

Taxonomic revision of *Geranium* sections *Andina* and *Chilensia* (Geraniaceae)

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The sections *Andina* and *Chilensia* of *Geranium* from South America, Australia and New Zealand are taxonomically revised. Fruits with 'seed ejection-type' dispersal have been found in all species, which confirms their classification within subgen. *Geranium*. Section *Andina* consist of four species, while sect. *Chilensia* comprises 11 taxa. In sect. *Andina*, *G. brevicaule* and *G. parodii*, previously considered as synonyms or recognized as infraspecific taxa, are accepted at species level. In contrast, *G. tucumanum*, *G. sessiliflorum* ssp. *novaezelandiae* and 17 other taxa have been reduced to synonyms. In sect. *Chilensia*, *G. patagonicum*, *G. fiebrigianum* and *G. drumondii* have been considered as synonyms of *G. berterioanum*, *G. fallax* and *G. solanderi*, respectively. Additionally, another 24 taxa have been reduced to synonyms. Diagnostic morphological features are analysed and compared within and between the sections. A multivariate morphometric study from 258 specimens was carried out to test the most significant characters. The chromosome number of six species (five never previously counted) was established. A key, species descriptions, a complete list of synonymy, a list of specimens examined and distribution maps are provided. Most species are illustrated for the first time. Thirty-seven lectotypes and one neotype are designated. © 2005 The Linnean Society of London, *Botanical Journal of the Linnean Society*, 2005, 149, 1–68.

ADDITIONAL KEYWORDS: Australia – chromosome number – New Zealand – South America.

INTRODUCTION

The genus *Geranium* L. comprises c. 400 species in temperate areas and tropical mountains throughout most of the world (Aedo, Muñoz Garmendia & Pando, 1998a). A brief history of the generic delimitation and infrageneric classification, as well as a description of the genus, can be found in Aedo (1996). In addition, a key for subgenera and sections can be found in Aedo, Aldasoro & Navarro (1998b) and Aedo *et al.* (1998a), respectively.

According to the currently accepted classification (Yeo, 1984), *Geranium* is divided into three subgenera: subgen. *Erodioidea* (Picard) Yeo, subgen. *Robertium* (Picard) Rouy, and subgen. *Geranium*. The subgen. *Erodioidea* which includes 22 species in four sections has recently been monographed (Aedo, 1996, 2001a): two sections are in the Mediterranean and western Asia, one is centred in the mountains of tropical East Africa, and one is in southern Brazil and northern Argentina. According to Yeo's (1984) sectional classifi-

cation, the subgen. *Robertium* comprises 30 species in eight sections, two of them not yet revised (Yeo, 1973, 1992, 2004; Aedo *et al.*, 1998b).

Geranium subgen. *Geranium*, the largest of the genus, comprises over 370 species; grouped in at least ten sections. Section *Tuberosa* (Boiss.) Reiche (Davis, 1970), sect. *Azorellويدa* Aedo, Muñoz Garm. & Pando, *Neoandina* Aedo and *Paramensia* R. Knuth (Aedo, Aldasoro & Navarro, 2002), sect. *Trygonium* Dumort. (Aedo, 2003), and sect. *Gracilia* R. Knuth (Aedo *et al.*, 2003) have already been revised. Most species are in sect. *Geranium*, which probably will be subdivided when a satisfactory knowledge of subgen. *Geranium* is obtained. Knuth's (1912, 1931) subdivision (32 sections) of the genus has been questioned by numerous authors, though without advancing an alternative until Yeo's (1984) review. However, Knuth's sections should be reconsidered when a new classification of the whole subgen. *Geranium* is undertaken.

Knuth (1912) described his sect. *Andina* for stemless species with 1-flowered cymules. In Aedo *et al.* (2002) we proposed a new section *Neoandina* (to include stemless species from the Andes without

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turnip-shaped rootstock and 1-flowered cymules) including all species of sect. *Andina* but *G. sessiliflorum* (which is the type of sect. *Andina*). According to this preliminary view both sect. *Andina* and sect. *Chilensia* should be united under the second name (Aedo *et al.*, 2002). However, in this study we preferred to maintain sect. *Andina* for stemless species with turnip-shaped rootstock and 1-flowered cymules, and include in sect. *Chilensia* species with turnip-shaped rootstock, 2-flowered cymules, and developed aerial stem. *Geranium brevicaule* which was included by Knuth (1912) as a synonym of *G. sessiliflorum*, is accepted here, while *G. bangii* is synonymized with *G. sessiliflorum*. We also included in section *Andina* two more species described after Knuth's (1912) monograph: *G. antrorsum* and *G. parodii*.

Knuth (1912) precisely described his sect. *Chilensia* as 'Radix incrassata, napiformis. Pedunculi bi-, rarius uniflori'. He recognized 23 species in this section, most of them based on the limited material available at that time, or sometimes supported only by literature records. From those taxa we accept here *G. solanderi* and *G. retrorsum* (included by Knuth under *G. pilosum* as different varieties), *G. berterioanum*, *G. limae*, *G. magellanicum*, *G. albicans*, *G. core-core*, *G. skottsbergii* (named by Knuth *G. ciliatum*). Additionally, we include *G. fiebrigianum* as a synonym of *G. fallax*, which was considered by Knuth (1912) as a doubtful synonym of *G. tucumanum* (in sect. *Rupicola* R. Knuth). The remaining species accepted by Knuth (1912) have been here considered synonyms, mainly of *G. berterioanum* and *G. core-core*. Later, Knuth described two species treated here: *G. tablasense* (Knuth, 1915) without any sectional assignment, and *G. venturianum* (Knuth, 1936) as belonging to sect. *Palustria* R. Knuth.

In addition to Knuth's (1912) monograph two contributions concerning sections *Andina* and *Chilensia* are relevant. Carolin (1965) studied the genus in the South-west Pacific, and included three species in his group IV: *G. retrorsum*, *G. solanderi* and *G. drummondii* and two in his group V: *G. sessiliflorum* (ssp. *novaezelandiae* and ssp. *brevicaule*) and *G. antrorsum*. We mainly agree with this taxonomy, although we consider *G. drummondii* as a synonym of *G. solanderi*, and accept *G. brevicaule* at specific level (including *G. sessiliflorum* ssp. *novaezelandiae*). Barboza (1996) studied the genus in Argentina. She accepted *G. albicans*, *G. core-core*, *G. venturianum*, *G. berterioanum*, *G. magellanicum* and *G. sessiliflorum*, with which we are in agreement. She also recognized *G. patagonicum* and *G. tucumanum* which are here considered as synonyms for *G. berterioanum* and *G. sessiliflorum*, respectively. She did not recognize *G. fallax* in the Argentinean flora but partially identified these speci-

mens as *G. patagonicum*, and included *G. parodii* as a variety of *G. magellanicum*.

The large size of the genus in South America makes it unfeasible to study *Geranium* as a single unit. The two sections comprise a reasonable number of species (15) for investigation. The species of this group have the 'seed ejection-type' of fruit discharge, and a turnip-shaped rootstock. They are mainly distributed in southern South America, Australia and New Zealand. Thus, following recent revisions of selected *Geranium* groups (Aedo, 1996, 2001a, 2003; Aedo *et al.*, 1998b, 2002, 2003), and in pursuit of a comprehensive monograph of the genus, we present here a revision of section *Andina* and *Chilensia*.

MATERIAL AND METHODS

This revision is based on 2008 herbarium specimens from the following herbaria: AAU, AK, B, BAF, BH, BM, BOLV, BR, C, CANB, CAS, CHR, CONC, CORD, CTES, E, F, FI, G, GH, GOET, H, HAL, HBG, HO, JE, JEPS, K, L, LD, LE, LIL, LP, LPB, M, MA, MERL, MICH, MO, MPU, NSW, NY, P, PERTH, PH, RSA, S, SGO, SI, SYD, U, UB, UC, UPS, US, W, WELT, WRSL, WU and Z (see the Appendix).

Curators from BA, BO, GB, KIEL, LY, PAD and TO kindly responded to our request, but they either did not find any of the requested specimens in their herbaria or sent some digital images.

For scanning electron microscopy (SEM), samples were glued to aluminium stubs, coated with 40–50 nm gold, and examined with an ITACHI S3000N scanning electron microscope at 18 kV.

Two hundred and fifty-eight specimens were used as operational taxonomic units (OTUs). They were distributed as follows: *G. antrorsum* (12), *G. brevicaule* (22), *G. sessiliflorum* (18), *G. magellanicum* (17), *G. parodii* (12), *G. limae* (22), *G. berterioanum* (19), *G. solanderi* (24), *G. skottsbergii* (15), *G. core-core* (21), *G. retrorsum* (19), *G. albicans* (16), *G. venturianum* (19), *G. tablasense* (4) and *G. fallax* (18). Unfortunately, *G. tablasense* is a restricted endemic species poorly represented in the herbaria. However, we considered the sample sufficient for the purpose of this study because it showed low variability.

In these specimens 28 quantitative characters were measured using a Mitutoyo CD-15DC digital calliper, and six ratios derived (Table 1). Each character was analysed for its mean value, range, standard deviation and significance using the STATISTICA package. To represent the variability of each descriptor within species box-plots were prepared. These plots contained medians and percentiles and were calculated using the STATISTICA package. Schemes of characters used to describe the leaf lamina and fruit are shown in Figures 1 and 2, respectively.

Table 1. Standardized coefficients obtained in discriminant analyses (DAs) for canonical variables

	DA1			DA2			DA3			DA4		
	Root 1	Root 2	Root 3	Root 1	Root 2	Root 3	Root 1	Root 2	Root 3	Root 1	Root 2	Root 3
Plant height	-0.4123	-0.15698	-0.36929	-0.66594	0.11652	-0.0999	-0.1072	0.694806	-0.62897	-0.91708		
Rootstock diameter	-0.5638	-1.04432	-1.05164	0.54462	0.2062	0.17003	0.0391	0.000749	1.63695	0.68860		
Stem diameter				0.7883	0.26027	0.1023	0.7396	0.232317	0.18968	0.40489		
Stem indumentum length				-0.62298	0.30061	-0.2916	0.7092	0.324868	1.66388	0.85805		
Segment width at the base/segment length ratio	-0.5263	-0.05411	1.33508	0.22161	0.26204	0.36399	0.1175	0.116438	2.63491	1.52890		
Main sinus length/main segment length ratio	0.3338	0.70739	0.23071	-0.8666	-0.01545	-0.11424	-0.2164	-0.422419	2.20175	0.22849		
Second sinus length	0.6403	-0.72181	-0.36895	0.2636	-0.08555	-0.41378	-0.225	0.205198	0.08615	0.21760		
Second sinus length/middle segment length ratio												
Maximum width/segment length ratio	-0.6579	0.07113	0.01589	0.57828	-0.42914	0.20358	-0.2452	0.083103	-1.66292	1.14659		
Segment lobes number	-0.6689	0.71058	-0.03404	0.46066	-0.13715	0.04302	0.4506	-0.073476	-0.12866	0.43777		
Stipule length	0.5408	0.24684	-1.20622	0.13966	0.29935	0.19848	-0.1276	0.01727	-0.49863	-0.69965		
Petiole indumentum length	0.1643	-0.45606	1.37008	0.19307	-0.32514	-0.07897	-0.5332	-0.425895	-1.17257	-1.13316		
Bracteole length	0.3651	-0.43729	-0.95225	1.00342	-1.00694	0.21161	-0.2428	0.14898	2.14319	0.10104		
Peduncle length	0.5160	1.18270	0.73328	0.13714	0.9616	0.32183	0.1732	-0.339816	0.20923	0.92213		
Pedicele length	0.9550	1.98610	-0.09041	-0.29173	0.09021	0.34455	-0.3025	-0.067035	1.17396	0.26579		
Pedicele indumentum length	-0.9922	-0.92374	-1.11325	-0.08006	0.58256	-0.40032	0.5153	0.037232	0.35918	0.35621		
Sepals length				0.09162	-0.56797	0.67617	0.4567	0.355175	0.39129	0.47439		
Sepal width/sepals length ratio	-0.2099	-0.62543	0.06108	-0.76174	-0.24096	0.67617	0.4567	0.355175	-0.95354	1.13534		
Mucro length	0.1481	0.37398	0.52588	-0.40459	-0.24807	-0.14765	-0.4625	0.331241	0.11448	-1.28503		
Sepals length/sepals length ratio	0.3382	0.16065	-1.24594	-0.02262	-0.69179	0.27895	-0.1138	0.330736	0.30293	0.35765		
Petal length	-0.5392	-1.00800	-1.66003	0.03521	0.95557	0.15956	-0.0314	-0.180518	-1.17235	-1.17304		
Filament length	0.7005	-0.67213	-0.64995	-0.06682	-0.55921	-0.14657	0.352	-0.24815	-0.68674	0.70108		
Anthers length	0.8457	0.75651	0.47374	-0.06682	-0.55921	-0.14657	0.352	-0.24815	-0.68674	0.70108		
Gynoecium length	0.0388	1.35594	1.91191	0.4942	-0.35191	-1.00646	-0.4891	0.138551	-0.42767	-0.93488		
Fruit length	3.5766	4.52796	-1.48949	-1.80264	1.67353	-0.54845	-0.7519	-0.824957	-0.48717	1.45223		
Mericarp length	-0.2189	-0.75266	0.19561	0.51719	-0.14956	0.06351	0.2466	-0.340464	-1.03937	-0.46177		
Mericarp indumentum length	0.4385	0.19180	-0.55117	-0.00678	-0.05502	0.44305	0.3351	0.202277	1.95348	1.32124		
Rostrum length	-3.9618	-5.36268	2.34770	0.93351	-0.87705	0.31924	0.5562	0.899789	-0.16345	-1.25432		
Rostrum narrowed apex length	1.7574	-0.49508	0.15644	-0.02051	0.11876	-0.67952	0.1173	0.178555	-0.44097	0.42061		
Rostrum indumentum length	0.1135	0.29290	0.50800	-0.30493	-0.35096	0.49714	0.3478	0.475094	-2.54130	0.14402		
Stigmatic remains length	0.1505	0.19515	0.49950	0.41139	-0.70379	-0.01419	-0.2007	0.008265	-2.31785	-0.01565		
Seed length	0.0479	1.54036	0.54997	0.41139	-0.70379	-0.01419	-0.2007	0.008265	-2.31785	-0.01565		
Eigen values	123.9878	28.93481	18.13762	6.07624	3.46148	9.65938	6.6613	2.822998	36.46717	19.42735		
Total cumulative proportion	0.7055	0.87015	0.97335	0.63707	1	0.50457	0.8525	1	0.65243	1		

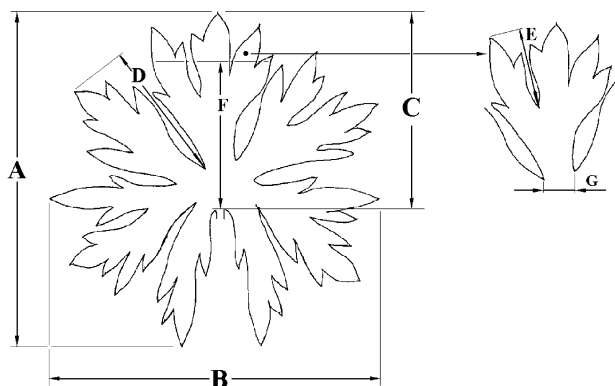


Figure 1. Scheme of characters used to describe the leaf lamina. A, lamina length; B, lamina width; C, segment length; D, main sinus length; E, second sinus length; F, maximum width; G, segment width at the base.

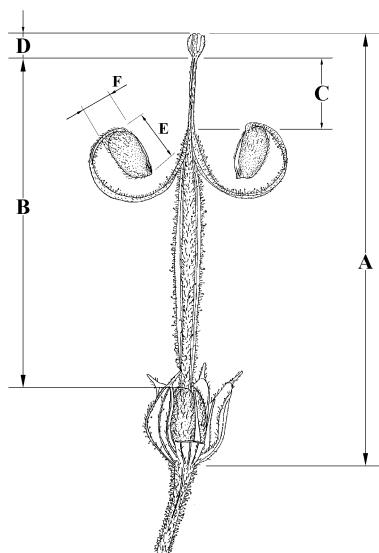


Figure 2. Scheme of characters used to describe the fruit. A, fruit length; B, rostrum length; C, rostrum narrowed apex length; D, stigmatic remains length; E, mericarp length; F, mericarp width.

Quantitative and qualitative characters are used in the key, being the discriminant quantitative characters inferred from box-plots. Several interesting characters have broad ranges of variability which cause some difficulties for their use. In order to avoid these problems the ranges are included in parentheses 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 given as percentiles and are shown outside the parentheses. Some overlapping was impossible to avoid at least in some cases.

To verify the significance of quantitative key characters, Kruskal–Wallis ANOVA and Median tests were carried out using the STATISTICA package. In each step of the key two groups were built assembling all measured specimens belonging to the species under that entry. Thus, the Kruskal–Wallis test was achieved on these two groups.

