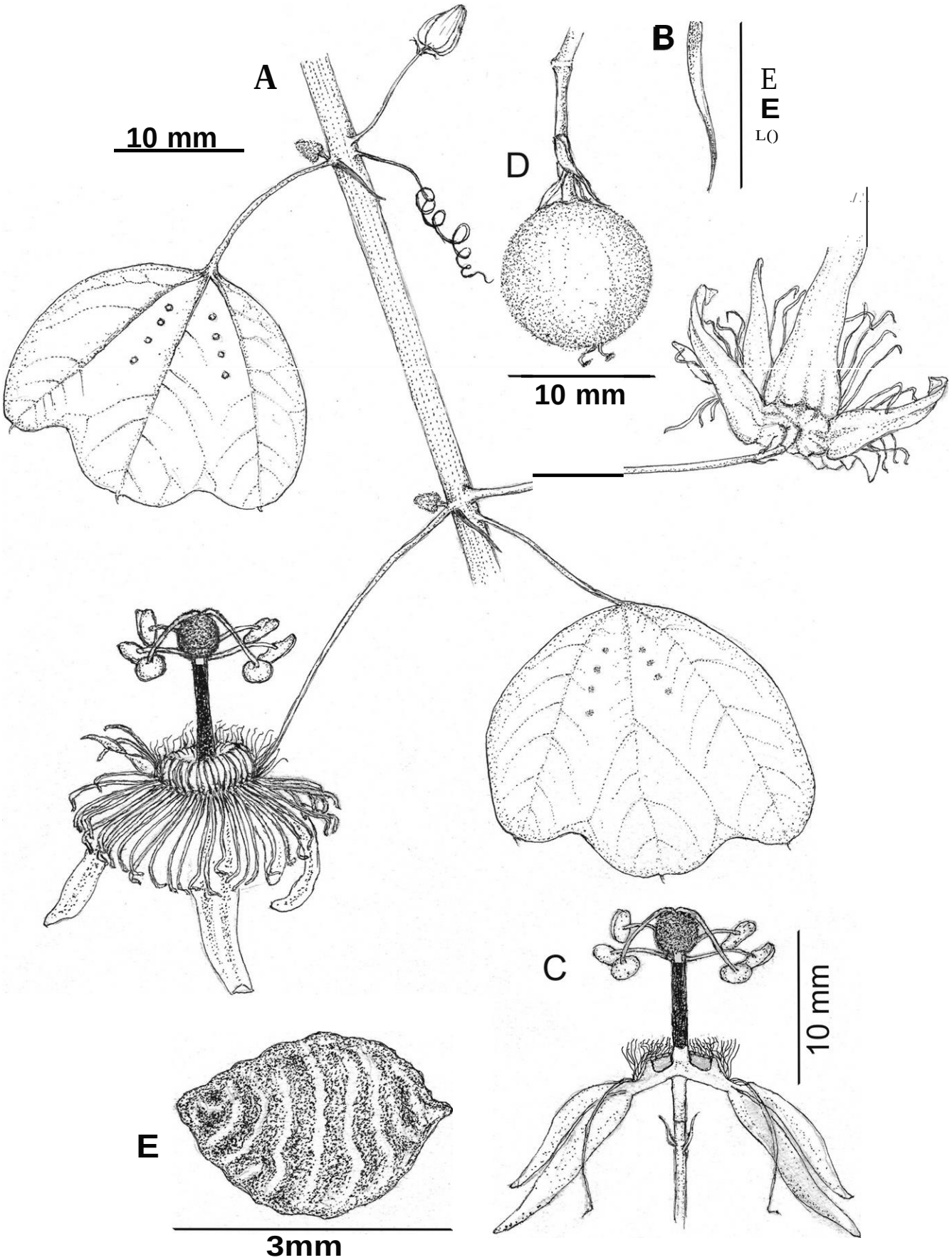
Geographical Distribution—This species is rare, endemic to the Colombian departments of Caldas, in the municipality of Palestina (1166 and 1248 m a. s. l.); Quindío, in the municipality of Buenavista (1202 m a. s. l.); Risaralda in the municipality of Pereira (1170, 1193, and 1219 m a. s. l.); Valle del Cauca in the municipality of Cartago (1072 m a. s. l.); eastern flank of the Central Cordillera of the Andean region (Fig. 1).

