

# *Geranium holosericeum* (Geraniaceae) revisited

C. AEDO<sup>1</sup>, J. L. FERNÁNDEZ ALONSO<sup>2</sup>, AND C. NAVARRO<sup>3</sup>

<sup>1</sup> Real Jardín Botánico, Consejo Superior de Investigaciones Científicas, Plaza de Murillo 2, 28014, Madrid, Spain; e-mail: aedo@rjb.csic.es

<sup>2</sup> Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado Aéreo 7495, Bogotá D.C., Colombia; e-mail: jlfernandeza@unal.edu.co

<sup>3</sup> Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense, 28040, Madrid, Spain; e-mail: cnavar@farm.ucm.es

---

**Abstract.** Variability of *Geranium holosericeum* is clarified and *G. lindenianum* and *G. schultzei* are differentiated from *G. holosericeum*. A new key, complete descriptions, distribution maps, and illustrations are provided for the three species. A neotype is proposed for **G. schultzei**.

**Key Words:** Geraniaceae, *Geranium*, Colombia, Venezuela.

**Resumen.** Se estudia la variabilidad de *Geranium holosericeum* y se diferencia de *G. lindenianum* y *G. schultzei*. Se presenta una nueva clave de identificación, descripciones completas, un mapa de distribución y dibujos para las tres especies. Se propone un neotipo para **G. schultzei**.

---

The genus *Geranium* L. comprises about 350 species distributed throughout most of the world. The genus is most diverse in South America, with over 100 species. Most of the South American species belong in *Geranium* subg. *Geranium*, with only a few species in subg. *Erodioidea* (Picard) Yeo section *Brasiliensia* R. Knuth (Aedo, 2001a); there are also some non-native representatives of subg. *Robertium* (Picard) Rouy (Aedo et al., 1998). The genus was monographed by Knuth (1912), but no recent revisions for South America are available. Aedo (2000, 2001b) revised *Geranium* in North America, and Moore (1943) revised the Central American species, but there are no native species in these revisions that occur south of Panama.

In pursuit of our aim to prepare a comprehensive monograph of the genus, we have studied some groups of *Geranium* from South America (Aedo, 2001a; Aedo et al., 2002, 2003, 2005). One of these taxonomic revisions was that of *Geranium* sect. *Gracilia* R. Knuth, which resulted in the recognition of nine endemic species from Colombia and Venezuela (Aedo et al., 2003). In this paper

we included within *G. holosericeum*, with some doubts, some robust specimens collected in northern Colombia and Venezuela. Now, with new collections available, we have revisited the circumscription of *G. holosericeum*, and concluded that two other close species should be recognized: *G. lindenianum* and *G. schultzei*. In this paper we provide a revised description of *G. holosericeum*, and a key to sect. *Gracilia* that includes *G. lindenianum* and *G. schultzei*.

## Materials and methods

All data were based on herbarium specimens from BC, COL, F, GH, HUA, K, LE, LL, MA, MICH, MO, MPU, NY, P, PORT, U, US, and VEN. Furthermore, photographs have been examined from B and KW. Indumentum, pollen, and seeds were investigated using scanning electron microscopy (SEM) in order to locate potential micromorphological features of taxonomic value. Samples were glued to aluminum stubs, coated with 40–50 nm gold, and examined with a JEOL-TSM T330A scanning electron micro-

scope at 15 kV. All SEM photographs are available on the *Geranium* web page at [http://www.rjb.csic.es/Geranium/index\\_geranium.php](http://www.rjb.csic.es/Geranium/index_geranium.php). Several interesting quantitative characters have broad ranges of variability, which caused some difficulties for their use. In order to avoid these problems, the ranges are included in brackets in the key and descriptions (even considering that in some rare cases they differed considerably from the mean values). The most frequent and useful values are represented as percentiles and are shown outside of the brackets. Some overlap was impossible to avoid at least in some cases.

### Results and discussion

Species of *Geranium* sect. *Gracilia* are perennials with leaves  $\pm$  hairy on the abaxial surface (but not tomentose), without an abscission zone between the lamina and petiole, with an inflorescence that has dichasial branching and 2-flowered cymules, and with basal callus on mericarps. Within this section, *G. holosericeum*, *G. lindenianum* and *G. schultzei* share glandular hairs on the peduncles, and are herbaceous, usually with robust aerial stems.

As in other species of sect. *Gracilia*, three trichome types have been found in *Geranium*

*holosericeum*, *G. lindenianum*, and *G. schultzei*, all of them simple and uniseriate (terminology of Theobald et al., 1979): 1) eglandular, unicellular hairs; 2) long glandular hairs, with 2–5 cells; and 3) short glandular hairs. These three types of hairs have also been found in other groups of *Geranium* (Fig. 1; Aedo et al., 2003).

Pollen is tricolpate and more or less isodiametric in the three species here studied. The exine is thin, semitectate, and reticulate with distinctly baculate, and gemmate suprategal elements. The pollen is similar to the *Geranium lignosum* group (Aedo et al., 2003). Exine ornamentation is similar to that found in previously studied species of the genus (Fig. 1; Bortenschlager, 1967; Verhoeven & Marais, 1990; Stafford & Blackmore, 1991).

The seeds are more or less ellipsoid, finely reticulate, without spots, and with scattered stomata in the three species here studied. The seed coat is uniform in structure and thickness, 25–30  $\mu\text{m}$  thick, similar to that found in other species of sect. *Gracilia* (Aedo et al., 2003). The reticulate surface is due to the prominence of outer and middle layers of the outer integument (Fig. 1).

### Key to species of *Geranium* sect. *Gracilia*

1. Pedicels without glandular hairs.
  2. Basal leaves cordate, densely ciliate with antrorse, appressed, eglandular hairs; petals ciliate on the basal margin . . . . . *G. santanderiense*
  2. Basal leaves subtruncate or cuneate, the margin glabrous or with spreading hairs; petals glabrous.
    3. Basal leaves coriaceous, with 3(–5) segments, subtruncate; with some eglandular hairs at the end of each segment and near the margin (sometimes with patent cilia); stipules of cauline leaves subulate . . . *G. lainzii*
    3. Basal leaves not coriaceous, with 5 segments, cuneate to subtruncate; with spreading eglandular hairs on the margin; stipules of cauline leaves lanceolate . . . . . *G. multiceps*
1. Pedicels with glandular hairs 0.15–1.7 mm long (rarely without glandular hairs, then the leaves velutinous abaxially).
  4. Shrub with ligneous, branches 4–5 mm diam.; short lateral branches with stipules groups and persistent rosettes of leaves. . . . . *G. lignosum*
  4. Plant with herbaceous aerial stems, erect, decumbent or climbing; lateral branches without stipules groups and persistent rosettes of leaves.
    6. Vegetative stems  $\pm$  horizontal, covered with imbricate stipules, usually without petiole remains.
      7. Sepal mucro (1.2–)1.7–2.2 mm long; inflorescence dense, with 2-flowered cymules on the first nodes and an aggregate of cymules (pseudoumbels) towards the apex of branches; stems (0.17–)0.31–0.62 cm diam . . . . . *G. lindenianum*
      7. Sepal mucro 0.4–0.8 mm long; inflorescence lax, without aggregates of cymules; stems 0.05–0.2(–0.24) cm diam. . . . . *G. holosericeum*
    6. Vegetative stems absent.
      8. Petals (12.8–)14.8–18.8 mm long . . . . . *G. schultzei*
      8. Petals 6–12.5 mm long.
        9. Petioles of basal leaves densely covered by patent hairs, the eglandular hairs 0.5–2.5 mm long, the glandular hairs 0.3–0.5 mm long . . . . . *G. sebosum*