All taxa were differentiated using a combination of qualitative and quantitative characters. This separation was tested by means of discriminant analysis (DA). This method requires the a priori assignment of OTUs to groups, and allows the determination of whether the recognized groups are statistically definable entities or if there is too much variation within groups to allow classification (Sneath & Sokal, 1973). For DA the raw matrix was obtained, the results sorted in discrete groups and calculations carried out using the STATISTICA package. As DA is indicated where there are a few close groups (Sneath & Sokal, 1973), we performed four different DAs to test the most similar species: (1) sect. *Andina* (four species) plus *G. magellanicum*; (2) *G. limae*, *G. berterioanum* and *G. solanderi*; (3) *G. skottsbergii*, *G. core-core*, *G. retrorsum* and *G. albicans*; (4) *G. venturianum*, *G. tablasense* and *G. fallax*.

In order to determine chromosome number, seeds of available species were germinated and transferred into pots for cultivation. Approximately two months later, young root tips were cut and incubated for 24 h in distilled water at 4 °C, then fixed with a mixture of 25% acetic acid and 75% ethanol, stained with aceto-orcein, squashed and counted.

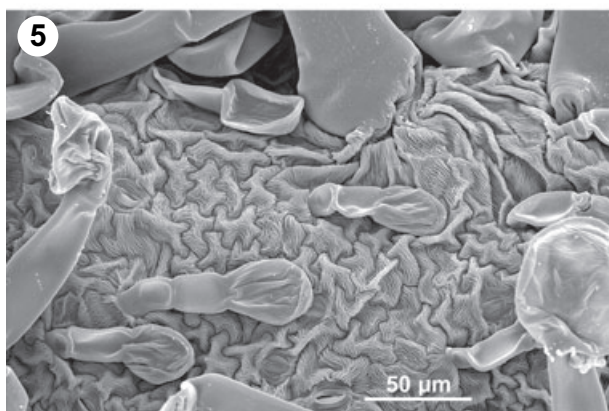
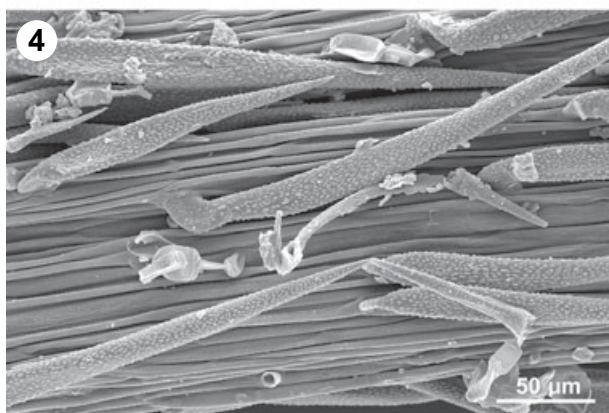
TAXONOMIC CHARACTERS

DURATION AND HABIT

All species of *Geranium* sect. *Andina* and *Chilensia* are perennial herbaceous plants. They share a \pm vertical, turnip-shaped rootstock, from which thin roots arise. Only three species have \pm thick and fleshy, fusiform roots: *G. fallax*, *G. tablasense* and *G. venturianum*. All species of sect. *Chilensia* have a decumbent to erect, leaved stem, while plants of sect. *Andina* are stemless.

INDUMENTUM

In the species studied here three trichome types have been found, all of them simple and uniseriate (Theobald, Krahulik & Rollins, 1979): (a) eglandular, unicellular hairs of variable length (0.1–2.2 mm), sometimes with an ornamented surface (Figs 3, 4). According to Payne (1978) they could be included in the ‘subulate’ type. They have been found in all species, widespread for all organs of the plant; (b) glan-



Figures 3–5. Scanning electron micrographs showing indumentum features of *Geranium* sect. *Andina* and sect. *Chilensia*. Fig. 3. Eglandular (smooth) and glandular hairs on sepals of *G. fallax* (Beck 21256, MA). Fig. 4. Eglandular hairs (with an ornamented surface) and short glandular hairs on pedicels of *G. core-core* (Aedo 7073, MA). Fig. 5. Short glandular hairs on sepals of *G. fallax* (Beck 21256, MA).

dular hairs of variable length (0.3–1.4 mm), usually with 2–4 cells, smooth, the foot consisting of cylindrical cells or of decussated cells; they are absent from sect. *Andina*, and in sect. *Chilensia* restricted to five spe-

cies: *G. berterioanum*, *G. skottsbergii*, *G. venturianum*, *G. fallax* and *G. tablasense* (Fig. 3). In the three first species the presence of glandular hairs varies. Some specimens have only eglandular hairs while others have also glandular hairs widespread on the stem, inflorescence, sepals, rostrum and/or mericarps. In contrast, in all studied specimens of *G. fallax* and *G. tablasense* there are glandular hairs; (c) short glandular hairs (<40 μm long), smooth, usually constituting two cells, although they sometimes have a bicellular foot (Figs 4, 5). They are present in all species studied here but they are not included in the descriptions because they are only evident at high magnification.

LEAVES

The leaves in all species of sect. *Andina* and sect. *Chilensia* are polygonal in outline, cordate, palmatifid, with 5–7 segments. Two exceptions are found in sect. *Andina*: some specimens of *G. sessiliflorum* showed a leaf rounded in outline, and in *G. antrorsum* the leaf base is cuneate to subtruncate. Basal leaves are in a rosette, usually deciduous in sect. *Chilensia* and persistent in sect. *Andina*. Cauline leaves are opposite in all species of sect. *Chilensia*. The middle segment is rhombic in *G. albicans*, *G. venturianum*, *G. fallax* and *G. tablasense*, while it is obtriangular in the remaining species of sect. *Chilensia*. In sect. *Andina* it is usually obtriangular with the exception of some specimens of *G. sessiliflorum* and *G. parodii*. Leaves are particularly divided in *G. skottsbergii* because it has narrow lobes and a deep secondary sinus.

INFLORESCENCE

All species of sect. *Chilensia* have a monochasial cyme with 2-flowered cymules arising along leafy stems. However, in *G. magellanicum* cymules of the basal part of the stem are usually 1-flowered (parts of them arise directly from the rootstock) and cymules of the upper part 2-flowered. Peduncles of *G. venturianum* are noticeably longer, reaching 25 cm long in some cases. In sect. *Andina*, 1-flowered cymules arise directly from the rootstock. In some cases they are bibracteate, with a short peduncle, while in others the pedicel is borne directly from the rootstock. Some exceptions are discussed under *G. parodii* and *G. sessiliflorum*.

CALYX

Sepals are smooth, not accrescent and 3-nerved in all species of the section. The most taxonomically significant sepal features are the outline and the mucro length. In *G. core-core* sepals are broadly ovate (with a

high width/length ratio) whereas the remaining species of the sections *Andina* and *Chilensia* have lanceolate sepals (with a low width/length ratio). The mucro is particularly long in *G. antrorsum*, and to a lesser extent, in *G. brevicaule*. Among species of sect. *Chilensia*, *G. venturianum* and *G. tablasense* show the longer mucro and *G. albicans* and *G. limae* the shorter ones.

COROLLA

The corolla of all species of sections *Andina* and *Chilensia* are actinomorphic. The petals usually have an entire or slightly notched apex, but *G. tablasense* shows a short notch. *Geranium tablasense* is also unique in having a short claw. In most species of both sections petals are glabrous on both sides and ciliate on the basal margin. However, *G. parodii* and *G. venturianum* are hairy on the base of the adaxial side. *Geranium sessiliflorum*, *G. brevicaule* and *G. tablasense* usually have glabrous petals, although in some specimens scattered cilia can be found on the basal margin. Finally, *G. antrorsum* has glabrous petals.

STAMENS, POLLEN AND NECTARIES

In *Geranium* the ten stamens are arranged in two whorls. The filaments of sect. *Andina* and *Chilensia* are not exerted, and lanceolate. They are ciliate at least at the base, and in some species hairy on the abaxial side.

Pollen of all species studied here, as in almost the entire genus (Weber, 1996; Aedo *et al.*, 2002, 2003), is characterized by reticulate exine ornamentation with distinctly baculate, clavate or gemmate suprategal elements (Figs 6–11).

The five hemispherical nectaries are arranged alternately to the external whorl of staminal filaments. They are glabrous except in *G. limae* and *G. parodii*, which usually exhibit a tuft of hairs at the top of each nectary.

FRUIT

Geranium sect. *Andina* and sect. *Chilensia* are assigned to subgenus *Geranium*, which exhibits the 'seed ejection-type' of fruit discharge (Yeo, 1984). In this type a single seed is actively discharged by the explosive recurvature of the awn of the fruit, which remains together with the mericarp, attached to the columella. Mericarps have a basal callus, on which are arranged some hairs that prevent the seed from dropping during the pre-explosive interval (Figs 12, 13). Mericarps have a similar size and are smooth (except in some specimens of *G. parodii* which have 1–2 trans-

versal veins at the apex) and brownish in all species (except in *G. fallax* and *G. solanderi* that are usually blackish). The rostrum abruptly ends in the stigmatic remains except in three species of sect. *Chilensia* (*G. fallax*, *G. tablasense* and *G. venturianum*), and in one of sect. *Andina* (*G. parodii*), which have a narrowed apex. The stigmatic remains are usually glabrous, and they are noticeably long in *G. tablasense* and *G. venturianum*.

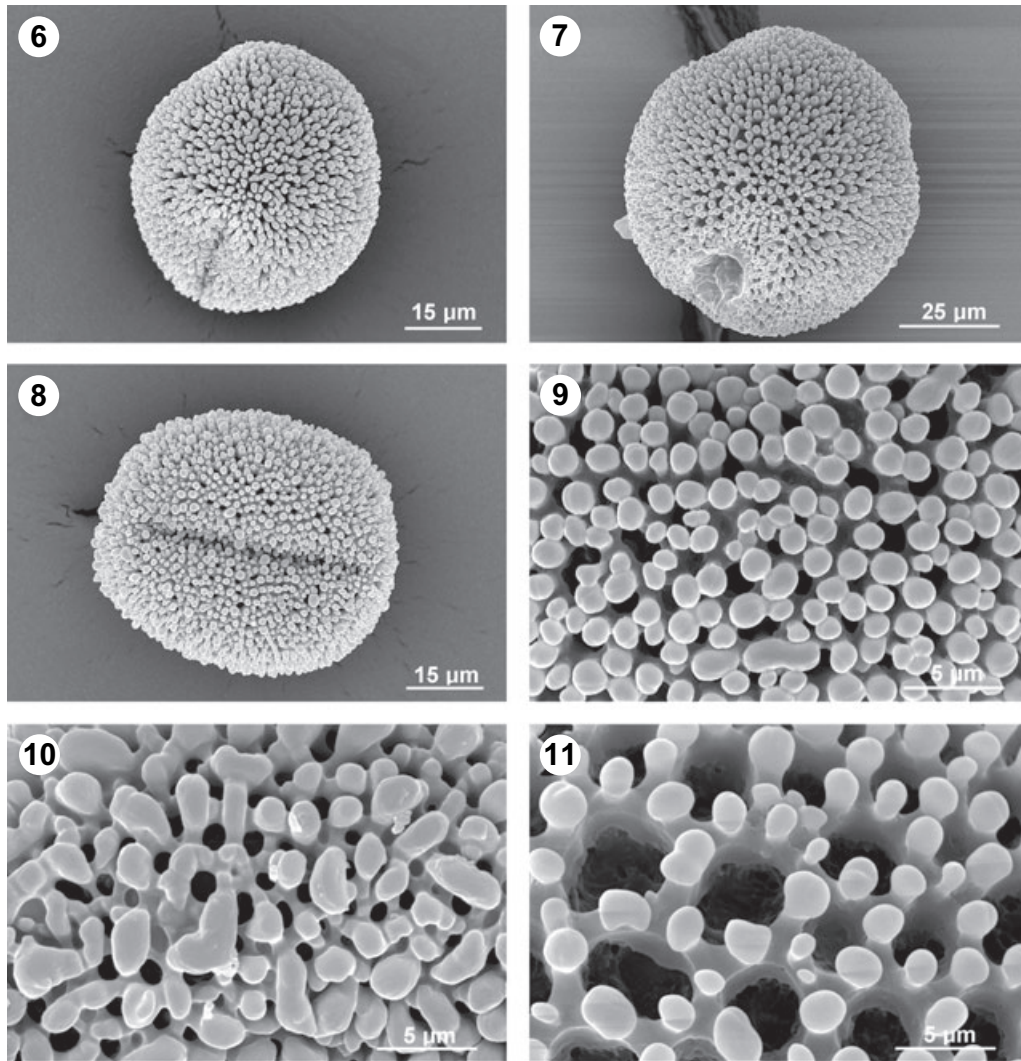
SEEDS

The seeds are more or less ellipsoid in the three sections. The seed-coat appears finely reticulate at a magnification of 30 \times , but SEM shows a reticulate surface due to the prominence of the outer and middle layers of the outer integument (Figs 14–19). The outer layer has cells with thickened walls and collapsed lumina, forming a polygonal structure. The seed-coat is usually brownish and bears scattered stomata.

Carolin (1965) characterized *G. retrorsum* by its seeds with 'isolateral alveolae' and *G. solanderi* by its seeds with 'large alveolae'. These species, and the remaining of sections *Chilensia* and *Andina*, show considerable variation in the form of cells of the seed-coat (Figs 18, 19). A broad range of variation from square to rectangular cells can be found in the same species, suggesting that this feature has little taxonomic value.

According to Corner (1976), seeds of Geraniaceae have cells which contain solitary crystals and tannin in the inner layer of the outer integument. These crystal cells are also present in the endotesta of *Hypseocharis* Remy and Oxalidaceae (Boesewinkel, 1988). According to Boesewinkel & Been (1979) crystals extend as small protrusions beyond the so-called light-line, and reach the coat surface of the seed (Figs 20, 21). They form bipyramidal figures produced by calcium oxalate trihydric crystals (Netolitzky, 1926). In *Geranium* sect. *Chilensia* crystals are present in all species. In contrast, among species of sect. *Andina*, crystals are absent on the seed coat (*G. antrorsum*, *G. brevicaule*, *G. sessiliflorum*) (Fig. 22) or they are very rare (*G. parodii*). A preliminary study of other groups of *Geranium* indicates that they are present in subgen. *Erodioidea* (*G. reflexum* L.), as well as in other sections of subgen. *Geranium* (*G. rotundifolium* L.). However, we found no crystal on the seed coat of species of subgen. *Robertium* (*G. robertianum* L.; *G. macrorrhizum* L.; *G. reuteri* Aedo & Muñoz Garm.).

The cotyledons are always conduplicate, one half of each cotyledon lying in the primary fold of the opposite cotyledon. They have entire margins, truncate bases and short petioles, as found in sect. *Neoandina* (Aedo *et al.*, 2002).



Figures 6–11. Scanning electron micrographs showing pollen features of *Geranium* sect. *Andina* and sect. *Chilensia*. Fig. 6. Pollen grain of *G. antrorsum* (Woodward s.n., SYD). Fig. 7. Pollen grain of *G. berterioanum* (Aedo 7391, MA). Fig. 8. Pollen grain of *G. brevicaule* (Morris 86146, HO). Fig. 9. Pollen ornamentation of *G. core-core* (Aedo 7006, MA). Fig. 10. Pollen ornamentation of *G. core-core* (Aedo 7197, MA). Fig. 11. Pollen ornamentation of *G. tablasense* (Cárdenas 758, US).

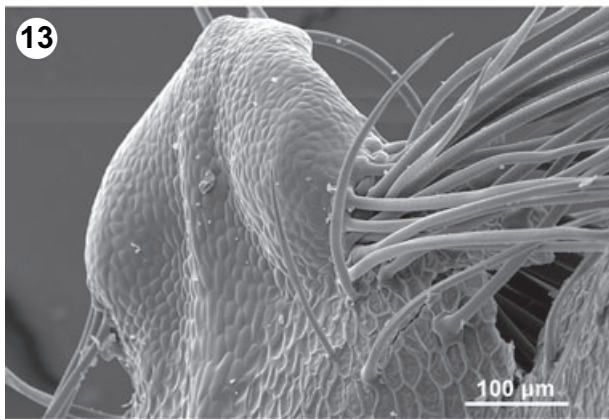
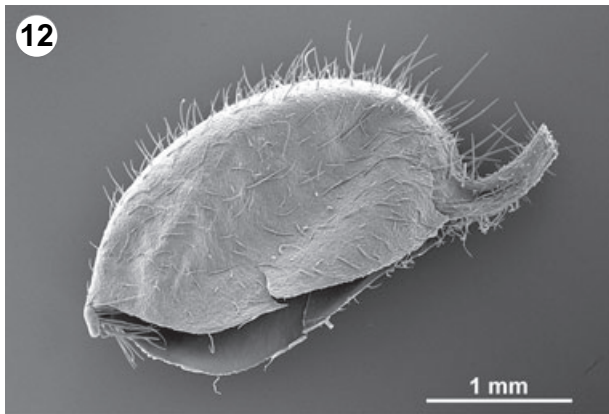
CHROMOSOME NUMBER

The only species of sect. *Andina* counted is *G. sessiliflorum* (Table 2). Three counts showed $2n = 56$ (one in this study and two from the literature), and one $n = 26$. The last number was attributed to *G. tucumanum* by Barboza (1983). This species has been considered in this study as a synonym of *G. sessiliflorum*, and the voucher of this count was reidentified as *G. sessiliflorum*. Unfortunately, neither Gauger (1937) nor Warburg (1938) indicated the origin of their specimens, and no vouchers of these counts were kept. Thus, some doubts about the identity of these plants may exist, especially if we consider that *G. sessiliflorum* ssp. *novaezelandiae* (here considered

as *G. brevicaule*) is commonly cultivated in European gardens.