Ecology—Passiflora quimbayensis was observed on hillsides, along roadsides, and along secondary forest margins, climbing onto shrubs or trees in thickets, at elevations ranging from 1072 to 1248 m above sea level. This species grows in areas with soils derived of volcanic ash with a high content of organic matter and a loamy texture; the annual mean temperature is 22.4°C and the annual rainfall is 1890 mm (regular rainfall); sunshine of 5–6 hr per day (Fick and Hijmans 2017).

Phenology—This new species has been observed flowering in the months of February–March to September–October and fruiting from April–May to November–December. Odor pleasant. Wasps (Polistes species) were observed visiting open flowers, being dusted with pollen on their wings and thorax, and may be associated as pollinator (Fig. 3H).

Conservation Status—Passiflora quimbayensis is known only from few collections and if a formal assessment were performed it would likely be considered as endangered (ED), based on two assessment criteria, B2a and D (IUCN 2014). Within category B, the new species would probably qualify as B2a, as its area of occupancy is estimated as less than 500 km^2 (28 km^2), and its range of occurrence is less than 5000 km^2 (956.68 km^2); habitats are severely fragmented and it is known to exist at seven locations. With respect to criterion D, the population size is estimated at less than 50 mature individuals, with just three plants observed during the collecting trips.

Etymology—The specific epithet is in honor of the Quimbaya civilization, a Pre-Columbian indigenous group that



FrG. 2. *Passiflora quimbaymsis* Ocampo & Forero. A. Branch with leaves, flowers, and young buds. B. Setaceous stipule. C. Schematic detail of a longitudinal section of the flower. D. Fruit. E. Seed. Drawn by Jairo Larrahonda from holotype (J. *Ocampo & M. T. Restrepo 19:* VALLE).