9. Petioles of basal leaves with only eglandular hairs (to 1 mm long).  
 10. Basal leaves glabrous abaxially (sometimes with short eglandular hairs on nerve channels); stolons present . . . . . *G. stoloniferum*  
 10. Basal leaves hairy abaxially; stolons absent.  
 11. Fruit reflexed; leaves coriaceous, velutinous abaxially. . . . . *G. velutinum*  
 11. Fruit erect; leaves not coriaceous, with eglandular hairs on the nerves of abaxial surface . . . . . *G. subnudicaule*

**Geranium holosericeum** Willd. ex Spreng., Syst. Veg. 3: 72. 1826. Type: "Amer. austr.", *F. W. Humboldt s.n.* (lectotype, designated by Knuth, 1912: B-Willd-12568, n.v.; MA-623257: photo). (Fig. 2)

*Geranium gracilipes* Triana & Planch., Ann. Sci. Nat., Bot. ser. 5, 17: 113. 1873. Type: Colombia. Quindío, *A. J. Bonpland s.n.* (lectotype, designated by Aedo et al., 2003: P).

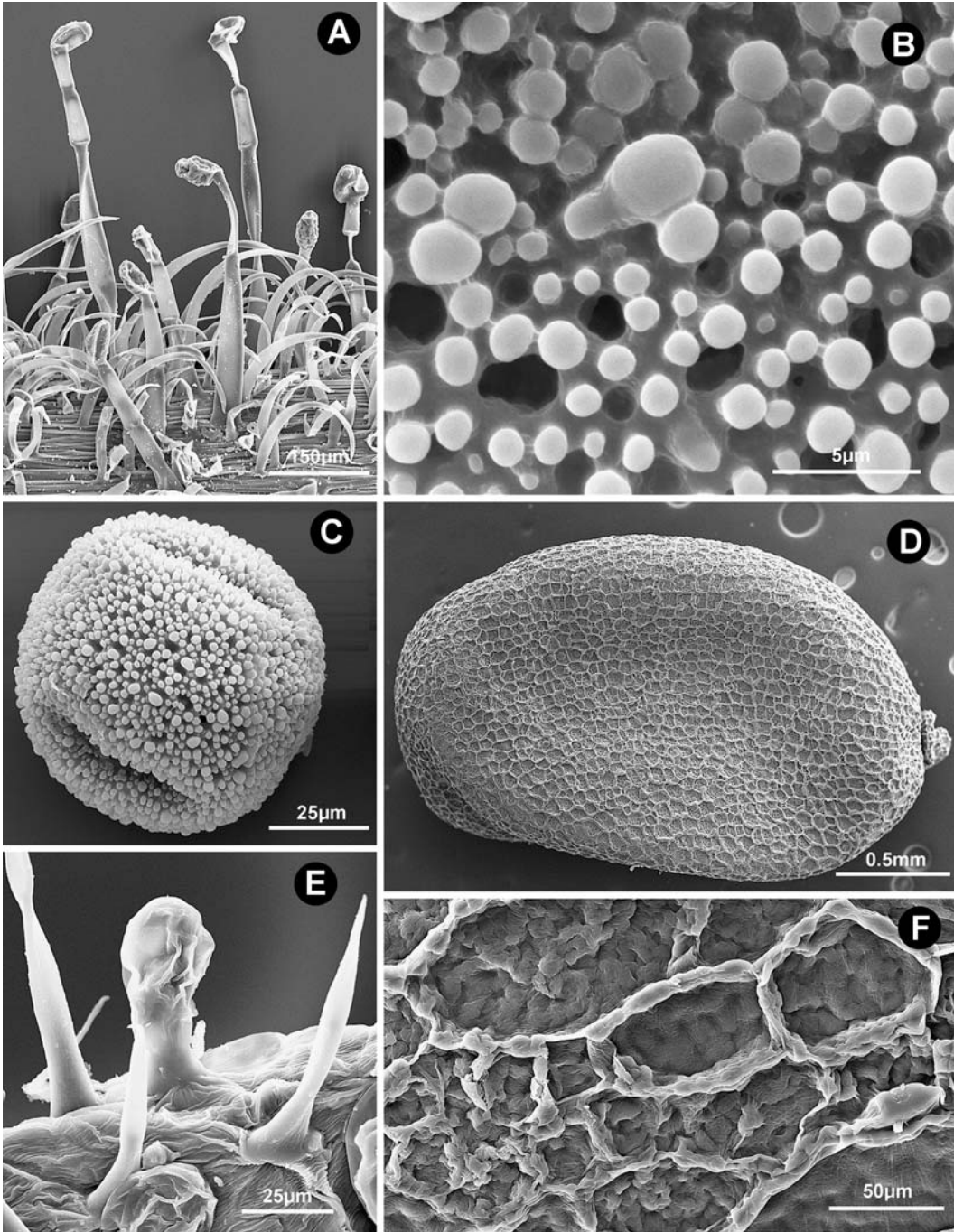
*Geranium holosericeum* var. *stuebelii* R. Knuth in Engl. (ed.), Pflanzenr. IV. 129 (Heft 53): 105. 1912. Type: Colombia. Cundinamarca: Páramo de Pasca, *M. A. Stuebel 146 p.p.* (holotype, B†; no authentic material located, Aedo et al., 2003: 102).

*Perennial herbs*, 19–60(–100) cm tall. Rootstock 2.1–6.4 mm diam., ± vertical. *Stem* 0.05–0.2(–0.24) cm diam., decumbent or climbing, with vegetative stems 5–10 cm long (± horizontal, covered with imbricate stipules, usually without petiole remains), leafy, herbaceous, with patent, eglandular hairs 0.2–2.2 mm long and patent, glandular (only on the inflorescence) hairs 0.3–1 mm long. *Basal leaves* in a persistent rosette; lamina 2.9–4.2(–5) × 3.2–5.2(–6) cm, polygonal in outline, cordate, palmatifid (ratio main-sinus length/ middle-segment length = (0.75)–0.82–0.89), pilose, with eglandular, appressed hairs, nervation not projected; segments 5, rhombic (ratio maximum width/ middle-segment length = 0.58–0.71), 3–9.5 mm wide at the base, 5–10(–15)-lobed in distal half (ratio second-sinus length/ middle-segment length = 0.12–0.32); cauline leaves opposite; petioles to 25 cm long, with eglandular, patent hairs 0.2–2.1 mm long, and rarely patent, glandular hairs 0.2–0.3 mm long; stipules 7–17.7 × 2.2–5.1 mm, lanceolate (with a setaceous apex 1–3.2 mm long), with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. *Inflorescence* in a dichasial cyme; cymules 2-flowered, solitary; peduncles (18–)30–100(–130) mm long, with patent to retrorse, eglandular hairs 0.15–2.5 mm long and patent, glandular hairs 0.3–1.3 mm long; bracteoles 4–9 ×