Six species of *Geranium* sect. *Chilensia* have been counted, five in this study and one by Barboza (1983) (Table 2). Barboza (1983) reported $n = 14$ for *G. albicans*, three numbers have been found for *G. berterioanum* ($2n = 52$, $2n = 56$ and $2n = 84$), one for *G. core-core* ($2n = 56$), *G. magellanicum* ($2n = 112$), and *G. solanderi* ($2n = c. 24$) and two for *G. skottsbergii* ($2n = c. 39$, $2n = 52$).

Among species of *Geranium* the most common chromosome number is $2n = 28$, particularly in subgen. *Geranium* and subgen. *Erodioidea*. Yeo (1984) considered $x = 14$ as a secondary basic number, while Van Loon (1984b) accepted $x = 14$ as the main basic chro-



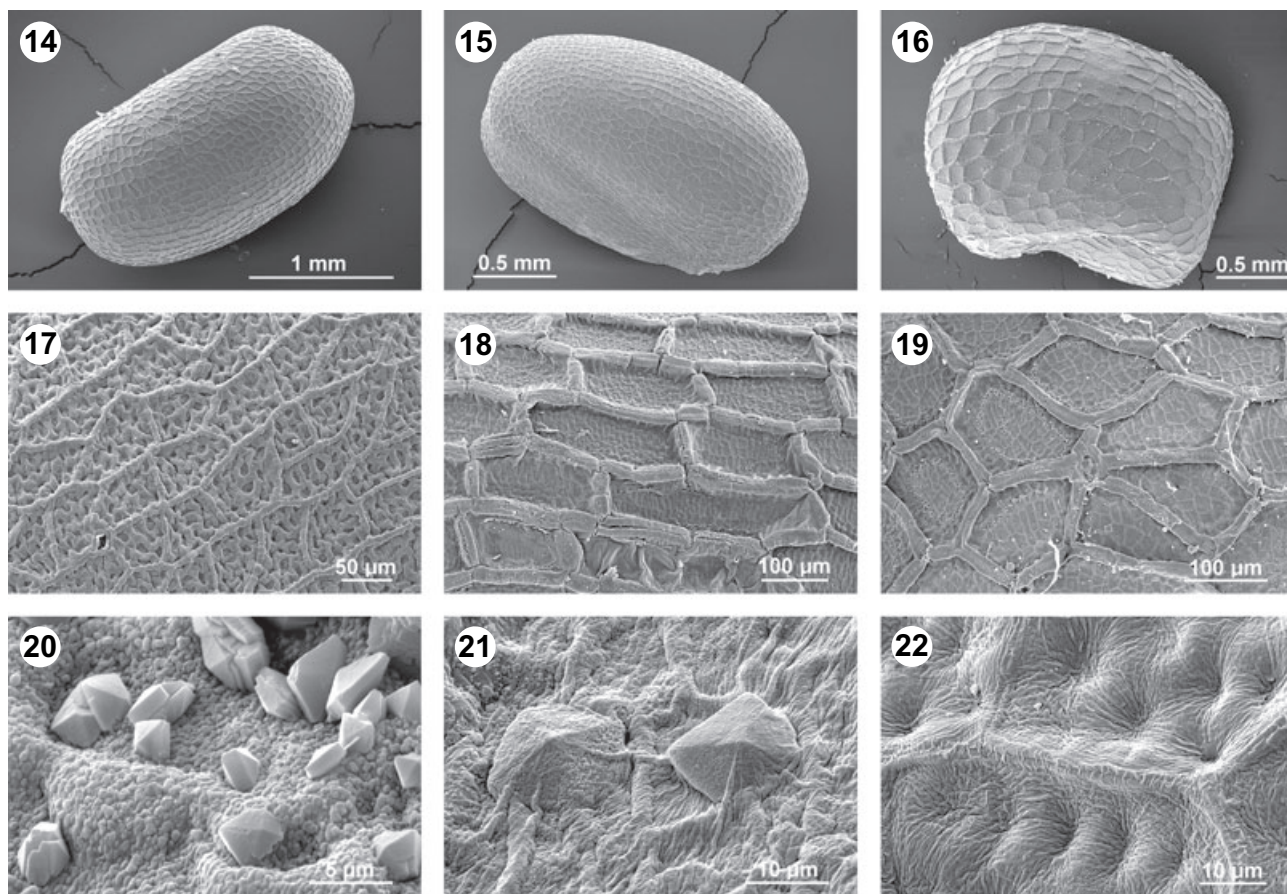
Figures 12–13. Scanning electron micrographs showing mericarp features of *Geranium* sect. *Andina* and sect. *Chilensia*. Fig. 12. Lateral view of a mericarp of *G. skottsbergii* (Aedo 6838, MA). Fig. 13. Basal callus of a mericarp of *G. limae*, showing hairs which prevent the seed from dropping during the pre-explosive interval (Goodspeed *et al.* 11526, UC).

mosome number in the genus. According to the last view, the number $2n = 56$ found in some species of sect. *Andina* and *Chilensia* would correspond to tetraploids, $2n = 84$ found in *G. berterioanum* to hexaploids, and $2n = 112$ found in *G. magellanicum* to octoploids. The number $2n = 84$ was reported previously only in *G. sanguineum* L. (Van Loon, 1984a). It is a European species also belonging to subgen. *Geranium*, which seems to be no relation to *G. berterioanum*. The number of *G. magellanicum* is unusually high in *Geranium*. Only in two species of the subgen. *Robertium* have higher chromosome numbers been recorded: $2n = 128$ (Yeo, 1973).

The number $2n = 52$, which has been found in *G. berterioanum*, *G. skottsbergii* and *G. sessiliflorum* seems to be restricted to American species of *Geranium* subgen. *Geranium*, and would be a tetraploid level for a basic number $x = 13$. It has been reported for six species from North America (Shaw, 1952; Faasen & Nadeau, 1976; Taylor & Taylor, 1977; Löve & Löve, 1982; Ward, 1984), three species from Mexico (Beaman, De Jong & Stoutamire, 1962; Seavey, 1975), one species from Peru (Huynh, 1965). All of those species belong to subgen. *Geranium*, although their relationships with species of section *Chilensia* and *Andina* remain unknown. Chatterjee & Sharma (1970) reported $n = 26$ in a specimen of *G. robertianum* from India. However, Van Loon (1984b) exhaustively studied this species (128 specimens counted), and found $2n = 64$ in all the cases. This suggests that the report of Chatterjee & Sharma (1970) should be confirmed. The number $2n = c. 24$ has been found in *G. solanderi*. In this species a more precise count should be made in order to determine the exact chromosome number. However, a basic number $x = 12$ or

Table 2. Chromosome counts in *Geranium* sect. *Andina* and sect. *Chilensia*. Digital images of the vouchers from CORD were studied

Section	Species	n	$2n$	Origin	Voucher	Source
<i>Andina</i>	<i>G. sessiliflorum</i>		56	cultivated	unknown	Gauger (1937)
	<i>G. sessiliflorum</i>		56	unknown	unknown	Warburg (1938)
	<i>G. sessiliflorum</i>	26		Argentina, Salta	<i>Barboza 13</i> (CORD)	Barboza (1983)
	<i>G. sessiliflorum</i>		56	Chile, Biobío	<i>Aedo 7500</i> (MA)	this study
<i>Chilensia</i>	<i>G. albicans</i>	14		Argentina, Córdoba	<i>Barboza 9</i> (CORD)	Barboza (1983)
	<i>G. berterioanum</i>		52	Chile, Maule	<i>Aedo 7154</i> (MA)	this study
	<i>G. berterioanum</i>		56	Chile, Región Metropolitana	<i>Aedo 6737</i> (MA)	this study
	<i>G. berterioanum</i>		84	Chile, Biobío	<i>Aedo 6913</i> (MA)	this study
	<i>G. berterioanum</i>		84	Chile, Magallanes	<i>Aedo 7459</i> (MA)	this study
	<i>G. core-core</i>		56	Chile, Antofagasta	<i>Aedo 7006</i> (MA)	this study
	<i>G. core-core</i>		56	Chile, O'Higgins	<i>Aedo 7073</i> (MA)	this study
	<i>G. magellanicum</i>		112	Chile, Magallanes	<i>Aedo 7445</i> (MA)	this study
	<i>G. solanderi</i>		<i>c. 24</i>	New Zealand, Chatham Is	<i>Lange 225</i> (AK)	this study
	<i>G. skottsbergii</i>		<i>c. 39</i>	Chile, Valparaíso	<i>Aedo 6821</i> (MA)	this study
	<i>G. skottsbergii</i>		52	Chile, Coquimbo	<i>Aedo 6832</i> (MA)	this study



Figures 14–22. Scanning electron micrographs showing seed features of *Geranium* sect. *Andina* and sect. *Chilensia*. Fig. 14. Seed of *G. core-core* (Aedo 7073, MA). Fig. 15. Seed of *G. brevicaule* (Hynes s.n., AK). Fig. 16. Seed of *G. solanderi* (Davis 8059, PERTH). Fig. 17. Seed coat of *G. sessiliflorum* (Aedo 7486, MA). Fig. 18. Seed coat of *G. solanderi* (Lange s.n., AK). Fig. 19. Seed coat of *G. solanderi* (Mueller s.n., U). Fig. 20. Seed coat of *G. solanderi*, showing a group of crystals (Davis 8059, PERTH). Fig. 21. Seed coat of *G. albicans*, showing two crystals (Sparre 209, S). Fig. 22. Seed coat of *G. antrorsum* (Woodward s.n., SYD).

$x = 13$, would be preliminarily attributed to this species. In *Geranium asphodeloides* Burm. f. and *G. sylvaticum* L. the number $2n = 24$ was also counted (Van Loon & Oudemans, 1982; Van Loon, 1984a; Baltisberger, 1991; Dmitrieva, 1986, respectively). Both Old World species belong to different groups of subgen. *Geranium*, apparently not related to species of section *Chilensia* and *Andina*. The number $2n = c. 39$ would be a triploid for a basic number $x = 13$. Triploid are rare in *Geranium*, and are reported in some Old World species of subgen. *Geranium* (*G. deprhesum* (E.G. Alm.) Lindm.; Warburg, 1938; *G. platypetalum* Fisch. & C.A. Mey.; Gauger, 1937, Warburg, 1938) all of them based in $x = 14$. Additionally, Van Loon (1984a) found $2n = 28$ and 42 in *G. macrostylum* Boiss. The plants with the chromosome number $2n = 42$ had a high percentage of small, abnormal pollen grains. The case of *G. skottsbergii* would be somewhat similar, but plants with $2n = c. 39$ show normal pollen grains.

HABITAT AND DISTRIBUTION

Geranium sect. *Andina* comprises four species, two from South America and two from Australia. *Geranium sessiliflorum* occurs along the Andes from central Peru to Patagonia over more than 5000 km. *G. parodii* shows an allopatric distribution occurring only in Sierra de Achala and neighbouring areas (central Argentina). On the other side of the Pacific Ocean, *G. brevicaule* is present in New Zealand, Tasmania and south-east Australia, whereas *G. antrorsum* is restricted to the Australian Alps.

Geranium sect. *Chilensia* comprises 11 species, nine from South America and two from Australia. *Geranium core-core* grows along the Andes from central Ecuador to Patagonia over more than 5400 km; it is also introduced in some temperate areas of Europe and North America. In addition, four more or less allopatric groups of species could be recognized: (1) species

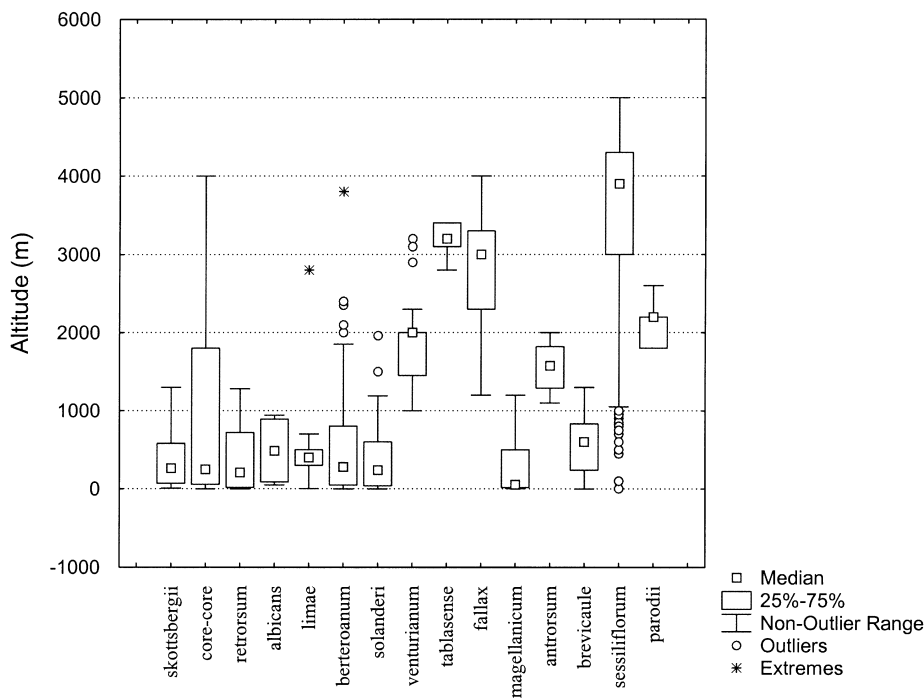


Figure 23. Box-plot representing altitude variation in species of *Geranium* sect. *Andina* and sect. *Chilensia*.