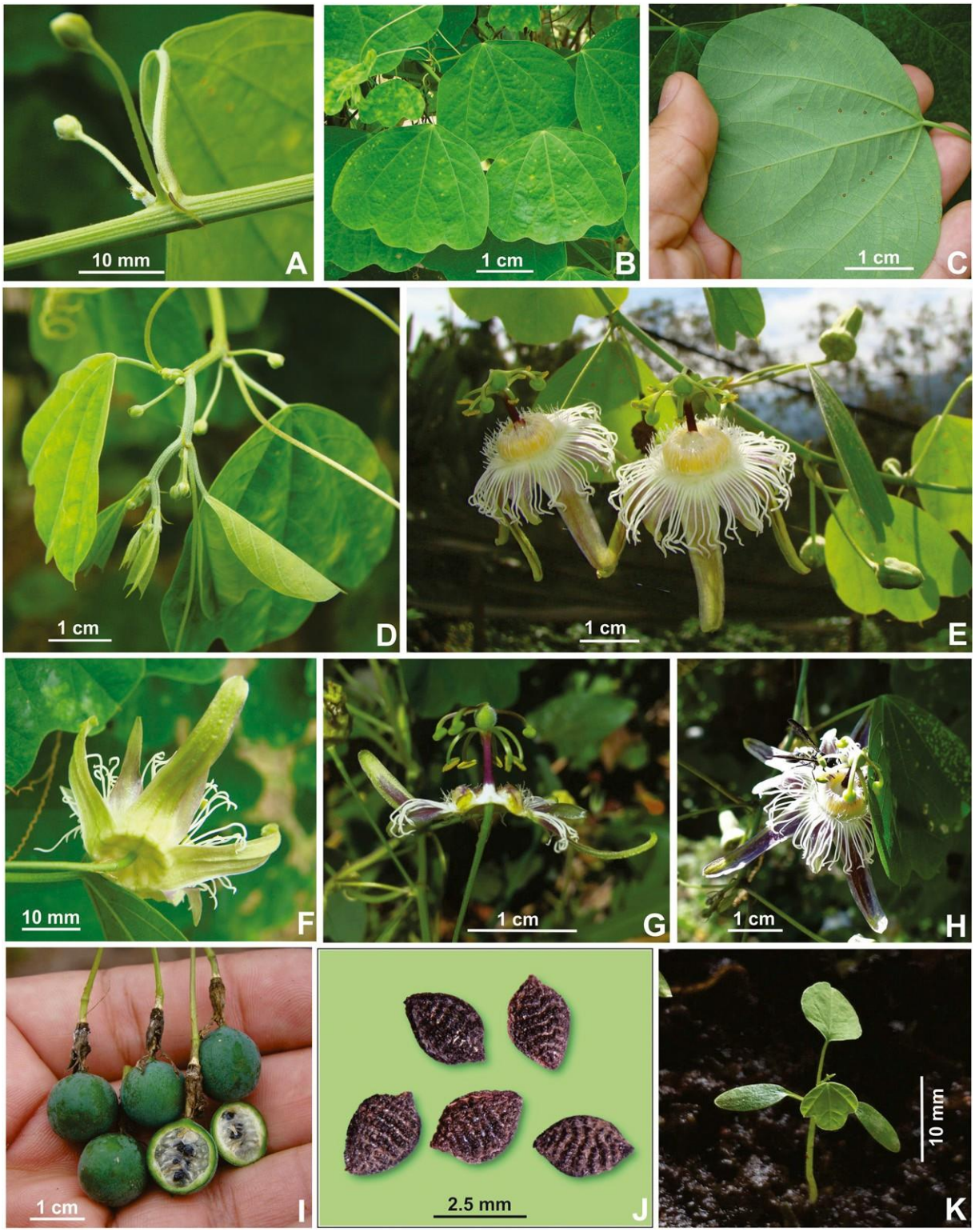


Fig. 3. Passiflora quimbayensis Ocampo & Forero. A. Setaceous stipules, petiole and young buds (mature plant). B. Mature leaves. C. Abaxial laminar ocellate-nectaries. D. Terminal branch showing bracts on peduncles, floral buds, and juvenile leaves. E. Buds and flowers. F. Peduncle, pedicel, bracts, and adaxial flower. G. Detail of a longitudinal section of the flower. H. Flower pollinated by Polistes sp. I. Unripe fruits showing mesocarp. J. Seeds. K. Seedling, five days after germination. Photographs by John Ocampo, from the holotype (J. Ocampo & M. T. Restrepo 19: VALLE).

lived ca. 10 centuries ago in the geographical region where the species was found. The Quimbaya were renowned for their spectacular work carried out using gold, and characterized by their technical accuracy and detailed designs.

Additional Collections Examined—Colombia.—Risaralda: Pereira, vereda los Visos, cerca del caserío Estación Villegas, acceso desde carretera Cerritos-Pereira en camino Real, loma empinada arriba del río Consota (tributario del rio la Vieja), bosque (75.80864°W, 4.81654°N), 1170–1219 m, 18 January 2005, P. Silverstone-Sopkin & Néstor Paz 7205 (CUVC, MO); kilómetro 7 vía a Cerritos, entrada por vivero Pavas, Hacienda Malabar (75.80864°W,

4.81654°N), 1249 m, 30 December 2003, J. Ocampo & C. González 11 (VALLE).—Quindío: Buenavista, estació n experimental Paraguacito – Cenicafé (75.73374°W, 4.39517°N), 1202 m, 11 November 2005, C.M. Caetano et al. 30 (VALLE).