0.8–1.5 mm, lanceolate to subulate, with eglandular hairs on both sides and on the margin; pedicels 9.5–36 mm long, with patent to retrorse, eglandular hairs 0.15–1.6 mm long and patent, glandular hairs 0.2–1.7 mm long. *Sepals* 6–7.9(–9) × 2.8–4.5 mm, not accrescent, 3–5-nerved, with mucro 0.4–0.8 mm long, with scarious margins 0.2–0.58 mm wide, with ± patent, eglandular hairs 0.3–1.5 mm long on the abaxial side and patent, glandular hairs 0.3–1.4 mm long, almost glabrous adaxially. *Petals* 10–13.3(–14.6) × 6.2–11.7 mm (ratio petal width/petal length = 0.49–0.88), erect-patent, entire or slightly notched (notch ca. 1 mm deep), glabrous on the adaxial side, hairy on the base of abaxial side, ciliate on the basal margin, purplish. *Staminal* filaments 4–6.3 mm long, lanceolate, pilose on the abaxial side, ciliate on all of its length, with eglandular hairs 0.3–1 mm long; anthers 1–1.7 × 0.7–1 mm. *Nectaries* 5, hemispheric, glabrous. *Gynoeceum* 4.7–8.2 mm long. *Fruit* 2–2.54 cm long; mericarps 3.3–4.2 × 1.6–2.1 mm, with patent, eglandular hairs 0.15–1.4 mm long and ± patent, glandular hairs 0.3–1.3 mm long, brownish; rostrum 13–18.3 mm long, with a narrowed apex 1.2–2.2 mm long, with patent, eglandular hairs 0.15–1 mm long and ± patent, glandular hairs 0.3–1 mm long; stigmatic remains 2.8–3.6 mm long, with 5 glabrous lobes. *Seeds* 2.2–2.5 × 1.2–1.6 mm, finely reticulate, reddish.

*Distribution and habitat.*—Colombia: Boyacá, Caldas, Cundinamarca, Meta, Norte de Santander, Quindío, and Santander (Fig. 3). Wet meadows, open paramo on slopes or wet areas, among *Espeletia* Mutis ex Bonpl., *Polylepis* Ruiz & Pav., and *Weinmannia* L. shrubs, 2600–4000 m. Flowering February to September.

**Additional specimens examined. COLOMBIA.** **Boyacá:** valle Ritacuva, 6°39'N, 72°18'W, 4 Apr 1959, *Barclay & Juajibioy 7215* (MO); vereda Butagá, Mata Blanca, 5°33'N, 73°03'W, 10 Dec 1981, *Bejarano 89*



**FIG. 1.** Scanning electron micrographs of *Geranium holosericeum*, *G. lindenianum* and *G. schultzei*. **A.** Eglanular, unicellular hairs and long glandular hairs on the pedicel of *G. holosericeum* (Uribe 7027, MA). **B.** Exine of *G. lindenianum* (Grant 10960, US). **C.** Pollen grain of *G. holosericeum* (Uribe 7027, MA). **D.** Seed of *G. holosericeum* (Fernández Alonso 7742, MA). **E.** Eglanular, unicellular hairs and short glandular hairs on the sepal of *G. schultzei* (Alwyn & Gentry 2782, MO). **F.** Detail of seed surface of *G. schultzei* (White & Alverson 553, NY).

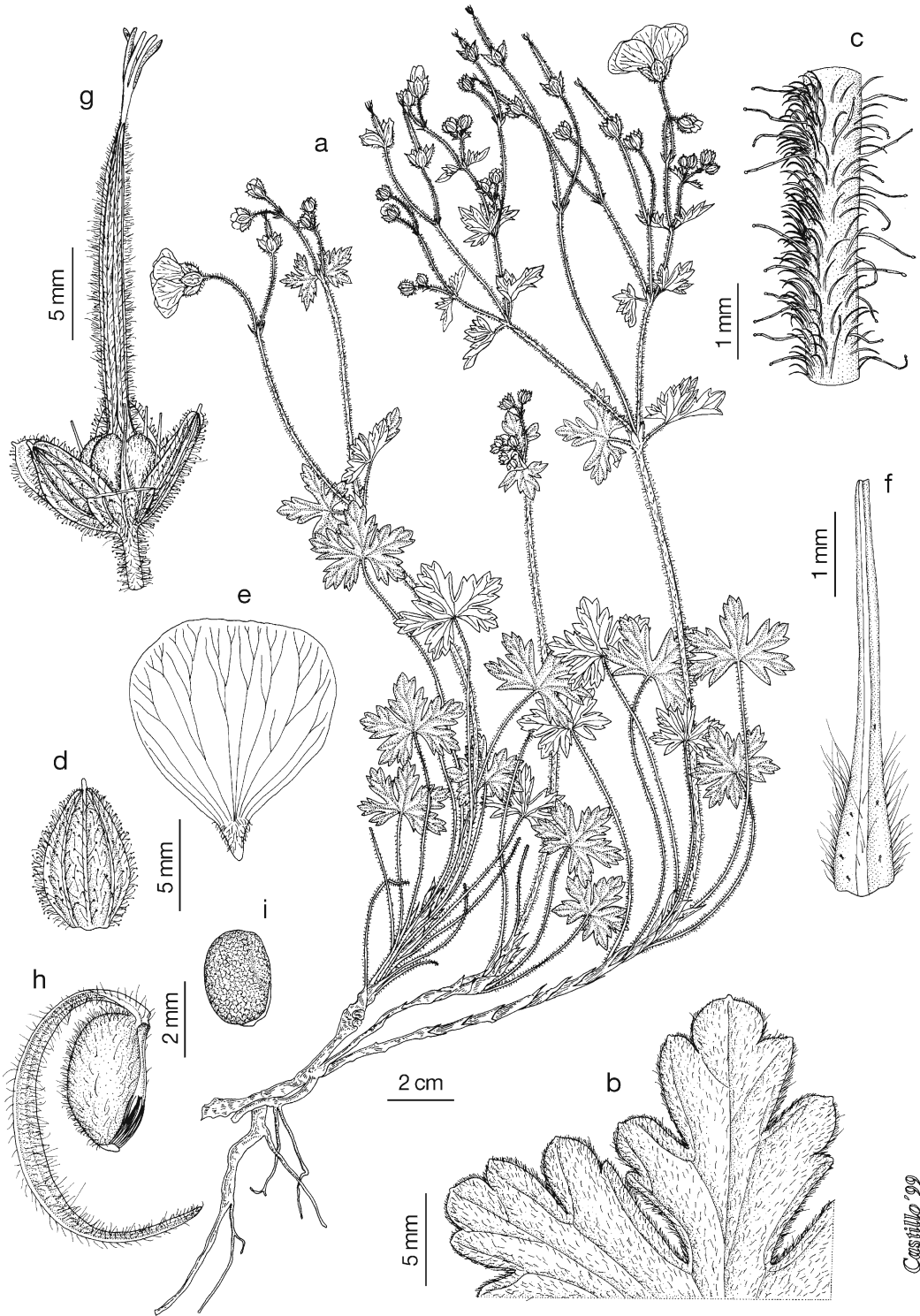


FIG. 2. *Geranium holosericeum*. a. Habit. b. Adaxial leaf surface. c. Peduncle. d. Sepal. e. Petal. f. Filament of stamen. g. Fruit. h. Mericarp. i. Seed. (Drawn from Uribe 6787, COL.)