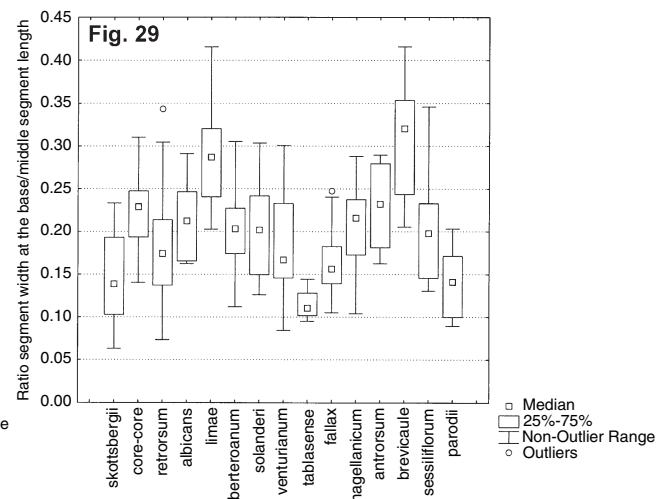
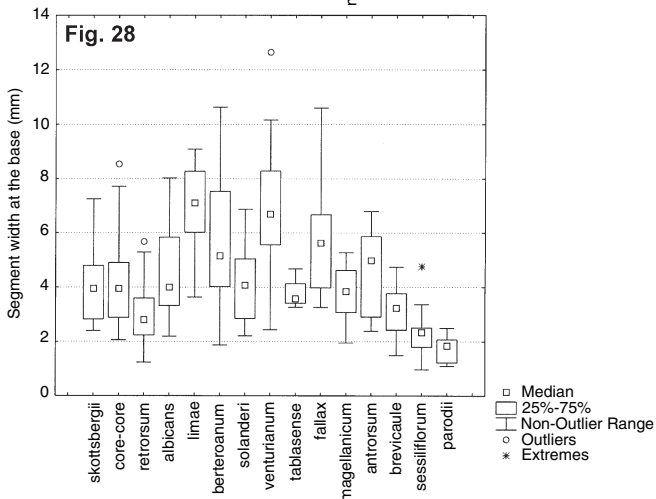
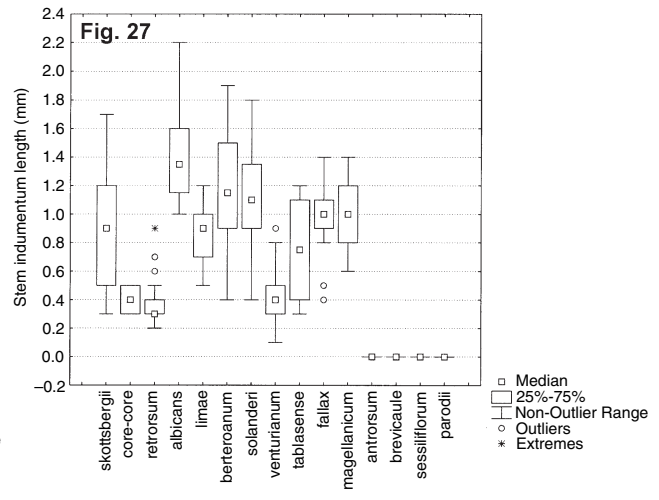
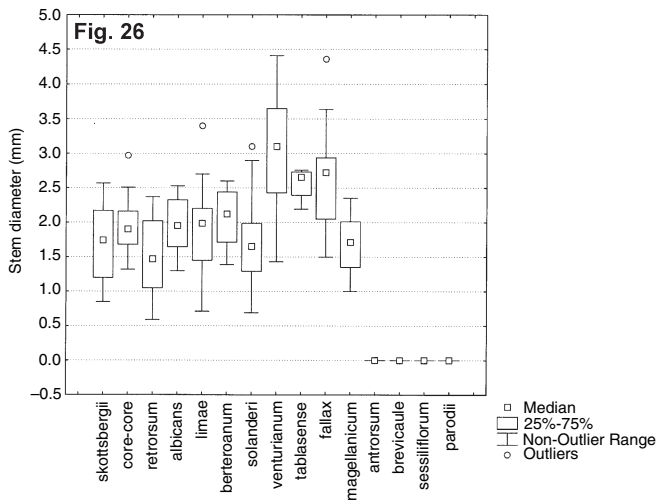
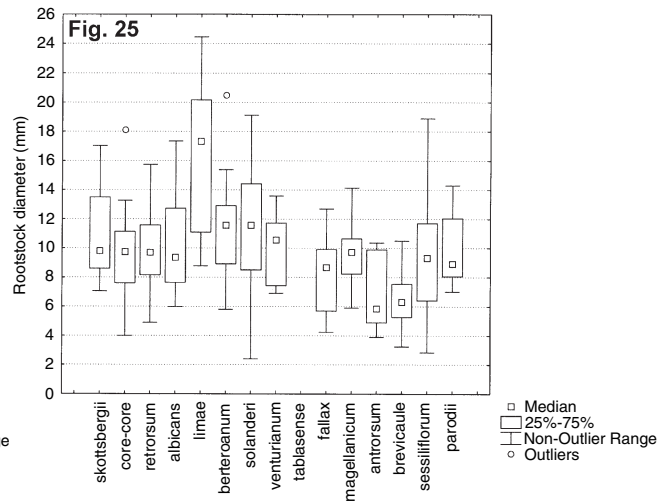
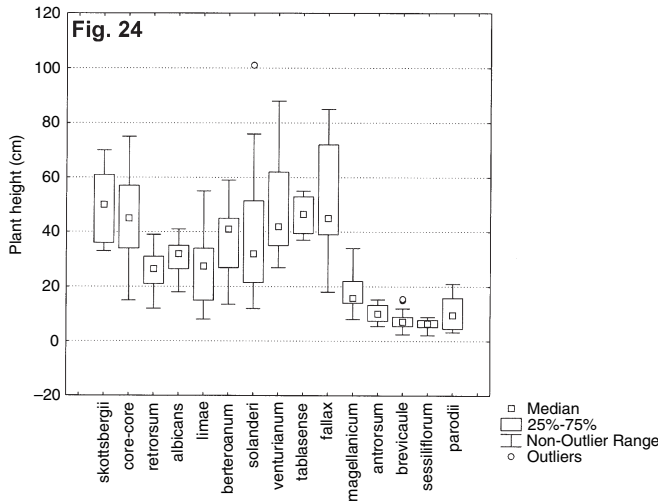
of coastal ranges of Peru (*G. limae*); (2) species of south-east Peru, Bolivia and northern Argentina (*G. fallax*, *G. venturianum* and *G. tablasense*); (3) species of north-east Argentina, Uruguay and southern Brazil (*G. albicans*); and (4) species of central and south Chile and neighbouring areas of Argentina (*G. berterioanum*, *G. magellanicum* and *G. skottsbergii*). In Oceania, *G. retrorsum* and *G. solanderi* grow sympatrically. Both species are found in south-west Australia, south and south-east Australia, Tasmania and New Zealand.

Species from sect. *Andina* grow in open habitats (dunes, river shores, turfy bogs, grasslands, puna or open forests) from sea level to c. 5000 m (Fig. 23). Species of sect. *Chilensia* are common in open forest or shrublands, although they can also be found in more exposed habitats such as roadsides, cultivated grounds, dunes, meadows, river shores or rocky and wet slopes, from sea level to c. 4000 m (Fig. 23).

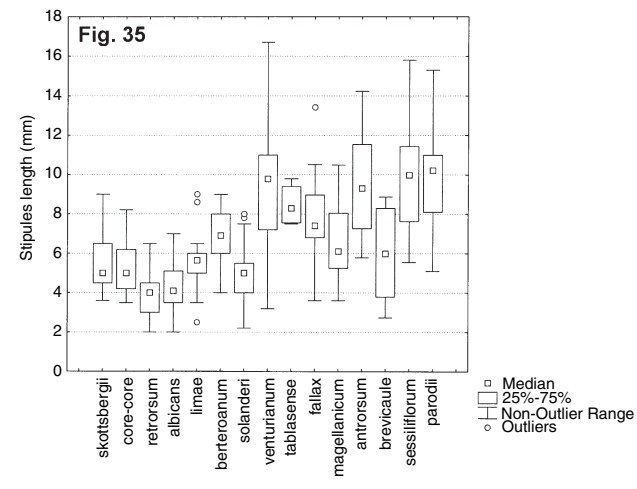
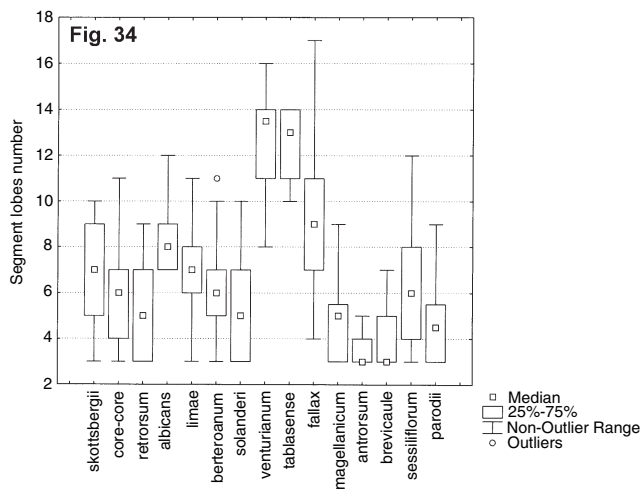
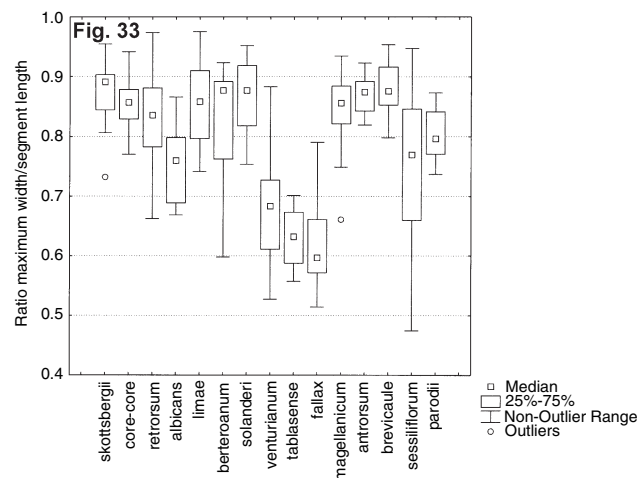
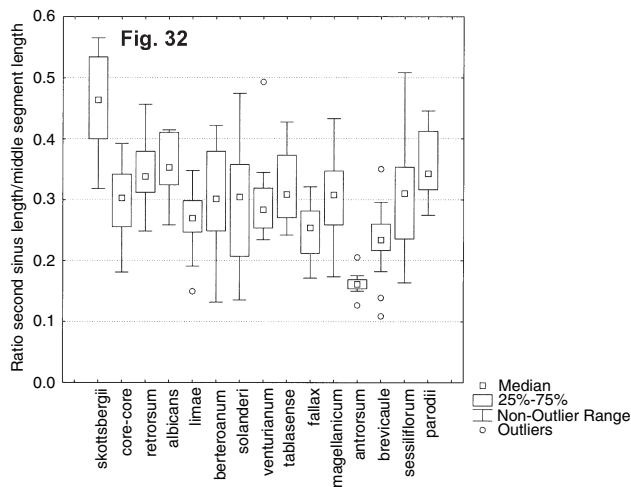
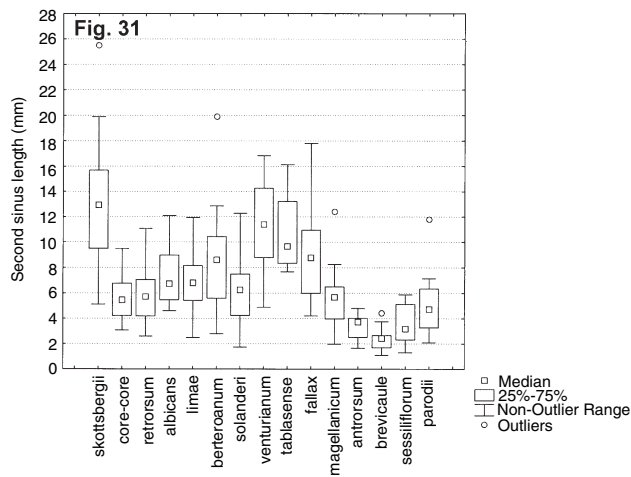
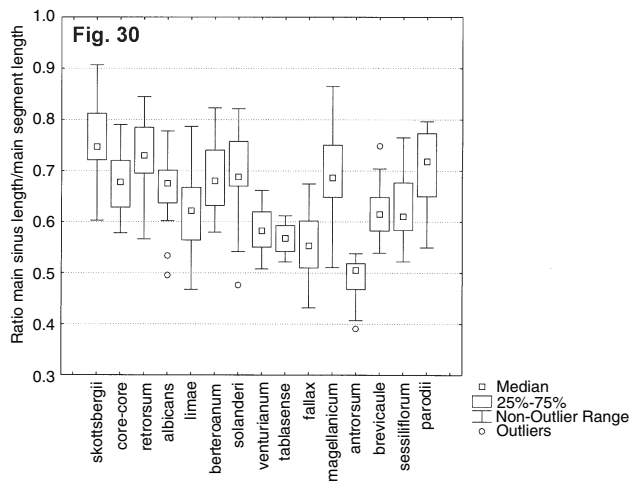
MORPHOMETRIC ANALYSIS

Box-plots showing the variability of the 34 most discriminant characters are shown in Figures 24–57. These characters were used to perform the discriminant analyses (see below), and the most operative ones to build the key of the species (in conjunction with qualitative characters).

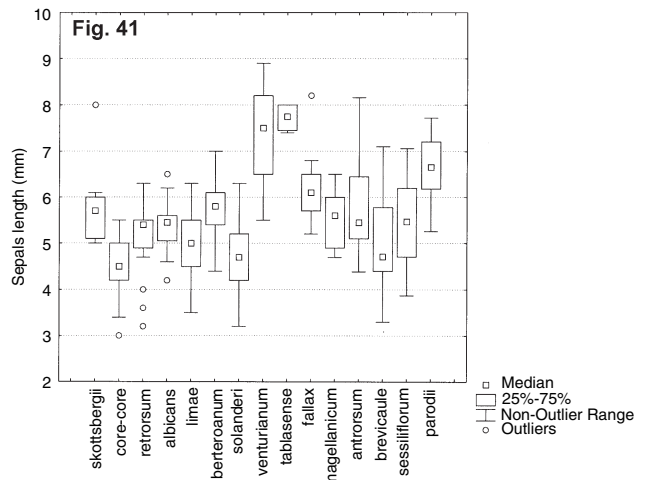
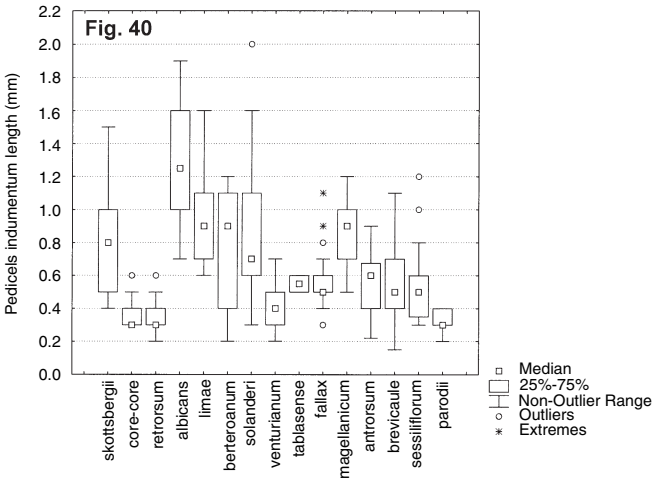
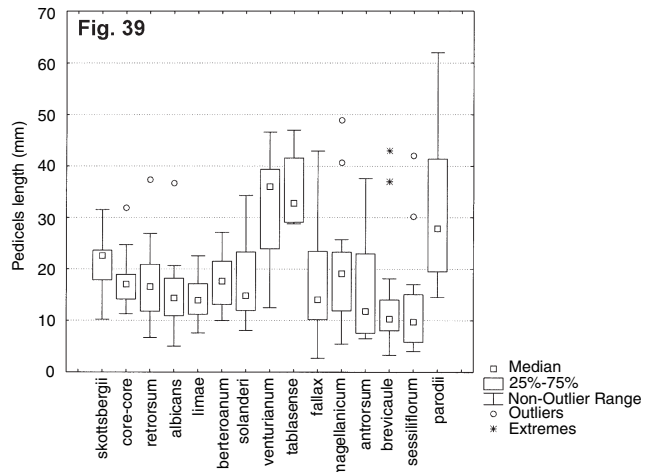
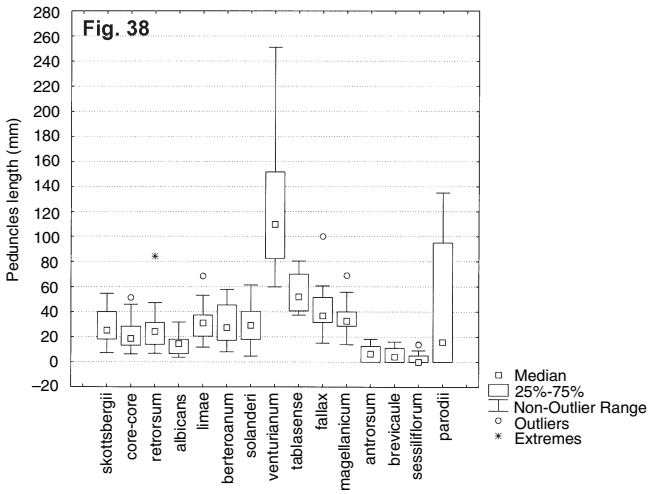
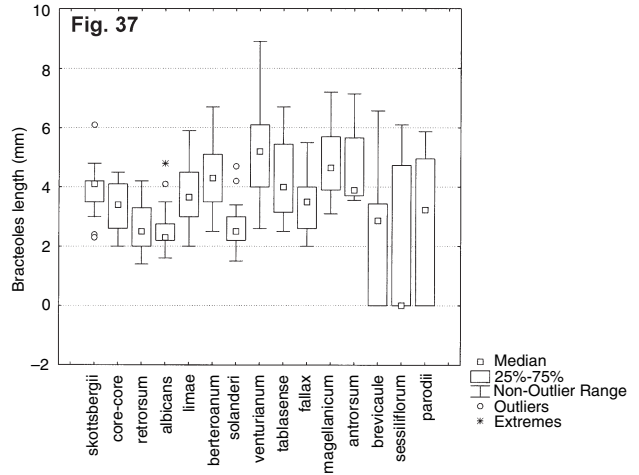
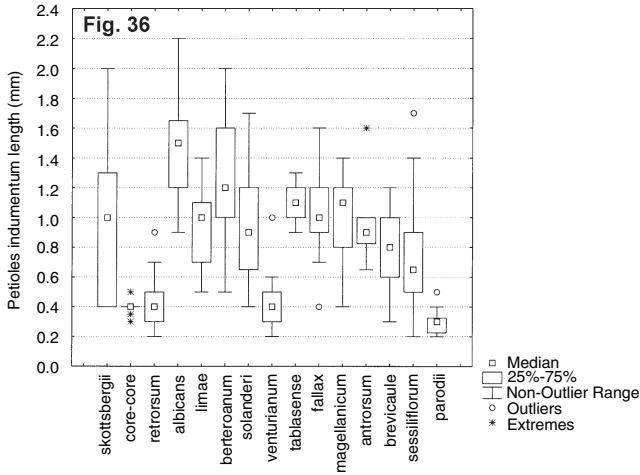
In Table 3 are shown the results of the Kruskal–Wallis ANOVA and Median tests for quantitative characters used in the key of species. The groups tested were significantly different at 99% in all cases but three. In step 5, the character petal length was significant at 95% in the Median test, although it was significant at 99% in the ANOVA test. This step was also supported by a qualitative character of petal indumentum, and another quantitative character, rostrum narrowed apex length, which was highly significant in both tests. In step 14, sepal mucro length was significant at 95% in the Median test, although