Additional Collections Examined (closest relative) Passiflora magdalenae—Colombia.—Caldas: La Dorada, near La Dorada, 250 m, 24 December 1936, O. Haught 2112 (COL, F, GH, NY, U, US); Victoria, 600 m, 4 January 1949, M. Schneider 757 (COL).—Cundinamarca: Guaduas: Between Guaduas and Peñon de Conejo, 1844, J. Goudot s.n. (P-00245685!, holotype).—Tolima: Honda, carretera, Honda y Mariquita, 400–500 m, 18–20 July 1961, H. Garcia-Barriga 17.323 (COL, US), 17.337 (COL, NY, US); Libano, 700–900 m, 26–29 December 1917, F.W. Pennell 3386 (GH, NY, US); Mariquita, carretera al Fresno, Rio Guali, 210–500 m, 29 November 1939, H. Garcia-Barriga 8193 (COL, GH, US); 5 km de Mariquita hacia Amero (1 km antes del Rio Guamo), 380 m, 25 August 1983, L.K. Escobar & J.I. Santa 3613 (HUA, TEX); Carretera entre Mariquita y Armero, 5 km de Mariquita, en rastrojo al lado de la carretera, 460 m, 10 June 1984, L.K. Escobar et al. 4591 (HUA, MA), 4593 (HUA, LPB, MA); Riberas del Rio Guali, a la orilla del rio, 500 m, 24 September 1959, A. Fernández-Pérez & L. Uribe 5664 (COL); Huertas, 547 m, April 1952, E. Pérez Arbeláez 10305 (COL); en grietas de la torre de la Iglesia, 530 m, 7 February 1954, L. Uribe Uribe 2568 (COL, F, MEDEL, NY, US); en la antigua huerta de la Expedición Botánica, 530 m, 7 February 1954, L. Uribe Uribe 2569 (COL, F, NY, U); Prado, lado del camino entre Prado y Dolores, 700 m, 29 December 1976, L.K. Albert de Escobar 429 (TEX); Venadillo, 100 m arriba de la Sierrita, cerca de la Cruz, pie de monte de la vertiente oriental de la cordillera central, 810 m, 13 August 1980, J.M. Idrobo et al. 11050.

U. S. A.—North Carolina: Durham, cultivated at Duke University from living material of Escobar 429, 1980–1983, J.M. MacDougal 663 (MO, MO-spirit); 11050 (COL).

Discussion

We have examined an initial exhaustive list of 81 morphological descriptors and concluded that in many traits a very high variability is expressed among the two compared species. Twenty two quantitative and seven qualitative traits were selected after analyzing variation, allowing us to confirm the existence of a new species of Passiflora (P. sect. Decaloba), using a strictly phenetic approach (Table 2). This new species was compared with its closest relative, P. magdalenae (P. sect. Decaloba, allopatric, also endemic to Colombia), from information gathered from specimens that were recorded from collecting trips, herbaria visits, literature consulted (Killip 1938; Mutis and Uribe 1955), and morphological characterization analysis. Passiflora quimbayensis is distinguished mainly by its stipule length (4–6 mm vs. 3.2–3.7 mm), leaf sinus depth (slightly deep vs. very to intermediately deep in both juveniles and adults), central lobe length (2–6.1 cm vs. 5.4–6.3 cm), petiole length (2.7–3.8 cm vs. 3.4–4.5 cm), number of laminar ocellate-nectaries (6–9, mean 7.5 vs. 2–9, mean 4.8), peduncle length (40–55 mm vs. 29–32 mm), sepal length (1.2–1.5 cm vs. 2.2–2.3 cm), outer filaments corona length (5–8 mm vs. 11.5–14 mm), corona filaments series (2 vs. 3 series), androgynophore length (5.0–6.5 mm vs. 8.9–10.1 mm), staminal filament length (4–5 mm vs. 4.1–6 mm), color of the styles and staminal filaments (green vs. violet), ovary length (3.6–3.8 mm vs. 2.5–3 mm), ovary shape (globose vs. subglobose), operculum color (translucent white, showing yellow nectary, with light violet at the margin vs. white with deep violet at the margin).

A point of discussion is the citation of the presence of corona filaments in two to three indefinite series and an ovary that is "tomentellous when young, at length nearly glabrous" in the description of P. magdalenae by Killip (1938). An unvouchered photograph by Klaas Kingma of a flower from the Botanical Garden of Quindío in Calarcá (pers. comm.), at the southern limit of the range of P. quimbayensis in Quindío seems to show three series of corona filaments. Likewise, in Triana and Planchon's original description of P. magdalenae, they mentioned a completely pubescent ovary, which is seen on the holotype. The label on MacDougal 663 mentioned the presence of a slightly pubescent ovary from living material cultivated at Duke University. In contrast, we observe in living and dry specimens (mentioned above) that this species systematically displays corona filaments in three series, and additionally note that P. magdalenae presents a glabrous ovary (only sometimes pubescent) in most specimens examined in this study. In the same way, our morphological analysis is supported with a previous molecular study by Ocampo et al. (2007b) based on two non-coding cpDNA regions (psbC-trnS and trnS-trnfM), in which P. quimbayensis and P. magdalenae are split into two divergent branches within clade Decaloba.