(COL); Pesca, Páramo de la Cortadera, vereda La Peña, 5°33'N, 73°03'W, 14 Aug 1982, *Bejarano 222* (COL); entre Arcabuco y Tunja, cruce carretera a Cómbita, 5°39' N, 72°26'W, 5 Jun 1989, *Castroviejo et al. 10686* (COL, MA, MO); Cordillera Oriental, Nevado del Cocuy, Quebrada de San Paulino, el Morrón, 6°24'N, 72°27'W, 11 Sep 1938, *Cuatrecasas et García Barriga 1375* (COL, F, US); hacia La Cueva, en la Zanja, 6°25'N, 72°21'W, 13 Sep 1938, *Cuatrecasas 1640* (BC, F, US); La Uvita, vereda el Hatico, zona de la Quebrada Honda, 6°19'N, 72°34'W, 26 Jul 1996, *Fernández Alonso et al. 14472* (COL); Sierra Nevada de Cocuy, above Guican, 6°24'N, 72°27'W, 26 Jul 1957, *Grubb et al. 53* (COL, K); km 118 on road between Tunja and Bogotá, 5°33'N, 73°23'W, 31 Aug 1953, *Langenheim 3661* (LL, MICH, US); Socha, páramo de Pisba, laguna Colorado, 5°43'N, 72°50'W, Aug 1976, *Rangel et al. 527* (COL); Alto del Sote, 5°39' N, 73°19'W, 15 May 1996, *Rangel et al. 13268* (COL). **Caldas:** Manizales, vía Manizales-Nevado del Ruiz, *Alvear 748* (COL); carretera al Nevado del Ruiz, 4°54' N, 75°18'W, 30 Aug 1966, *Panchón et al. 65* (COL). **Cundinamarca:** Chapinero, près de Bogotá, 1907, *Apollinaire 5* (MPU); Páramo de Coachi, près de Bogotá, 4°31'N, 73°55'W, 24 Apr 1909, *Apollinaire 89* (MPU); laguna de Verjón, above Bogotá, 4°30'N, 74°03'W, *Ariste 755* (US); entre los municipios de Tausa y Cogua, zona del embalse de Neusa, 5°08'N, 73°58'W, 18 Oct 1982, *Ballesteros 45* (COL); Páramo de La Siberia, NE de Bogotá, 4°40'N, 73°45'W, 24 May 1959, *Barclay et Juajibioy 7707* (COL, MO); Parque Nacional de Sumapaz, Santa Rosa, margen izquierda del río Santa Rosa frente al Centro de Servicios, 4°17'N, 74°12'W, 28 Jun 1999, *Betancur et al. 8125* (HUA, MA); Páramo de Neusa, 50 km N of Bogotá, 5°08'N, 73°58'W, 1 Mar 1975, *Burbidge 75/240* (NY); Yomasa, near Bogotá, 4° 24'N, 73°57'W, 26 May 1948, *Camilo s.n.* (US); Vereda Lagunitas, 5°11'N, 73°53'W, 23 Jun 1998, *Cortés & Rodríguez 2552* (COL); macizo de Bogotá, Quebrada de San Cristobal, 4°34'N, 74°05'W, 28 May 1939, *Cuatrecasas 5123* (F, US); Páramo de Chisacá, Quebrada de Santa Rosa, 16 Sep 1961, *Cuatrecasas & Jaramillo 25992* (P); al S de Usme, entre La Regadera y El Hato, estación Agrícola Experimental Usme, 4°28'N, 74°06'W, 9 Jun 1950, *Idrobo et al. 310* (COL); cerca de la laguna de Chisacá, 4°17'N, 74°12'W, 17 Apr 1986, *Fernández Alonso et al. 6341* (COL); Bogotá, Páramo de Sumapaz, después de la laguna de Chisacá, cerca del río Taquecito, 4°11'N, 74°11'W, 9 Nov 1987, *Fernández Alonso et al. 7742* (COL, MA); Páramo de Chisacá, km 56 al S de Bogotá, 4°17'N, 74°12'W, 27 Sep 1952, *Fernández Pérez & Jaramillo 1499* (COL); on road to Villavicencio, above Chipaque, just below Páramo de Cruz Verde, 4°30' N, 74°03'W, 28 Feb 1943, *Fosberg 20249* (NY, US); Páramo de Sumapaz, río Arroz, 4°17'N, 74°12'W, 16 Aug 1943, *Fosberg 20839* (NY); Fómeque, Parque Natural Nacional de Chingaza, alrededores de la Laguna de Chingaza, 4°31'N, 73°46'W, *Franco 382* (COL); Subachoque, Páramo el Tablazo, 5°00'N, 74°14'W, 1 Sep 1983, *García 39* (COL); valle del río San Cristobal, alto de la Horqueta, 4°34'N, 74°05'W, 16 Nov 1958, *García Barriga 16141* (COL); *García Barriga 16180* (COL); *García Barriga 16181* (COL); Tausa, represa de Neusa, 5°08'N, 73°58'W, 16 Apr 1974, *Garzón 11* (COL); *Garzón 67* (COL); Moquentiva valley, 22 km

NW of Gachetá, 4°59'N, 73°40'W, 25 Jun 1944, *Grant 9481* (NY); Páramo de Cruz Verde, camino hacia Coachi, 4°31'N, 73°55'W, 21 Apr 1942, *Gutiérrez 254* (GH); W of Bogotá, 4°31'N, 73°55'W, 6 Jul 1968, *Mullen 38914* (GH); vereda Santa Rosa, alrededores de la laguna de los Tunjos, 4°16'N, 74°12'W, 7 Aug 1998, *Pedraza et al. 320* (MA); Páramo Tablazo, 5°0'N, 74°14'W, 6 Jul 1990, *Pipoly & Orozco 12069* (COL, MO); Zipaquirá, en Pantano Redondo, 5°01'N, 74°00'W, 23 Oct 1949, *Romero Castañeda 1831* (COL); Usme Experimental Station ca. 10 km S of Usme, Cordillera Oriental, 4°28' N, 74°06'W, 15 Jun 1950, *Smith et al. 1101* (COL, US); Páramo de Choachi, abajo Peñazul, 4°34'N, 74°00'W, 22 Jul 1963, *Soejarto 257* (COL); Chisaca, valley between Usme and Nazareth, 4°13'N, 74°11'W, 16 Jul 1998, *Stancik 289* (COL); Tausa, Páramo La Guerrero-Cuchilla Laguna seca, 5°13'N, 74°02'W, 17 Jul 1998, *Stancik 372* (COL); *Stancik 390* (COL); Villapinzón, Páramo La Calavera, 5°12'N, 73°33'W, 22 Jul 1998, *Stancik 398* (COL); Páramo de Guasca, cumbre, 4°50'N, 73°50'W, 4 Oct 1948, *Uribe 1814* (COL); macizo de Sumapaz, cerca de La Regadera, 4°28'N, 74°06'W, 30 Sep 1963, *Uribe 4475* (COL, NY); represa de Neusa, 5°08'N, 73°58'W, 4 Feb 1966, *Uribe 5522* (COL); Carupa, cerca al boquerón de Peña de Sumagá, 5°21'N, 73°54'W, 4 Aug 1967, *Uribe 5908* (COL, NY); Páramo de Sumapaz, cerca de las lagunas de Chisacá, en el sitio La Carcel, 4°17'N, 74° 12'W, 22 May 1974, *Uribe 6787* (COL); cerca de San Cayetano, 5°18'N, 74°04'W, 21 Oct 1977, *Uribe 7027* (COL-177869, MA). **Meta:** Macizo de Sumapaz, vertiente oriental de la cordillera, Hoya de la quebrada El Buque, 3°52'N, 74°25'W, 9 Jul 1981, *Díaz et al. 2733* (COL). **Norte de Santander:** Pamplona SW de la ciudad, por el Piñuelal, 7°24'N, 72°38'W, 30 Jun 1945, *Garganta Fábrega 1039* (F). **Santander:** near Mutisqua, N. Granada, 6°08'N, 73°29'W, -1848, (K). **Santander-Norte de Santander:** Cordillera Oriental, páramo cerca de la carretera Pamplona-Bucaramanga, 7°12'N, 72°50' W, 18 Jun 1966, *Schulz et al. 439* (U).