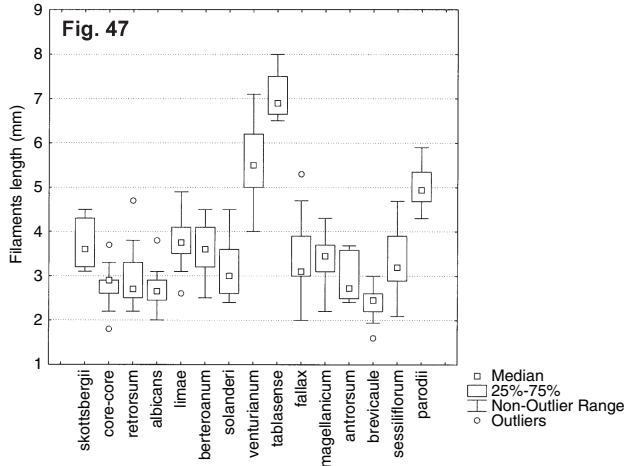
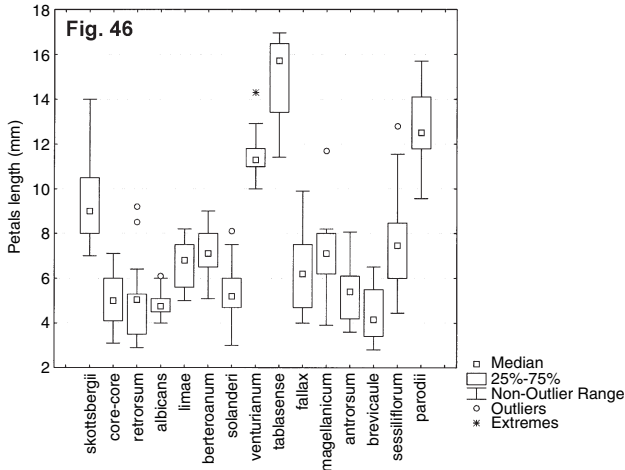
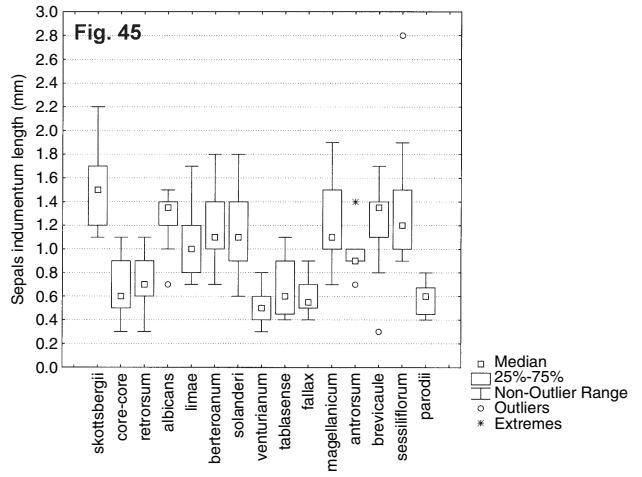
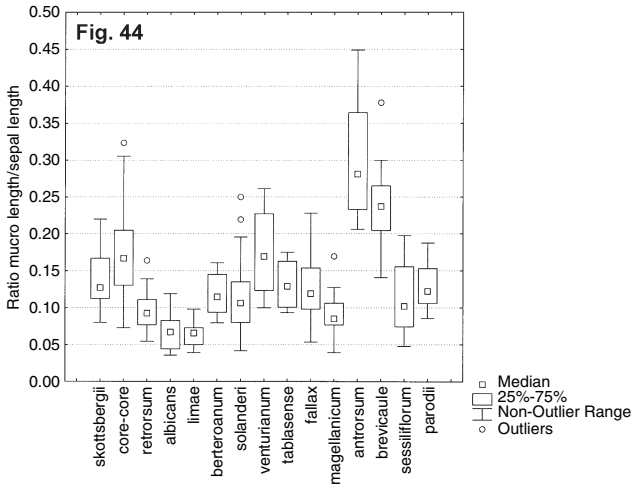
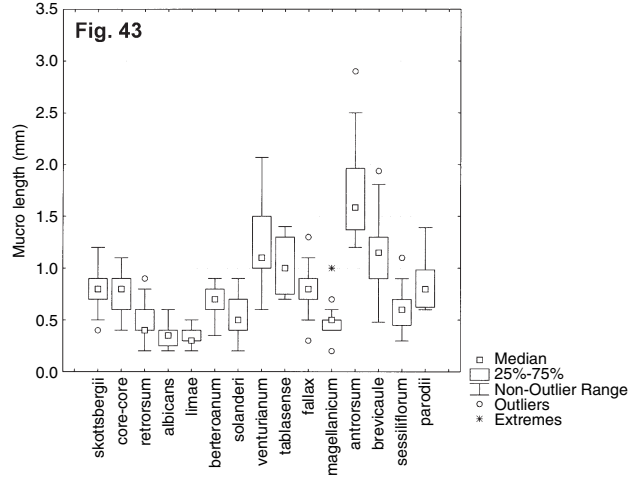
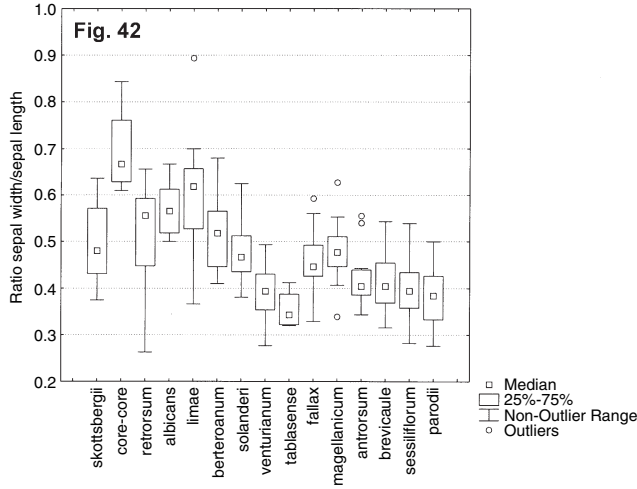
Figures 24–57. Box-plots representing the variability of quantitative characters in *Geranium* sect. *Andina* and sect. *Chilensis*.



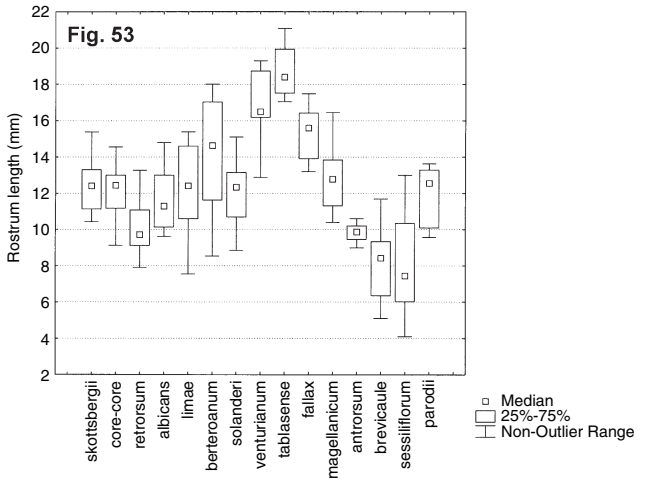
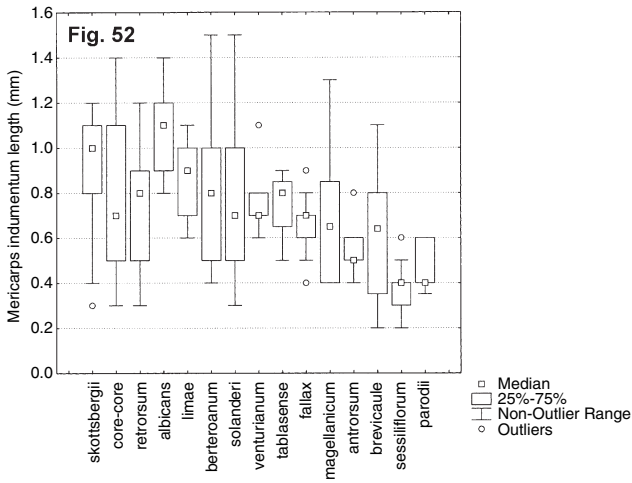
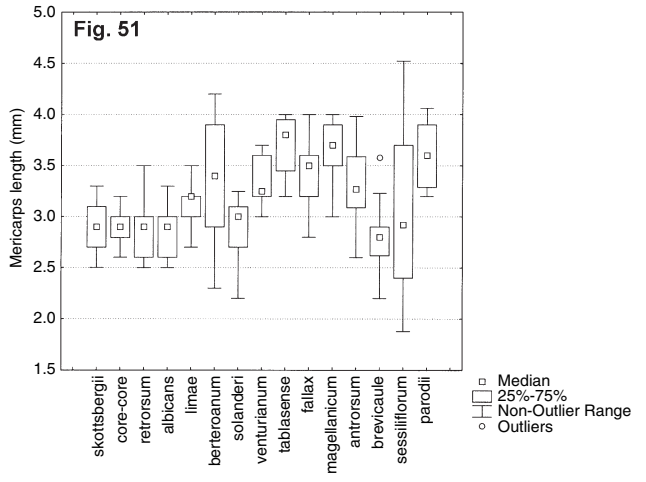
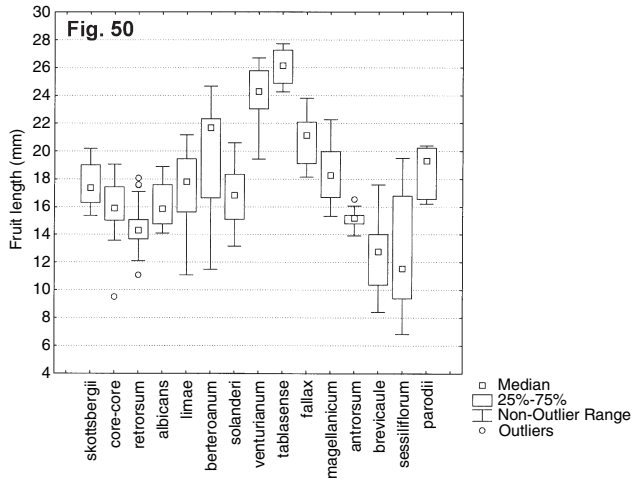
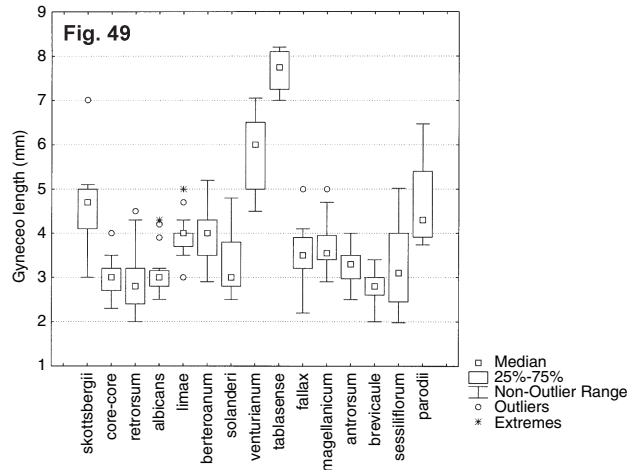
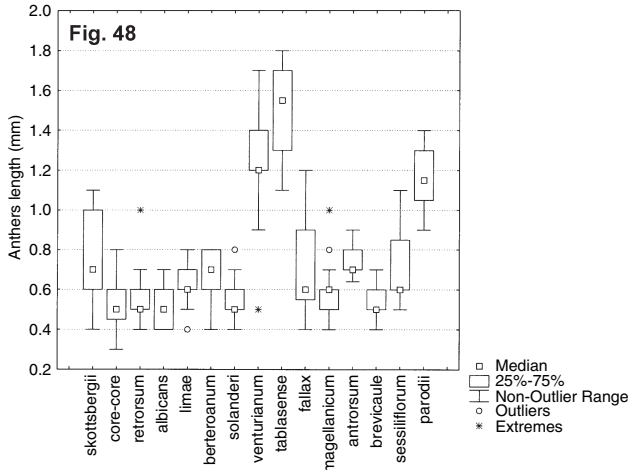
Figures 24–57. Continued



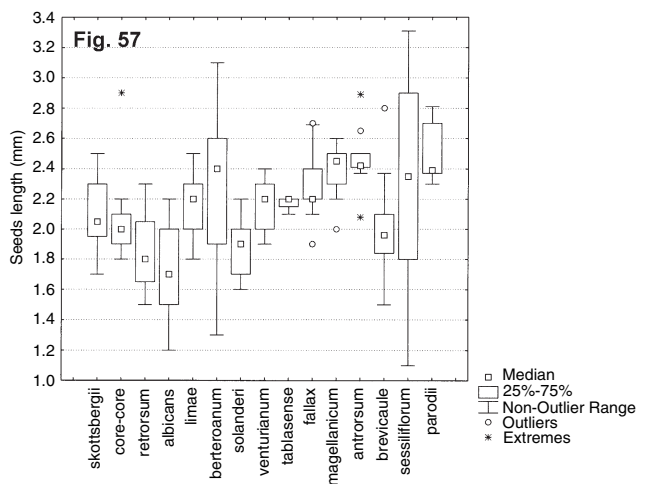
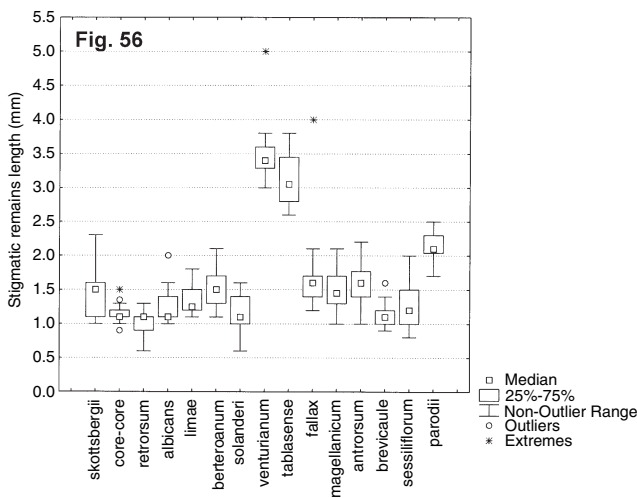
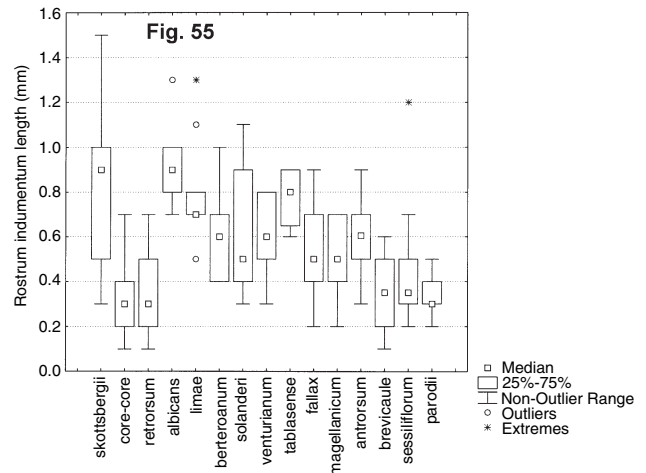
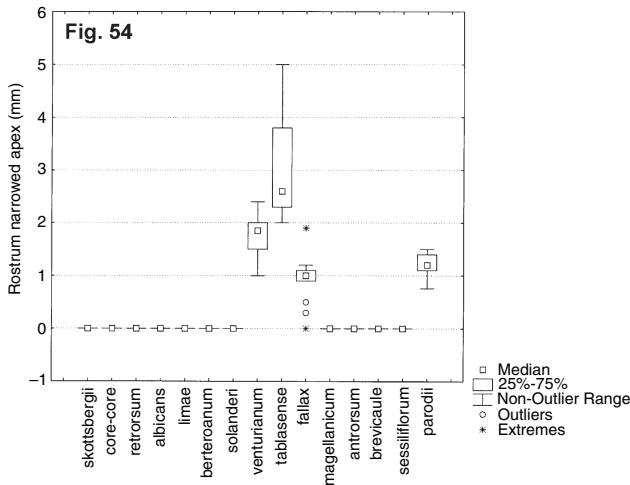
Figures 24–57. Continued



Figures 24–57. Continued



Figures 24–57. Continued



Figures 24–57. Continued

it was significant at 99% in the ANOVA test. This step was also supported by a qualitative character, main leaf segment shape, and another quantitative character, petal length, which was highly significant in both tests. Finally, in step 16 stigmatic remains length was not significant in the Median test, although it was significant at 99% in the ANOVA test. This step is also supported by a quantitative character, sepal length, which is highly significant in both tests.