It should be noted that one of the herbarium specimens of this new species, Silverstone-Sopkin & Paz 7205, historically had been misidentified as Passiflora filipes Benth., and this false identification became the basis for several erroneous records of the species in Colombia (e.g. Hernández and Bernal 2000; Herná ndez and García 2006; Ocampo et al. 2007a; and Hernández et al. 2015). Passiflora filipes, though native in neighboring Venezuela and Ecuador, has not been found in Colombia.

The uplift of the Andes created new habitats and increased local isolation, favoring high speciation rates in many taxa. Indeed, radiation has been very active in the Andes with a particular contribution during this period to the fast evolution in various groups of vascular plants (Gentry 1982). In Passiflora, a particularly striking example is given by Passiflora supersections Decaloba (P. subg. Decaloba) and Tacsonia (P. subg. Passiflora) whose large-flowered species are strictly adapted to high altitudes in cloud forest and pollination is carried out by the sword-billed hummingbird Ensifera ensifera Boissonneau (e.g. P. trinervia and P. quindiensis Killip), which shows the same distribution (Ocampo et al. 2010; Abrahamczyk et al. 2014; J. Ocampo, pers. obs.). In this study, the specimens of these two species collected during our expeditions were located under different ecological conditions in two different inter-Andean valleys (P. quimbayensis, 1072 to 1249 m a. s. l. and P. magdalenae, 203 to 1051 m a. s. l.) at average distances of approximately 100 km and separated by the Central Cordillera with a maximum elevation of 5312 m above sea level in Los Nevados National Natural Park (Fig. 1). Indeed, dispersal is one of the fundamental processes crucial to understanding the distribution of organisms, and the speciation of P. quimbayensis and P. magdalenae most probably was due to this biogeographic event.

Passiflora are considered biodiversity indicators in Colombia for their multiple ecological interactions with many organisms (Ocampo et al. 2010). However, the distribution of species has been drastically affected by deforestation, mainly in the Andean region. Its historical range corresponds to a region with a long history of livestock (pasturing) and agricultural practices that now supports extensive coffee, sugar cane, rice, banana, and potato plantations (Ocampo et al. 2007a). In this context, most Colombian Passifloraceae (71%) are under some degree of threat according to the IUCN criteria. The discovery of P. quimbayensis during field surveys growing on road edges in severely fragmented habitats, emphasizes the need for vegetation remnant protection. The ex situ conservation at botanical gardens and seedbanks is a strategy that must be implemented in case critical habitats are destroyed. This

strategy has begun to be implemented in joint collaboration with the Botanical Gardens of Quindío and Cali by providing them with young individuals of this species.

Passifloraceae have been inventoried in Colombia in taxonomic works by Hernández and Bernal (2000), Hernández (2003), Ocampo et al. (2007a, 2010), and Hernández et al. (2015), identifying 174 species distributed in all the biogeographic regions. Sixty of them are endemic to Colombia, mostly living in the Andean region. The discovery of this new rare endemic species adds up to 59 the number of species belonging to the Passiflora subgenus Decaloba reported in Colombia, and suggests that both Mexico and Colombia are centers of diversity for Passiflora subgenus Decaloba, both with ca. 59 species presently reported. However, the low level of exploration in various zones of the Andes, the Caribbean, the Amazon, the Orinoquia, and the Pacific raises the expectation that Colombia might still harbor many unknown species (Ocampo et al. 2010, 2015).

In conclusion, morphological analysis reveals a new species of Passiflora native to the Andean region of Colombia, and we can underline that a combination of many quantitative and qualitative descriptors selected in this study appear to be efficient in discriminating among species of Passiflora section Decaloba, including some that previously passed undetected. Additionally, biogeographic patterns show P. quimbayensis growing under different ecological conditions than its closest relative species. This study has also emphasized the urgent need to conserve this threatened species, as well as their disturbed habitats. More broadly, this investigation emphasizes urgency for more intensive phenetic studies on other "polymorphic" species in Passiflora to help reveal the basis of poorly known variation patterns.

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