In Aedo et al. (2003), *Geranium holosericeum* was distinguished primarily by the vegetative stems, which produce distinctive buds towards the apex. These buds are sometimes quite long, composed of stipules (usually without petiole remains), and bear a rosette of leaves and an inflorescence. This structure could be the growth of each vegetative period, and is also found in some species of sect. *Neoandina* Aedo (Aedo et al., 2002). Aedo et al. (2003) also reported some specimens from northern Colombia and Venezuela that deviated from the usual morphology. Now we have studied more collections and found some important features, which permit a new taxonomy for this complex group.

In addition to its vegetative stems, *Geranium holosericeum* is characterized by its dichotomously branched, lax inflorescence.

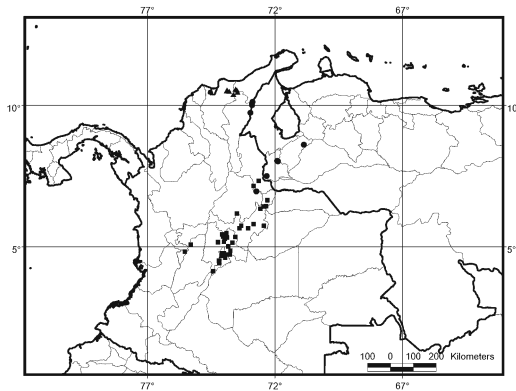


FIG. 3. Distributions of *Geranium holosericeum* (squares), *G. lindenianum* (circles) and *G. schultzei* (triangles).

This inflorescence has well-differentiated, 2-flowered, loose cymules even towards the top of branches. It also can be distinguished from *G. lindenianum* by its sepals with a shorter mucro. Although with some overlap, additional useful characters are found in the sepals, petals, petal hairs, and fruit length (shorter in *G. holosericeum* than *G. lindenianum*). According to some field observations the species differ in general appearance. *Geranium holosericeum* is a decumbent, weak plant that usually climbs on the surrounding vegetation, while *G. lindenianum* develops a uniquely erect and robust stem. Unfortunately, these features are difficult to appreciate in the fragments included in herbarium specimens. *Geranium lindenianum* and *G. holosericeum* share two features that are never found in *G. schultzei*: 1) vegetative stems, covered with imbricate stipules, usually without petiole remains, and 2) lanceolate stipules with a remarkable setaceous apex. Both species come in contact in the paramos dividing departments of Santander and Norte de Santander. Southward only *G. holosericeum* has been found. Northward, *G. lindenianum* is found both in Venezuelan paramos and in the Sierra de Perijá.

***Geranium lindenianum*** Turcz., Bull. Soc. Imp. Naturalistes Moscou 31(2): 418. 1858. Type: Venezuela. Táchira: Páramo del Portachuelo, 1843, *J. J. Linden 1394* (lectotype, designated by Aedo et al., 2003:

KW, n.v., seen as photocopy; isotypes: K, LE, MPU). (Fig. 4)

*Perennial herbs*, 32–63 cm tall. Rootstock 7.2–7.6 mm diam., ± horizontal. *Stem* (1.7–)3.1–6.2 mm diam., erect, with vegetative stems 6–22 cm long (± horizontal, covered with imbricate stipules, usually without petiole remains), leafy, herbaceous, sometimes subligneous, with patent, eglandular hairs 0.5–2.3 mm long and usually patent, glandular hairs 0.1–1.2 mm long. *Basal leaves* in a ± persistent rosette; lamina 4.3–10.4×4.4–12 cm, polygonal in outline, cordate, palmatifid (ratio main-sinus length/middle-segment length = 0.80–0.90), pilose, with ± erect, eglandular hairs and sometimes glandular ones, the nervation not projected; segments 5, rhombic (ratio maximum width/middle-segment length = 0.60–0.73), 5–12.2 mm wide at the base, 8–17-lobed in distal half (ratio second-sinus length/middle-segment length = 0.18–0.34); cauline leaves opposite; petioles to 15 cm long, with patent to retrorse, eglandular hairs 0.4–2.6 mm long, and usually patent, glandular hairs 0.2–0.6 mm long; stipules 9–25×1.8–5.6 mm, lanceolate (with a setaceous apex 1.9–7.7 mm long), glabrous or with eglandular and sometimes glandular hairs on abaxial surface, ciliate on the margin, almost glabrous adaxially. *Inflorescence* in a dichasial cyme; cymules 2-flowered, solitary or in aggregates at the top of each branch; peduncles 1.4–8.52 cm long, with patent, eglandular hairs 0.2–2.1 mm long, and patent, glandular hairs 0.3–1.6 mm long; bracteoles 6.9–14.5×0.8–2.2 mm, lanceolate, with eglandular and sometimes glandular hairs on both sides and on the margin; pedicels 15–85 mm long, with patent, eglandular hairs 0.3–1.8 mm long, and patent, glandular hairs 0.4–1.6 mm long. *Sepals* (6.4–)8–12.4×3.7–5.3 mm, not accrescent, 3–5-nerved, with mucro (1.2–)1.7–2.2 mm long, with scarious margins 0.2–0.5 mm wide, with ± patent, eglandular hairs 0.4–1.9 mm long and patent, glandular hairs 0.2–1.1 mm long on abaxial side, ± hairy adaxially. *Petals* (1.23–)1.31–1.93×.65–1.15 cm (ratio petal width/petal length = 0.47–0.88), erect-