In Discriminant Analysis 1 (DA1) the four species of sect. *Andina* (*G. antrorsum*, *G. brevicaule*, *G. parodii* and *G. sessiliflorum*) plus *G. magellanicum* were analysed. The plot of root 1 against root 2 shows a great separation for *G. magellanicum* and *G. parodii* OTUs (Fig. 58). The characters contributing most to this separation were: rostrum length, fruit length, rostrum narrowed apex, pedicel length, pedicel indumentum length, seed length, gynoeceum length, peduncle length, rootstock diameter length and petal length.

Geranium antrorsum, *G. brevicaule* and *G. sessiliflorum* were more clearly discriminated in the plot of root 2 against root 3 (Fig. 59). In this case rostrum length, gynoeceum length and petal length were the most relevant characters (Table 1).

In DA2 *G. limae*, *G. berterioanum* and *G. solanderi* were analysed (Fig. 60). The most discriminant characters were: fruit length, bracteoles length, rostrum length, ratio main sinus length/main segment length, peduncle length and filament length (Table 1).

In DA3 *G. albicans*, *G. skottsbergii*, *G. core-core* and *G. retrorsum* were analysed. The plot of root 1 against root 2 shows a great separation for *G. skottsbergii* and *G. albicans* OTUs (Fig. 61), while OTUs of *G. core-core* and *G. retrorsum* were more clearly discriminated in the plot of root 2 against root 3 (Fig. 62). The most discriminant characters were gynoeceum length, ratio sepal width/sepal length, fruit length, stem diameter, stem indumentum length and rostrum length (Table 1).

Table 3. Kruskal–Wallis ANOVA and median test results for each step of *Geranium* sect. *Andina* and *Chilensia* species key. Values of Chi-square and H higher than 3.84 are significant at 95%, and higher than 6.64 at 99%. Steps without quantitative characters are not shown; *indicates step with additional qualitative character

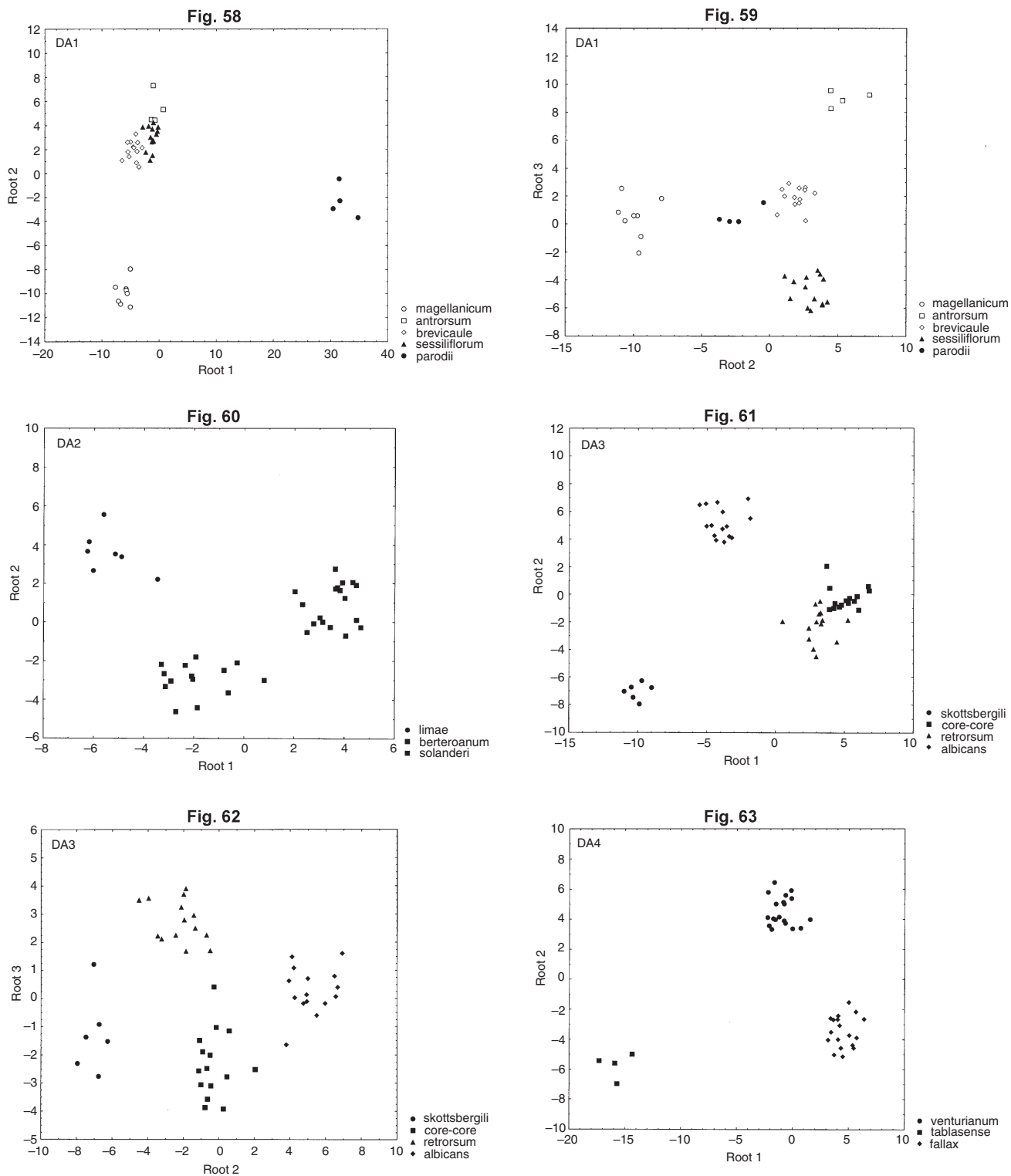
Key step	Character	Valid N		Median test		Kruskal–Wallis ANOVA	
		group 1	group 2	Chi-square	P	H	P
3*	petal length	32	12	16.50	0.0000	23.00764	0.0000
4	petal length	15	17	15.18431	0.0001	16.48857	0.0000
4	mucro length/sepal length	22	18	25.85859	0.0000	24.75166	0.0000
5*	petal length	173	4	4.138991	0.0419	11.074459	0.0009
5	rostrum apex	153	4	18.11675	0.0000	24.96222	0.0000
6*	peduncle length	170	19	21.34825	0.0000	49.86967	0.0000
8*	rostrum narrowed apex	29	32	21.94903	0.0000	21.06862	0.0000
9	second sinus/middle segment length	19	15	9.663158	0.0019	15.77173	0.0001
9	petal length	19	12	7.038755	0.0080	9.926733	0.0016
11	second sinus/middle segment length	119	15	9.083473	0.0026	25.92280	0.0000
11	petal length	115	12	17.91498	0.0000	25.28147	0.0000
13	sepal width/sepal length	21	19	22.55639	0.0000	24.57248	0.0000
14*	petal length	62	16	12.13781	0.0005	19.06564	0.0000
14	mucro length	64	16	5.568182	0.0183	6.231933	0.0125
15*	segment width at base/segment length	42	22	13.57576	0.0002	22.28891	0.0000
15	mucro length	42	22	21.48962	0.0000	24.86179	0.0000
16	sepal length	23	19	18.62434	0.0000	13.91956	0.0002
16	stigmatic remains length	19	18	3.634013	0.0566	8.802685	0.0030

Table 4. Correct classifications and values of *P* obtained in discriminant analyses (DAs) of *Geranium* sect. *Andina* and *Chilensia*

	DA	No. of OTUs	Correct classifications (%)	<i>P</i>
<i>G. sessiliflorum</i>	1	14	100	0.32558
<i>G. brevicaulis</i>	1	13	100	0.30233
<i>G. antrorsum</i>	1	4	100	0.09302
<i>G. parodii</i>	1	4	100	0.09302
<i>G. magellanicum</i>	1	8	100	0.18605
<i>G. berterioanum</i>	2	18	100	0.46154
<i>G. solanderi</i>	2	14	100	0.35879
<i>G. limae</i>	2	7	100	0.17949
<i>G. albicans</i>	3	15	100	0.30000
<i>G. core-core</i>	3	15	100	0.30000
<i>G. retrorsum</i>	3	14	100	0.28000
<i>G. skottsbergii</i>	3	6	100	0.12000
<i>G. tablasense</i>	4	4	100	0.09756
<i>G. venturianum</i>	4	19	100	0.46341
<i>G. fallax</i>	4	18	100	0.43902

In DA4 *G. venturianum*, *G. tablasense* and *G. fallax* were analysed (Fig. 63). The most discriminant characters were: segment width at the base, rostrum indumentum length, stigmatic remains length, ratio main sinus length/main segment length, bracteole length, fruit length and sepal indumentum length (Table 1).

The OTUs correctly classified were in all the cases of the 100%, which strongly support the correct delimitation of the species (Table 4). It should be noted that some qualitative characters, which are discussed under each species, also contributed to delimitation of the species.



Figures 58–63. Plots of the Discriminant Analyses in *Geranium* sect. *Andina* and sect. *Chilensis*.

KEY TO SPECIES

1. Plant acaulescent; hairs always eglandular
 2. Pedicels with antrorse hairs; leaf cuneate to subtruncate (with basal leaf segments patent or upward) 3. *G. antrorsum*
 2. Pedicels with patent to retrorse hairs; leaf cordate (with basal leaf segments downward)
 3. Petals hairy on margin and base of abaxial side (9.5–)11.5–15.7 mm long; nectaries hairy; rostrum with a narrowed apex 0.7–1.5 mm long 4. *G. parodii*
 3. Petals glabrous (rarely with few cilia on the basal margin), 2.8–8(–12.8) mm long; nectaries glabrous; rostrum without narrowed apex.
 4. Petals (4.5–)6–12.8 mm long; sepal mucro short (mucro length/sepal length ratio = (0.04–)0.07–0.15(–0.19)) 1. *G. sessiliflorum*
 4. Petals 2.8–5.5(–6.5) mm long; sepal mucro long (mucro length/sepal length ratio = (0.14–)0.20–0.26(–0.37)) 2. *G. brevicaulis*
1. Plant caulescent; hairs glandular or eglandular
 5. Petals (11.4–)13.4–16.4(–16.9) mm long, glabrous, rarely with few cilia on the basal margin; rostrum with a narrow apex (2–)2.3–3.8(–5) mm long 13. *G. tablasense*
 5. Petals (2.9–)5–8(–14.3) mm long, ciliate on the basal margin (in *G. venturianum* also on the base of the abaxial side); rostrum usually without a narrow apex (in *G. venturianum* and *G. fallax* (0–)0.9–2(–2.4) mm long)
 6. Peduncles (5.9–)8.2–15.1(–25.1) cm long; petals hairy on the margin and on the base of the abaxial side 14. *G. venturianum*
 6. Peduncles (0.36–)1.68–3.8(–10) cm long; petals ciliate on the basal margin
 7. Peduncles with glandular hairs
 8. Middle segment rhombic; rostrum with a narrow apex (0–)0.9–1.1(–1.9) mm long 15. *G. fallax*
 8. Middle segment obtriangular; rostrum without a narrow apex
 9. Basal leaves deeply divided with narrow lobes (second sinus/middle-segment length ratio = (0.31–)0.40–0.53(–0.57)); petals (7–)7.9–10.2(–14) mm long 10. *G. skottsbergii*
 9. Basal leaves not deeply divided (second sinus/middle-segment length ratio = (0.13–)0.24–0.38(–0.42)); petals (5.1–)6.5–8(–9) mm long 5. *G. berterioanum*
 7. Peduncles without glandular hairs
 10. Plant decumbent, with cymules of the basal part of the stem usually 1-flowered (part of them arises directly from the rootstock), and cymules of the upper part 2-flowered 8. *G. magellanicum*
 10. Plants usually erect to ascending with all cymules (always 2-flowered) arising along leafy stems
 11. Basal leaves deeply divided with narrow lobes (second sinus/middle segment length ratio = (0.31–)0.40–0.53(–0.57)); petals (7–)7.9–10.2(–14) mm long 10. *G. skottsbergii*
 11. Basal leaves not deeply divided (second sinus/middle segment length ratio = (0.13–)0.21–0.41(–0.47)); petals (2.9–)3.5–7.5(–9.2) mm long
 12. Pedicels with hairs retrorse-appressed
 13. Sepals broadly ovate (width/length ratio = (0.60–)0.62–0.76(–0.84)) ... 11. *G. core-core*
 13. Sepals lanceolate (width/length ratio = (0.26–)0.44–0.59(–0.65)) 12. *G. retrorsum*
 12. Pedicels with hairs patent
 14. Petals (4–)4.5–5.1(–6.1); sepal mucro (0.2–)0.25–0.4(–0.6) mm long; main leaf segment rhombic 9. *G. albicans*
 14. Petals (3–)4.7–8(–9); sepal mucro (0.2–)0.3–0.8(–0.9) mm long; main leaf segment obtriangular
 15. Segment width at the base/middle-segment length ratio = (0.20–)0.24–0.32(–0.42); nectaries usually hairy; sepal mucro (0.2–)0.3–0.4(–0.5) mm long 7. *G. limae*
 15. Segment width at the base/middle-segment length ratio = (0.11–)0.15–0.24(–0.31); nectaries glabrous; sepal mucro (0.2–)0.4–0.8(–0.9) mm long
 16. Sepals (3.2–)4.2–5.2(–6.3) mm long; stigmatic remains (0.6–)1–1.4(–1.6) mm long 6. *G. solanderi*
 16. Sepals (4.4–)5.4–6.1(–7) mm long; stigmatic remains (1.1–)1.3–1.7(–2.1) mm long 5. *G. berterioanum*

TAXONOMIC TREATMENT

I. *Geranium* sect. *Andina* R. Knuth in Bot. Jahrb. Syst. 32: 222 (1903)

Type: *G. sessiliflorum* (lectotype, designated by R. Knuth, 1912: 45)

Perennial herbs with rootstock usually vertical, not tuberculate, turnip-shaped, without fusiform-swollen roots; aerial stem absent; without vegetative stems or stolon. Leaf lamina orbicular to polygonal in outline, cordate (with basal leaf segments downward), sometimes cuneate to subtruncate cordate (with basal leaf segments patent or upward), without abscission zone, palmatifid, hairy, not coriaceous and with nerves not projected; segments 5–7, obtriangular or rhombic, 3–12-lobed in the distal half; cauline leaves absent; stipules lanceolate, free, papery, reddish, hairy. Inflorescence with 1-flowered cymules arising directly from the rootstock, usually solitary; peduncles (when present) and pedicels hairy; bracteoles linear-lanceolate, hairy; pedicel and peduncle together usually not overtopping the subtending leaf. Sepals ovate, smooth, not accrescent, 3-nerved, mucronate, with scarious margins, hairy. Petals erect-patent, ± obovate, entire, rarely emarginate, without claw, glabrous to hairy, purplish to white. Stamens ten, both whorls bearing anthers; filaments not exerted, lanceolate yellowish, hairy. Nectaries hemispherical, usually glabrous. Fruit of the seed-ejection type; mericarps usually smooth, without longitudinal rib, without basal beak, with a basal callus, without a basal prong, usually with eglandular hairs, brownish; rostrum with or without a narrowed apex; stigmatic remains with five hairy or glabrous lobes. Seeds ellipsoid, finely reticulate, brownish; hilum 1/4–1/6 as long as the perimeter. Cotyledons entire.

Notes: Species of *Geranium* sect. *Andina* are recognized by their stemless habit, turnip-shaped rootstock, and 1-flowered cymules. This section includes two species from South America and two species from Australia and New Zealand. Knuth (1912) proposed his sect. *Andina* to include all stemless species with 1-flowered cymules, but some of them have been segregated in the new section *Neoandina* (Aedo et al., 2002). According to this taxonomic interpretation, stemless species with ramified rootstock should be included in sect. *Neoandina*, and those with turnip-shaped rootstock in sect. *Andina*.

1. *Geranium sessiliflorum* Cav., Diss. 4: 198, tab. 77 fig. 2 (1787)

Type: Chile. Estrecho de Magallanes, *Commerison s.n.* (lectotype designated by Garilleti, 1993: 91, MA-475750!, isolectotype, P!)

Geranium caespitosum Walp. in Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur. 19 (suppl. 1): 315 (1843), nom. illeg., nom. E. James 1823

Type: Peru. *Meyen s.n.* (lectotype, here selected, K!)
Geranium bangii Hieron. in Bot. Jahrb. Syst. 21: 314 (1895)

Type: Bolivia. Oruro, Capi, Mar. 1890, *Bang* 788 (lectotype designated by Knuth, 1912: 85, B†; isolectotypes, BM!, E!, F!, GH!, K!, MO!, NY!, W!) [18°47'S, 68°12'W]

Geranium sessiliflorum var. *microphyllum* Kuntze, Revis. Gen. Pl. 3(2): 33 (1898)

Type: Bolivia. Cochabamba, Tapacari, 17.iii.1892, *Kuntze s.n.* (lectotype, here designated, NY!) [17°33'S, 66°28'W]

Geranium sessiliflorum var. *lanatum* R. Knuth in Bot. Jahrb. Syst. 37: 565 (1906)

Type: Bolivia. *Fiebrig* 3291 (lectotype, here designated, LD!) [probably from Tarija]

Geranium pflanzii R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 576 (1912)

Type: Bolivia. Palca-La Paz 1908, *Pflanz* 206 (holotype, B†; no authentic material found; photo, G!, GH!, MO!, NY!)

Geranium sessiliflorum var. *compactum* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 85 (1912)

Type: Bolivia. La Paz-Palca-Illimani, *Hauthal* 323 (lectotype, here designated, GOET!)

Geranium tucumanum R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 147 (1912)

Type: Argentina. Sierra de Tucumán, La Ciénaga 1874, *Hieronymus* 584 (holotype, B†; isotype, K!)

Geranium razuhillaense R. Knuth in Repert. Spec. Nov. Regni Veg. 28: 2 (1930)

Type: Peru. Ayacucho, Huanta, Mte. Razuhilla, *Weberbauer* 7495 (lectotype, here designated, F!; isolectotypes, G!, K!)

Geranium malpasense R. Knuth in Repert. Spec. Nov. Regni Veg. 34: 146 (1933)

Type: Bolivia. Chuquisacá, Cordillera de los Sombreros, Cuesta Malpaso, 13.xii.1927, *Troll* 705 (holotype, B!; isotypes, JE! M!)

Geranium staffordianum R. Knuth in Repert. Spec. Nov. Regni Veg. 40: 216 (1936)

Type: Peru. Cuzco, *Stafford* 208 (holotype, K!)

Geranium sessiliflorum var. *albatum* J.F. Macbr. in Publ. Field Mus. Nat. Hist., Bot. Ser. 13(3): 533 (1949)

Type: R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 84 fig. 15 (1912) (lectotype, here designated)

Herbs 2.2–8.9 cm tall. Rootstock 2.8–18.9 mm diam., without fusiform roots. Basal leaves in a persistent rosette; lamina 7.3–27.2 × 8.8–31 cm, orbicular to polygonal in outline, cordate (with basal leaf segments downward), palmatifid (divided for 0.52–0.76 of its

length), glabrescent to pilose (sometimes sericeous) on both sides, with appressed, eglandular hairs; segments 5–7, rhombic to obtriangular, 0.9–4.7 mm at the base (segment width at the base/segment length ratio = (0.13–)0.16–0.23(–0.64)), 3–12-lobed in distal half (second sinus length/middle-segment length ratio = (0.16–)0.23–0.35(–0.50)); petioles to 8 cm long, with patent to retrorse, appressed, eglandular hairs 0.2–1.7 mm long; stipules 5.5–15.8 × 0.8–3.1 mm, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Inflorescence with cymules 1-flowered, solitary; peduncles 0–0.5(–1.4) cm long, with retrorse, appressed, eglandular hairs 0.3–1 mm long; bracteoles 5–6.1 × 1–1.65 mm, linear-lanceolate, with eglandular hairs on both sides and on the margin; pedicels 0.4–4.2 cm long, with retrorse to patent, appressed, eglandular hairs 0.3–1.2 mm long; pedicel not overtopping the subtending leaf. Sepals (3.8–)4.7–6.2(–7.1) × 1.44–3.37 mm, lanceolate (width/length ratio = (0.28–)0.35–0.43(–0.53)), with mucro (0.3–)0.45–0.7(–1.1) mm long (mucro length/sepal length ratio = (0.04–)0.07–0.15(–0.19)), with scarious margins 0.1–0.2 mm wide, with erect-patent, eglandular hairs 0.3–0.6 mm long on the abaxial side, patent hairs 0.9–2.8 mm long on the margin, glabrescent adaxially. Petals (4.5–)6–12.8 × 1.6–5 mm, entire, rarely emarginate, notch 1 mm deep, without claw, glabrous, rarely with few cilia on the basal margin, purplish, sometimes white. Filaments 2.1–4.6 mm long, yellowish, with eglandular hairs 0.2–0.3 mm long on the abaxial side and margin; anthers 0.5–1.1 × 0.3–0.64 mm, yellowish; pollen unknown colour. Nectaries glabrous. Gynoecium 1.9–5 mm long, yellowish. Fruit 6.8–19.5 mm long; mericarps 1.8–4.5 × 0.9–2.25 mm, smooth, with erect-patent, eglandular hairs 0.1–0.6 mm long, brownish; rostrum 4.1–13 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.2–1.2 mm long; stigmatic remains (0.8–)1–1.5(–2) mm long, with 5 glabrous lobes. Seeds 1.1–3.3 × 0.9–2.1 mm, finely reticulate; hilum 1/4 as long as the perimeter.

Area: Central and South Peru, Bolivia, Chile and Argentina (Fig. 64).

Habitat: Beaches, river shores, turfy bogs, natural grasslands, open, moist puna, or clearing of *Nothofagus* or *Polylepis* forest; 0–5000 m.

Phenology: Flowering January – December.

Illustration: Figure 65.

Notes: *Geranium sessiliflorum* is a species distributed over a large area of more than 5000 km between the northernmost localities in Central Peru and the south-

ernmost ones in Tierra de Fuego. It displays an uncommon variability, mainly in leaf shape and indumentum. Leaf outline may be orbicular or polygonal, and more or less divided. Middle leaf segment varies from obtriangular with three lobes to rhombic with 12 lobes. In extreme cases, leaves are white sericeous (only in southern Peru, Bolivia, and northern Argentina), although they usually are pilose, with scattered appressed hairs. A continuum of intermediates suggests that these forms do not deserve taxonomic recognition. Fruit size also shows a remarkable range of variation, between 6.8 and 19.5 mm long, but no correlation with leaf shape or indumentum has been found.

Geranium sessiliflorum is usually stemless with all cymules borne on the rootstock apex. However, some specimens have (together with cymules borne on the rootstock) elongate internodes bearing a tuft of stipules, from which an aggregate of cymules is born. Sometimes a pair of leaves is also present in these nodes. These forms have been named *G. tucumanum* in North Argentina, but they are also present over all the *G. sessiliflorum* area. Intermediate forms can be found even on the same herbarium sheet. All these data suggest that there is no basis for recognizing *G. tucumanum*, which we have subsumed under *G. sessiliflorum*. The type of *G. malpasense* has long (12 mm) and emarginate petals. Otherwise, it is similar to other specimens of *G. sessiliflorum*.

Although *G. magellanicum* is quite similar to *G. sessiliflorum*, it is easily distinguishable by its 2-flowered cymules spread on decumbent and foliate stems. The differences between *G. sessiliflorum* and the remaining species of sect. *Andina* are addressed in the discussion under *G. brevicaulis*, *G. parodii* and *G. antrorsum*.

Representative specimens examined: ARGENTINA. CATAMARCA: Aconquija, 27°0'S, 65°55'W, 16.ii.1951, *Brücher s.n.* (LD); Andalgala, 27°36'S, 66°19'W, .1917, *Jørgensen 1387* (MO, GH). JUJUY: 20 km W of Humahuaca, 23°12'S, 65°23'W, 13.iii.1936, *West 6335* (CAS, MO); camino Abra de Lizeite, primer arroyo despues de Cajas, 22°15'S, 65°18'W, .xii.1979, *González 105* (LIL). LA RIOJA: Chilecito, Sierra Famatina, camino a La Mejicana, 29°3'S, 67°51'W, 6.ii.1927, *Parodi 7972* (GH); Sierra Famatina, Corral Colorado, 29°20'S, 67°41'W, 12.ii.1879, *Hieronymus & Niederlein 7776* (G); MENDOZA: Atuel valley, 2–3 km N of Campamento Atuel, 34°45'S, 69°59'W, 29.ii.1955, *Böcher et al. 1275* (MO, C); Malargüe, Paso Pehuenche, 35°59'S, 70°24'W, 26.ii.1989, *Leuenberger & Arroyo 3932* (B). NEUQUÉN: Aluminé, 10 km W de Primeros Pinos, 38°52'S, 70°35'W, 11.xii.1985, *Correa et al. 9181* (CTES); Cerro Chapelco, 40°14'S, 71°16'W, 24.i.1966, *Schojovskoy 100* (M); Río NEGRO: 3.3 km S

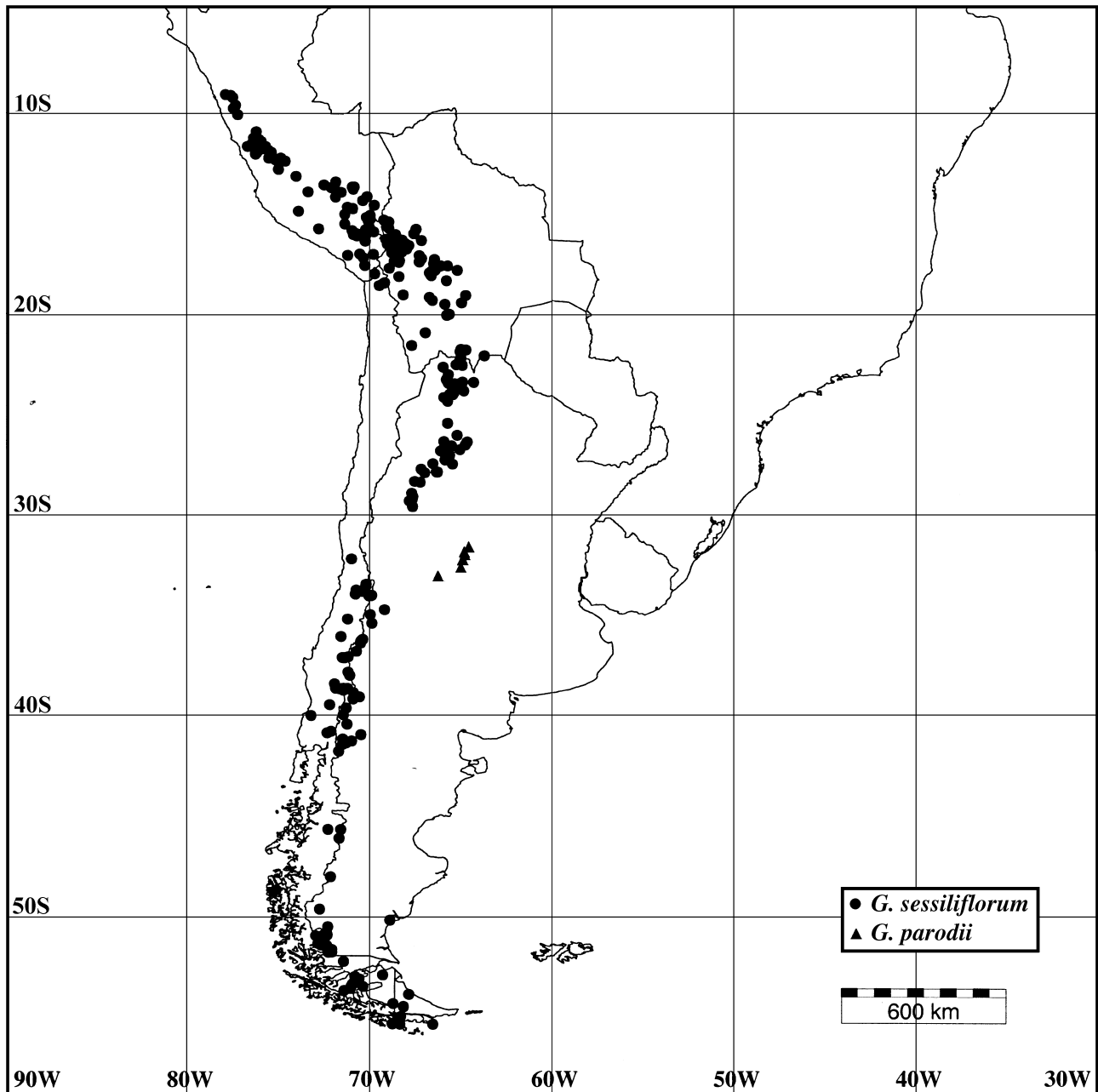


Figure 64. Area of distribution of *Geranium sessiliflorum* (dots) and *G. parodii* (triangles).

of El Foyel on route 258, 41°35'S, 71°43'W, 3.xii.1984, *Stuessy et al.* 6794 (LP, CAL); Cerro Catedral, San Carlos de Bariloche, 41°13'S, 71°30'W, 22.i.1964, *Ward s.n.* (MO). SALTA: Cerro del Cajón, La Laguna, 25°46'S, 65°14'W, 24.i.1914, *Rodríguez 1305* (SI, BAF, NY); Chicoana, camino a Cachi, Piedra de Molino, 25°10'S, 65°46'W, 26.iii.1979, *Cabrera et al.* 30721 (SI). SANTA CRUZ: 5 km al NE del Lago Belgrano, 47°50'S, 72°9'W, 8.xii.1980, *Cei s.n.* (MERL); Comandante Piedrabuena, 49°59'S, 68°54'W, 1.xii.1945, *O'Donell 3930*

(HBG, CAS, NY, TEX). TIERRA DE FUEGO: Cabo Domingo, 53°41'S, 67°51'W, 11.xii.1965, *Goodall 193* (LP); Cordón de los Cristales, Estancia Lago Roca, 50°33'S, 72°45'W, 26.xii.1958, *James 109* (BM). TUCUMÁN: Chicligasta, Estancia Santa Rosa, La Cueva, 27°12'S, 65°30'W, 17.ii.1926, *Venturi 6902* (US); Lara, 26°21'S, 65°56'W, 21.i.1912, *Rodríguez 263* (SI). BOLIVIA. CHUQUISACA: Punilla-Chanauca, cerro Chataquila, 18°48'S, 64°46'W, 27.ii.1994, *Wood 8042* (LPB). COCHABAMBA: Arque, 6 km E de Challa, 17°37'S, 66°40'W,

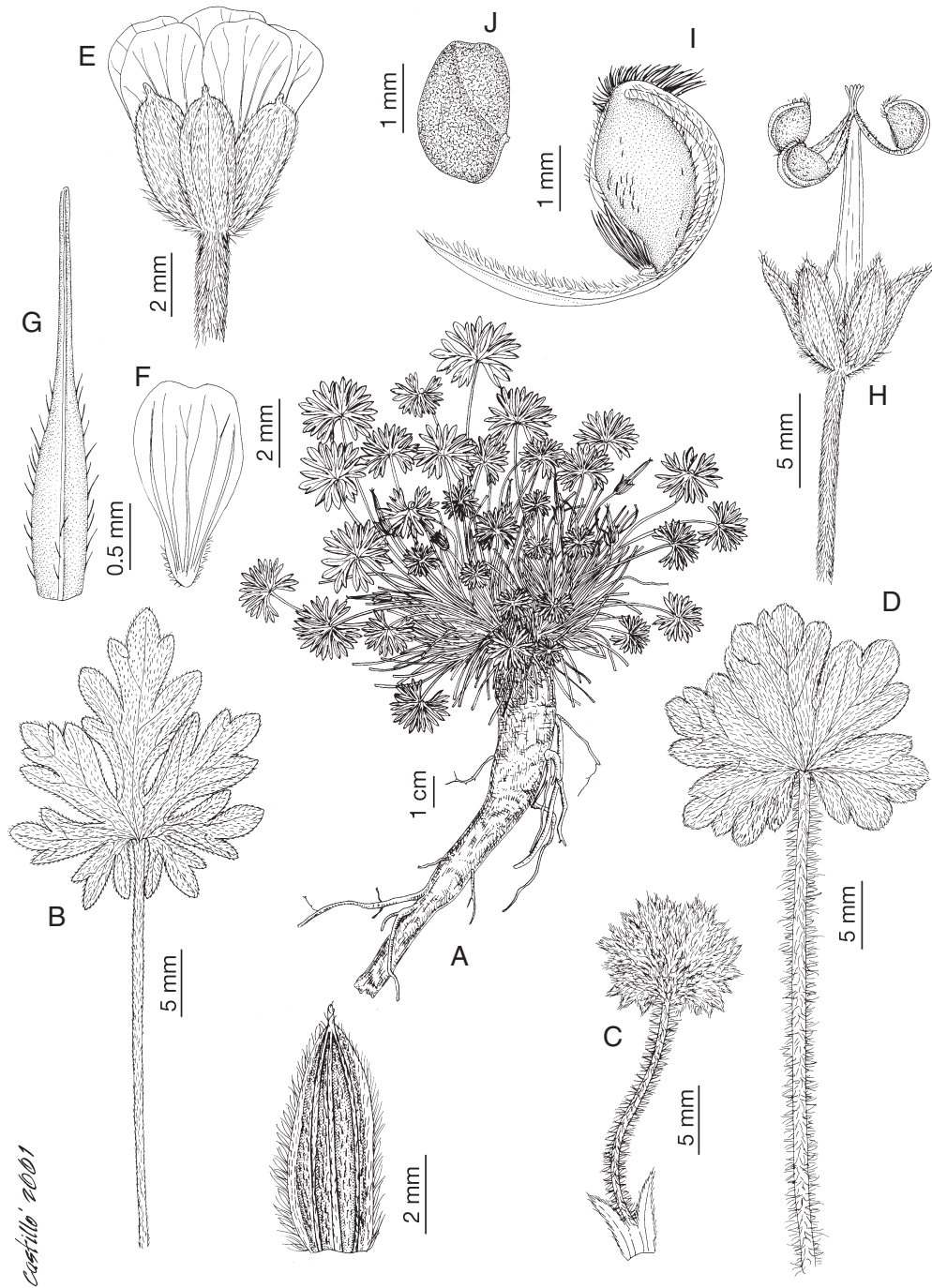


Figure 65. *Geranium sessiliflorum* Cav. A, habit; B–D, leaves; E, flower; F, petal; G, staminal filament; H, fruit; I, mericarp; J, seed [A: Aedo 7500 (MA); B: Sanches 24b (LPB); C: Rossel 101 (LPB); D: Macbride 3006 (MA); E–G: Mez y Barrera 1568 (SGO); H–J: Hohenacker 1160 (S)].