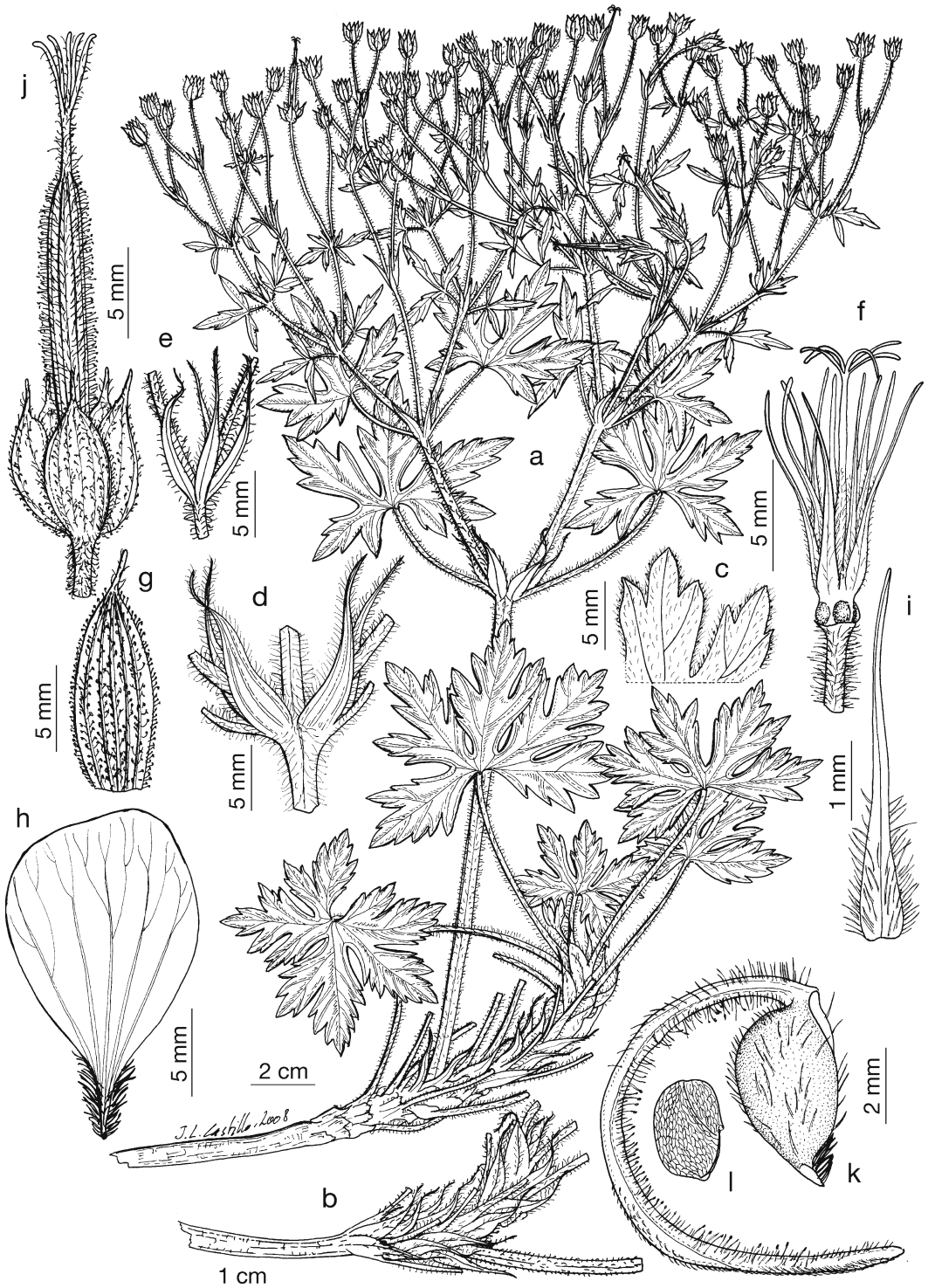


FIG. 4. *Geranium lindenianum*. a. Habit. b. Vegetative stem. c. Leaf indumentum on the adaxial side. d. Stipules. e. Bracteoles. f. Flower without petals and sepals. g. Sepal. h. Petal. i. Staminal filament. j. Fruit. k. Mericarp. l. Seed. (a–e, i from Cuatrecasas & Romero 25045, US; f–h from Carriker 26, US; j–l from Steyermark 125435, US.)



patent, entire, hairy on both sides (mainly on the base of adaxial side), ciliate on the margin, purplish. *Staminal* filaments 0.57–1.13 cm long, lanceolate, pilose on the abaxial side, ciliate on the proximal half, with eglandular hairs 0.5–1.3 mm long; anthers 1.6–2.8×0.8–1.2 mm. *Nectaries* 5, hemispheric, glabrous. *Gynoecium* 0.52–1.25 cm long. *Fruit* 2.43–3.58 cm long; mericarps 3.4–4.6×1.7–2.4 mm, with patent, eglandular hairs 0.8–1.3 mm long and usually ± patent, glandular hairs 0.6–0.9 mm long, brownish; rostrum 1.6–2.36 cm long, with a narrowed apex (1.7–)2.2–6.6 mm long, with patent, eglandular hairs 0.2–1.2 mm long, and patent, glandular hairs 0.4–1.1 mm long; stigmatic remains 2.7–5 mm long, with 5 glabrous lobes. *Seeds* 2.4–3.1×1.4–1.9 mm, finely reticulate, reddish.

*Distribution and habitat*.—Colombia: César, La Guajira and Santander; Venezuela: Táchira (Fig. 3). Wet paramo, among shrubs, between rocks, or on margin of the roads, 2700–3500 m. Flowering February to November.

**Additional specimens examined. COLOMBIA.**

**César:** east of Manaure, Sabana Rubia, 10°20'N, 72°54'W, 22 Jul 1987, *Cuadros 3717* (MO), 6 Nov 1959, *Cuatrecasas & Romero 25045* (COL, MO, US); Sierra de Perijá, 25 km east of Codazzi, on the Venezuelan border, 10°02'N, 72°58'W, 16 Feb 1945, *Grant 10960* (COL, NY, US); Serranía de Perijá, La Paz, 24 Feb 2006, *Rangel 13644* (COL), Cerro El Avion, Manaure, 3400 m, 6 Nov 1993, *Rangel 11196* (COL); Serranía de Perijá, Codazzi, 25 Feb. 2006, *Rivera et al. 3091* (COL). **Guajira:** Sierra Perijá, cerro Pintado, 10°27'N, 72°53'W, 3 Jul 1942, *Carriker 26* (US). **Santander:** Páramo del Almorzadero, región media, 6°59'N, 72°44'W, 20 Jul 1940, *Cuatrecasas & García Barriga 9972* (COL), *R. Sánchez 4662* (COL); Páramo del Almorzadero, municipio Cerrito, vereda Morcyño-La Cascada, 6°59'N, 72°44'W, 25 Feb 1999, *Stancik & Medina 2517* (COL).

**VENEZUELA. Táchira:** Páramo de Portachuelo, 8°10'N, 71°55'W, 23 Oct 1978, *Luteyn et al. 6025* (GH, MO); Páramo del Zumbador, carretera Tárriba-El Cobre, 7°35'N, 72°20'W, 25 Jul 1976, *Stergios 636* (MO, PORT); Uribante, faldas y quebradas afluentes del río Uribante, 48 km NW Pregonero, 8°09'N, 71°53'W, 28 Sep 1981, *Steyermark 125435* (US, VEN).

**Geranium schultzei** R. Knuth, *Repert. Spec. Nov. Regni Veg.* 28: 2. 1930. Type: Colombia. Magdalena: Sierra Nevada de Santa Marta, old Aracataca glacier, 10°35'N, 74°11'W, 1928, *A. Schultze 1328* (holotype, B†). Sierra Nevada de Santa Marta,

30 mi inland from Dibulla, July 1932, *W. E. Seifriz 462* (neotype, **here designated:** US-1572282!). (Fig. 5)

*Perennial herbs*, 36–88(–100) cm tall. Rootstock 5.5–9.7 mm diam., ± horizontal. *Stem* 2.8–7.6 mm diam., erect, without vegetative stems, leafy, herbaceous, with patent, eglandular hairs 0.6–1.9 mm long and usually patent, glandular hairs 0.3–0.4 mm long. *Basal leaves* in a ± persistent rosette; lamina 4.5–6.6×6.3–9.9 cm, polygonal in outline, cordate, palmatifid (ratio main-sinus length/ middle-segment length = 0.70–0.95), pilose, with ± erect, eglandular hairs and sometimes glandular ones, the nervation not projected; segments 5, rhombic (ratio maximum width/ middle-segment length = 0.55–0.79), 3.1–9.6 mm wide at the base, (9–)14–22-lobed in distal half (ratio second-sinus length/middle-segment length = 0.17–0.36); cauline leaves opposite; petioles to 42 cm long, with patent to retrorse, eglandular hairs 0.1–1 mm long, and usually patent, glandular hairs 0.2–0.5 mm long; stipules 0.64–2.17×0.2–0.6 cm, lanceolate, usually with eglandular hairs on margins and glabrous on both surfaces. *Inflorescence* in a dichasial cyme; cymules 2-flowered, solitary or in aggregates at the top of each branch; peduncles 2.1–5.7 cm long, with patent, eglandular hairs 0.6–2.1 mm long, and patent, glandular hairs 0.3–1.2 mm long; bracteoles 3.3–9.1×0.9–1.8 mm, lanceolate, with eglandular and sometimes glandular hairs on abaxial side and on the margin, glabrous adaxially; pedicels 2.0–4.1 cm long, with patent, eglandular hairs 0.3–1.2 mm long, and patent, glandular hairs 0.4–1.4 mm long. *Sepals* (6.8–)7.6–9.7×2.9–7.6 mm, not accrescent, 3–5-nerved, with mucro (0.6–)1–1.7 mm long, with scarious margins 0.2–0.6 mm wide, with ± patent, eglandular hairs 0.3–1.2 mm long and patent, glandular hairs 0.6–0.9 mm long on abaxial side, almost glabrous adaxially. *Petals* (1.28–)1.48–1.88×0.67–0.17 cm (ratio petal width/petal length = 0.53–0.70), erect-patent, entire, hairy on both sides (mainly on the base of adaxial side), ciliate on the margin, purplish, rarely white. *Staminal* filaments 4.4–6.9 mm long, lanceolate, pilose on the abaxial side, ciliate on the proximal half, with eglandular hairs 0.5–

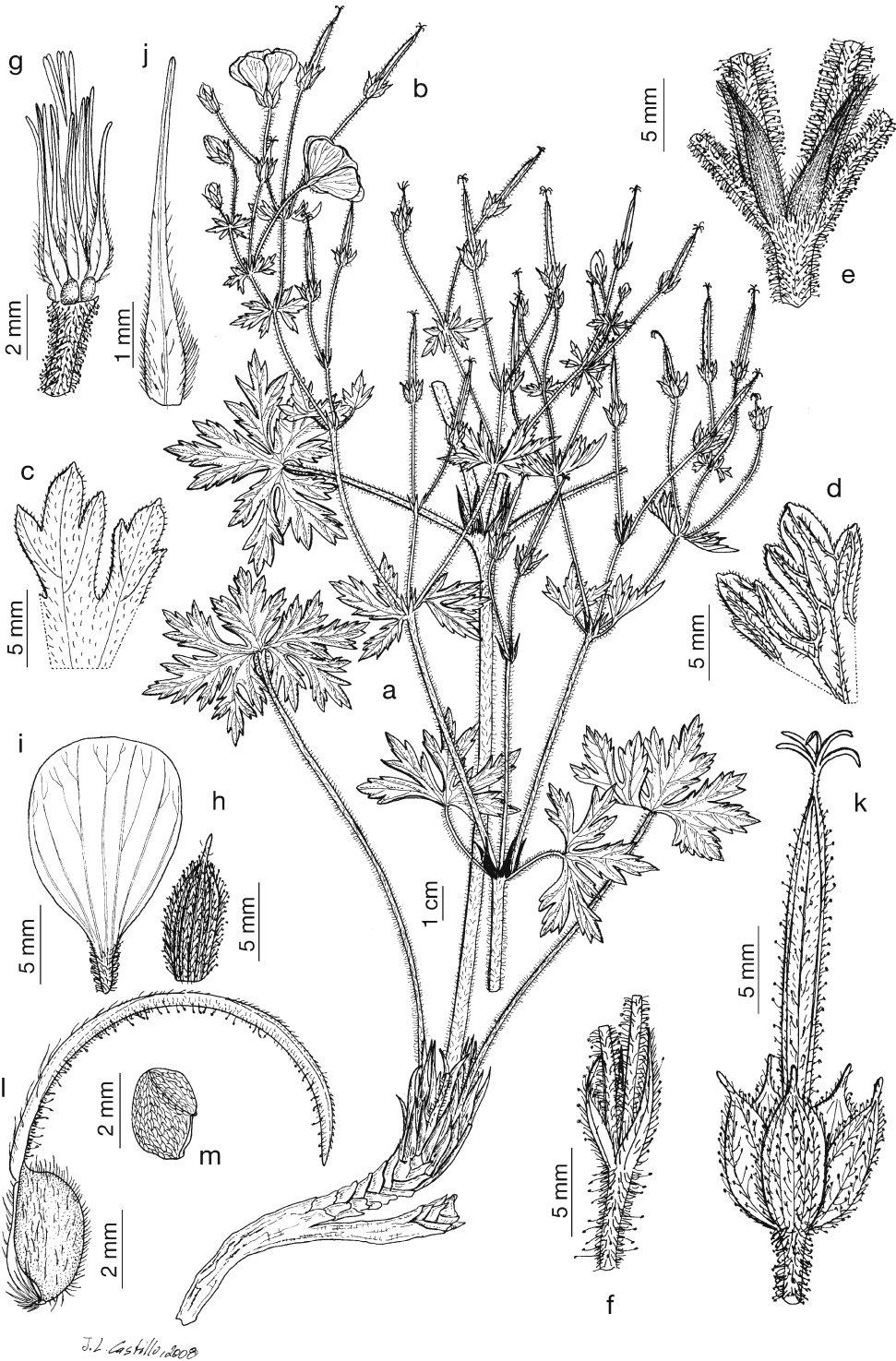


FIG. 5. *Geranium schultzei*. a–b. Habit. c. Leaf indumentum on the adaxial side. d. Leaf indumentum on the abaxial side. e. Stipules. f. Bracteoles. g. Flower without petals and sepals. h. Sepal. i. Petal. j. Staminal filament. k. Fruit. l. Mericarp. m. Seed. (From White & Alverson 553, NY.)

0.8 mm long; anthers 1.1–1.7×0.6–0.9 mm. *Nectaries* 5, hemispheric, glabrous. *Gynoeceum* 4.4–7.4 mm long. *Fruit* 2.5–2.96 cm long; mericarps 3.5–4.3×1.8–2.7 mm, with patent, eglandular hairs 0.5–1.6 mm long and ± patent, glandular hairs 0.4–0.9 mm long, brownish; rostrum 1.59–2.04 cm long, with a narrowed apex 1.8–2.7 mm long, with patent, eglandular hairs 0.1–0.8 mm long, and patent, glandular hairs 0.6–0.9 mm long; stigmatic remains 2.8–4.2 mm long, with 5 glabrous lobes. *Seeds* 2.1–2.7×1.1–2 mm, finely reticulate, reddish.

*Distribution and habitat.*—Colombia: Guajira and Magdalena (Fig. 3). Wet paramo with shrubs, between large outcrops, 2700–3900 m. Flowering May to August.

**Additional specimens examined. COLOMBIA.** **Guajira:** above Macotama, 10°55'N, 73°30'W, 16 May 1939, *Hanbury-Tracy 441* (K). **Magdalena:** Sierra Nevada de Santa Marta, alrededores de cabeceras del río Sevilla, 10°53'N, 73°54'W, 20 Jan 1959, *Barclay & Juajibioy 6678* (COL, MO, US); Sierra Nevada de Santa Marta, alrededores de las cabeceras del río Ancho, Páramo de Macotama, 10°57'N, 73°33'W, 16 Feb 1959, *Barclay & Juajibioy 7034* (COL, MO); Sierra Nevada de Santa Marta, 1 km al NW de la quebrada de la Laguna Río Frío, en dirección al Pico José Hilario, 10°55'N, 73°53'W, 31 Jul 1972, *Forero & Kirkbride 634* (COL, NY); Sierra Nevada de Santa Marta, transecto del Buritaca, filo La Cumbre, 10°52'N, 73°48'W, 15 Aug 1977, *Rangel & Cleef 944* (COL); in the vicinity of two small lakes near source of río Yebosimeina, 10°45'N, 73°38'W, 24 May 1977, *White & Alverson 553* (NY, MO);

The specimen *Forero 634* (COL, NY) is a fragment without basal parts and has more deeply divided leaves and hairy stipules, but otherwise matches *Geranium schultzei*. The type material in Berlin was lost through fire and no duplicate has been identified. Fortunately there is a collection in US from Sierra Nevada de Santa Marta, labeled by R. Knuth as “*G. Schultzei*”, and this has been selected as neotype.

*Geranium schultzei* was included in *G. holosericeum* by Aedo et al. (2003) and only one collection was examined (*Hanbury-Tracy 441*, K). Now that more collections of *G. schultzei* are available, this can be recognized as a taxon endemic to Sierra de Santa Marta. It was described by Knuth as being similar to *G. sylvaticum* L. in appearance, but up to 1.5 m in height. Herbarium specimens of *G. schultzei*

are very robust, showing a strong rootstock from which arises a single, erect, thick aerial stem. This stem can reach 7.6 mm in diameter and ca. 1 m high (according to the labels), but it is herbaceous. *Geranium schultzei* is usually dichotomously branched and bears a large inflorescence with 2-flowered cymules on the first nodes and an aggregate of cymules (pseudoumbels) towards the apex of branches. This species also has stipules that are usually long, glabrous on both surfaces, and remarkably dark reddish. The petals are also noticeably long. Glandular indumentum covers most of the plant but is abundant only in the inflorescence. Leaf indumentum is made up of spreading, usually eglandular hairs, longer than those in *G. lignosum* R. Knuth. *Geranium schultzei* has an inflorescence similar to that of *G. lindenianum*; however it lacks vegetative stems, and its stipules are lanceolate, not ending in a setaceous apex.

### Acknowledgments

We thank M. Gibby and anonymous reviewer for their critical review of the manuscript, Á. García Díaz and A. Martín for their technical support, and S. Castroviejo for uncompromising support. We are also grateful to the curators of the cited herbaria for kind assistance during our visits and for loan of specimens. This work was partly financed by the Spanish Dirección General de Investigación through the research project CLG2007-60184/BOS.

### Litarature Cited

- Aedo, C. 2000. The genus *Geranium* L. (Geraniaceae) in North America. I. Annual species. *Anales del Jardín Botánico de Madrid* 58: 39–82.
- . 2001a. Taxonomic revision of *Geranium* sect. *Brasiliensia* (Geraniaceae) *Systematic Botany* 26: 205–215.
- . 2001b. The genus *Geranium* L. (Geraniaceae) in North America. II. Perennial species. *Anales del Jardín Botánico de Madrid* 59: 3–65.
- , J. J. Aldasoro, L. Sáez & C. Navarro. 2003. Taxonomic revision of *Geranium* sect. *Gracilia* (Geraniaceae). *Brittonia* 55: 93–126.
- , J. J. Aldasoro & C. Navarro. 2002. Revision of *Geranium* sections *Azorelloida*, *Neoandina* and *Paramensia* (Geraniaceae). *Blumea* 47: 205–297

- , **F. Muñoz Garmendia & F. Pando.** 1998. World checklist of *Geranium* L. (Geraniaceae). *Anales del Jardín Botánico de Madrid*. 56: 211–252.
- , **C. Navarro & M. L. Alarcón.** 2005. Taxonomic revision of *Geranium* sections *Andina* and *Chilensia* (Geraniaceae). *Botanical Journal of the Linnean Society* 149: 1–68.
- Bortenschlager, S.** 1967. Vorläufige Mitteilungen zur Pollenmorphologie in der Familie der Geraniaceen und ihre systematische Bedeutung. *Grana Palynologica* 7:400–468
- Knuth, R.** 1912. Geraniaceae. *In*: A. Engler, (ed.), *Das Pflanzenreich* IV. 129 (Heft 53): 1–640. Wilhelm Engelmann, Leipzig.
- Moore, H. E.** 1943. A revision of the genus *Geranium* in Mexico and Central America. Contributions from the Gray Herbarium of Harvard University 146: 1–108, 5 “Plate”
- Stafford, P. J. & S. Blackmore.** 1991. Geraniaceae. *In*: W. Punt & S. Blackmore, (editors.), *The northwest European pollen flora*, VI: 49–78. Elsevier, Amsterdam, London, New York & Tokyo.
- Theobald, W. L., J. L. Krahulik & R. C. Rollins.** 1979. Trichome description and classification. *In*: C. R. Metcalfe & L. Chalk (eds.). *Anatomy of the Dicotyledons*. Edition 2. 1: 40–53. Clarendon Press, Oxford.
- Verhoeven, R. L. & E. M. Marais.** 1990. Pollen morphology of the Geraniaceae. *In*: P. Vorster (ed.). *Proceedings of the International Geraniaceae symposium*. University of Stellenbosch, Stellenbosch, South Africa.