31.iii.1979, *Beck 970* (LPB); bajada a Morochata km 60, Tunari, 17°14'S, 66°32'W, 19.xi.1990, *Saravia 30* (LPB). LA PAZ: Bautista Saavedra, Khata, 15°9'S, 69°0'W, 6.i.1983, *Menhofer 1825* (MA); Camacho, Ambana 2 km hacia el S, 15°28'S, 69°0'W, 19.xii.1980,

Beck 4179 (LPB); Incachaca, 16°25'S, 68°4'W, 21.xii.1920, *Asplund 6111* (US, NY); Ingavi, al SE de Viacha, 16°39'S, 68°18'W, .xii.1990, *Beck 20935* (MA). ORURO: Avaroa, Challapata, 18°54'S, 66°46'W, 31.iii.1921, *Asplund 3272* (S); Cordillera de Azanaque,

- 19°3'S, 66°37'W, 25.xii.1926, *Troll 2983* (B, M). POTOSÍ: above Animas mine, W of Chocaya, 21°18'S, 67°44'W, 21.ii.1936, *West 6072* (MO, CAS, GH); Linares, inter Kachitambo et Potosí, 19°47'S, 65°49'W, 4.iv.1934, *Hammarlund 452* (S). TARIJA: Avilés, Pasto, camino de Tajzara, 21°55'S, 65°2'W, 6.ii.1986, *Bastión 749* (MA); Calderillo, 21°48'S, 63°45'W, 9.i.1904, *Fiebrig 2627* (W, E, G, GH, HBG, M, P, S, U). CHILE. AISÉN: Balmaceda, 45°55'S, 71°41'W, 11.xii.1954, *Pfister s.n.* (CONC); Coyhaique Alto, 45°29'S, 71°36'W, 25.i.1990, *Martínez et al. 23* (SGO). BIOBÍO: termas de Chillán, 36°54'S, 71°24'W, 27.i.2002, *Aedo 7500* (MA). COQUIMBO: Cordillera del río Mauro, 31°58'S, 71°2'W, .ii., *Reiche s.n.* (SGO). La Araucanía: Curacautin, Malalcahuello, 38°27'S, 71°35'W, 4.i.1948, *Pfister s.n.* (CONC); Malleco, Pino Hachado a 100 m del límite, 38°39'S, 70°55'W, 11.ii.1960, *Ricardi & Marticorena 5112* (CONC). LOS LAGOS: Osorno, Parque Nacional Puyehue, límite con Argentina, 40°35'S, 72°8'W, 14.ii.1972, *Muñoz 537* (SGO); Valdivia, Quetrupillan, 39°48'S, 73°14'W, 20.iii.1982, *Schlegel 7532* (SGO). MAGALLANES: Cerro Donoso, río de las Chinas, 50°44'S, 72°31'W, 9.ii.1987, *Arroyo et al. 870253* (CONC); Punta Arenas, pr. Lago Parrillar, 53°24'S, 71°3'W, 21.i.2002, *Aedo 7486* (MA). MAULE: Curicó, orillas de la laguna de Teno, 34°59'S, 71°14'W, 10.iii.1967, *Marticorena & Matthei 883* (CONC); Linares, valle Aguirre, 36°10'S, 70°32'W, 20.i.1961, *Schlegel 3554* (CONC); Talca, Paso Pehuenche, 35°59'S, 70°24'W, 30.i.1994, *Villagrán et al. 8227* (CONC). SANTIAGO: Cajón del Yeso, Termas El Plomo, 33°14'S, 70°13'W, 17.i.1995, *Muñoz et al. 3488* (SGO); estación de eski Valle Nevado, 33°20'S, 70°14'W, 12.xii.2001, *Aedo 7125* (MA). TARAPACÁ: Aguas Calientes, Tacora, 17°44'S, 69°46'W, 17.ix.1955, *Ricardi et al. 3374* (CONC); Parinacota, cerca de la laguna de Cotacotani, camino a Guaneguane, 18°10'S, 69°14'W, 9.iii.1984, *Arroyo 84-172* (CONC). TIERRA DE FUEGO: Altos de Boquerón, 53°17'S, 69°17'W, 15.xii.1971, *Moore & R.N. Goodall 19015* (H); Isla Grande, 55°9'S, 68°46'W, .i., *Maza s.n.* (SGO). PERU. ANCASH: Carhuaz, Huascarán National Park, Quebrada Ishinca, 9°22'S, 77°25'W, 11.ii.1985, *Smith et al. 9441* (MO, F, ISC); Huaylas, Huascarán National Park, Auquispuquio area of ruins, 8°50'S, 77°58'W, 7.iv.1986, *Smith et al. 11990* (MO, F, ISC). APURIMAC: Andahuaylas, 13°40'S, 73°25'W, .ii., *Pearce s.n.* (BM). AREQUIPA: Arequipa, 17°19'S, 70°19'W, 26.iii.1923, *Guenther & Buchtien 1356* (HBG); Cajatambo, 15°35'S, 71°1'W, s.d., *Weberbauer 2775* (WRSL). AYACUCHO: laguna Yaurihuirí, about 205 km from Nazca on the road to Abancay, 14°38'S, 73°57'W, 13.iii.1987, *Brandbyge 319* (AAU); Señal Cerro Palmaderas, 80 km above Nazca on road to Poquío, 14°40'S, 74°29'W, 11.iii.1987, *Brandbyge 275* (AAU). CUZCO: Calca, Amparaes, centre of the town, around the bridge, SW from Cuzco and S of town, 13°10'S, 71°54'W, 13.xii.1986, *Núñez 6749* (MO); Canas, Langui, 14°25'S, 71°16'W, 13.i.1975, *Chávez 2317* (MO). HUANCAYELICA: cerros de Laría, a 8 km de Conaica, 12°33'S, 75°3'W, 30.iii.1952, *Tovar 912* (US); Tayacaja, Montepungo, 5 km E of Surcubamba, 12°8'S, 74°41'W, 13.i.1939, *Stork & Horton 10383* (F, CAL). JUNÍN: 5 km E of Huancayo, 12°4'S, 75°14'W, 31.xii.1938, *Stork & Horton 10217* (F); between Tarma and Jauja, 11°36'S, 75°37'W, 24.iv.1929, *Killip & Smith 21971* (NY, US). LIMA: Canta, 11°25'S, 76°45'W, 2.v.1963, *Acleto 735* (MA); Río Blanco, 11°44'S, 76°15'W, 20.iii.1923, *Macbride 3006* (MA, F, G). MOQUEGUA: 5 km E of Lago Suche, 16°56'S, 70°23'W, 11.xii.1951, *Pearson 20* (F, CAL); Coalaque, 16°49'S, 71°15'W, 6.iii.1923, *Guenther & Buchtien 1318* (HBG). PASCO: Huarón, 11°0'S, 76°25'W, 12.vi.1922, *Macbride & Featherstone 1148B* (F); Huayllay to Canta road, 11°1'S, 76°21'W, 6.iii.1977, *Boeke 1118* (MO, NY). PUNO: 3 km SE of Vilque, 15°46'S, 70°15'W, 11.i.1963, *Iltis et al. 1373* (BH); 4 km E of Tincopalca, 15°51'S, 70°45'W, 12.i.1963, *Iltis et al. 1475* (BH).
2. *Geranium brevicaule* Hook. f. in J. Bot. (Hooker) 1: 252 (1834)
Geranium sessiliflorum ssp. *brevicaule* (Hook. f.) Carolin in Proc. Linn. Soc. New South Wales ser. 2, 89: 357 (1965)
 Type: Australia. Tasmania, *Gunn 256* (lectotype, designated by Carolin, 1965: 357), K!; isolectotypes, BM!, F!
Geranium sessiliflorum ssp. *novaezealandiae* Carolin in Proc. Linn. Soc. New South Wales ser. 2, 89: 356 (1965)
 Type: New Zealand. Inland Kaikoura Mts., Marlborough, 4 Dec. 1960, *Hamlin 915* (holotype, WELT 11508!; isotype, UC!)
Geranium sessiliflorum var. *arenarium* G. Simpson & J.S. Thomson in Trans. & Proc. Roy. Soc. New Zealand 73: 158 (1943)
 Type: New Zealand. Stewart Island, Paterson's Inlet, *Simpson & Thomson s.n.* (CHR, not located according to Carolin, 1965: 357)
Geranium sessiliflorum var. *maculatum* G. Simpson & J.S. Thomson in Trans. & Proc. Roy. Soc. New Zealand 73: 157 (1943)
 Type: New Zealand. Lake Lyndon, *Simpson & Thomson s.n.* (lectotype, designated by Carolin, 1965: 356, CHR 75697!)
Geranium sessiliflorum var. *glabrum* R. Knuth in Bot. Jahrb. Syst. 37: 565 (1906)
 Type: New Zealand. [without locality], *Bastian s.n.* (lectotype, designated by Carolin, 1965: 357, K!)
- Herbs 2.5–15.5 cm tall. Rootstock 3.2–10.5 mm diam., without fusiform roots. Basal leaves in a persistent rosette; lamina 0.78–2.56 × 0.89–3.18 cm, polygonal in

outline, cordate (with basal leaf segments downward), palmatifid (divided for 0.53–0.74 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 1.4–4.7 mm at the base (segment width at the base/segment length ratio = (0.20–)0.24–0.35(–0.41)), 3–7-lobed in distal half (second sinus length/middle-segment length ratio = (0.10–)0.21–0.26(–0.35)); petioles to 13 cm long, with patent to retrorse, appressed, eglandular hairs 0.3–1.2 mm long; stipules 2.7–8.8 × 0.9–2.5 mm, with scattered eglandular hairs on both surfaces and on the margin. Inflorescence with cymes 1-flowered, solitary; peduncles 0–1.1(–1.6) cm long, with patent to retrorse, eglandular hairs 0.15–1.1 mm long; bracteoles 2–6.57 × 0.6–1.25 mm, linear-lanceolate, with scattered eglandular hairs on both surfaces and on the margin; pedicels 0.33–4.3 cm long, with patent to retrorse, eglandular hairs 0.15–1.1 mm long; pedicel not overtopping the subtending leaf. Sepals (3.3–)4.4–5.7(–7.1) × 1.4–3.14 mm, lanceolate (width/length ratio = (0.31–)0.36–0.45(–0.54)), with mucro (0.48–)0.9–1.3(–1.95) mm long (mucro length/sepal length ratio = (0.14–)0.20–0.26(–0.37)), with scarious margins 0.1–0.2 mm wide, with erect-patent, eglandular hairs 0.3–0.6 mm long on the abaxial side (patent hairs 1–1.7 mm long on the margin), glabrescent adaxially. Petals 2.8–5.5(–6.5) × 1–3.1 mm, entire, without claw, glabrous, rarely with few cilia on the basal margin, deep pink to white. Filaments 1.6–3 mm long, yellowish, glabrous on both sides, ciliate on the basal margin, with hairs up to 0.1–0.2 mm long; anthers 0.4–0.7 × 0.2–0.7 mm, yellowish; pollen unknown colour. Nectaries glabrous. Gynoecium 2–3.4 mm long, unknown colour. Fruit 8.4–17.6 mm long; mericarps 2.2–3.58 × 1–1.74 mm, smooth, with erect-patent, eglandular hairs 0.2–1.1 mm long, brownish; rostrum 5.1–11.7 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.1–0.6 mm long; stigmatic remains 0.9–1.2(–1.6) mm long, with 5 hairy lobes. Seeds 1.5–2.8 × 0.7–1.4 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Australia (south-east Australia and Tasmania), and New Zealand (Fig. 66).

Habitat: Sand dunes, lake shores, grasslands, rock cranny on dry coastal hillside, or open *Eucalyptus* forest; 0–1300 m.

Phenology: Flowering October – June.

Illustration: Figure 67.

Notes: Carolin (1965) considered two subspecies of *G. sessiliflorum*, one endemic to New Zealand and other restricted to south-east Australia and Tasmania. He distinguished ssp. *novazelandiae* by the long hairs of the calyx tending to be inserted towards the margin

(also on the abaxial surface on ssp. *brevicaule*), the relatively shorter sepal mucro (*c.* 1 mm in ssp. *novazelandiae*, and 1 mm or longer in ssp. *brevicaule*), and longer petals (*c.* 1.5 times as long as the sepals in ssp. *novazelandiae*, and shorter than to slightly exceeding the sepals in ssp. *brevicaule*). On the studied material we are not able to find any difference in sepals indumentum or mucro length among plants from Australia (and Tasmania) and New Zealand. Petals from New Zealand plants are sometimes a bit longer than in Australian ones. However, we have found a great overlap in this character, which made it impossible to distinguish between these groups. Thus, we prefer to include all these plants in a single taxon which could be more easily distinguished from South American *G. sessiliflorum*.

Geranium brevicaule shares with *G. antrorsum* a relatively longer sepal mucro. However, it can be easily distinguished by its pedicels with patent to retrorse hairs (antrorse hairs in *G. antrorsum*), and by its leaves with downward basal segments (patent or upward in *G. antrorsum*). Additionally, *G. antrorsum* has a longer gynoecium and rostrum than *G. brevicaule*. *G. sessiliflorum* is a very variable species with a large geographical distribution, and includes most of the differential characters proposed for *G. brevicaule*. However, two quantitative characters permit the differentiation of the species, although with some overlap. Petals of *G. brevicaule* are shorter than in *G. sessiliflorum*, and the sepal mucro of *G. brevicaule* is longer than in *G. sessiliflorum*. The ratio between mucro length and sepal length also supports this difference.

Representative specimens examined: AUSTRALIA. NEW SOUTH WALES: Bankstown City Council's Native Reserve, 7 Sylvan Grove, Picnic Point, 33°58'S, 150°58'E, 14.ii.1989, *Miller 22* (NSW); Kosciusko Hotel Dam, 36°30'S, 148°12'E, 24.i.1959, *Carolin 778a* (K). TASMANIA: Ben Lomond National Park, along Rafferty Creek, 41°34'S, 147°39'E, 3.ii.1980, *Noble 29008* (HO); Bluff Marshes, Drys Bluff, 41°43'S, 146°48'E, 13.i.1981, *Brown 781* (HO); Fern Tree, 42°55'S, 147°15'E, 7.xii.1986, *Morris 86146* (HO); Port Arthur, 43°8'S, 147°50'E, .i.1929, *Ecbhin s.n.* (HO); Preservation Island, 40°29'S, 148°3'E, 7.x.1979, *Harris s.n.* (HO). NEW ZEALAND. NEW ZEALAND NORTH I: Blue Creek Cave, Waikoropupu stream, 41°20'S, 175°24'E, 26.ii.1993, *Lange 1998* (AK); Desert Rd., E Ruapehu, 39°17'S, 175°34'E, .i.1965, *Druce s.n.* (CHR); Hora Hora, Middle Waikato, 37°59'S, 175°38'E, 16.xi.1912, *Petrie s.n.* (WELT); Marton, Tyrone Farm, 39°59'S, 175°22'E, 9.iv.2001, *Ogle 3823* (AK); Patateri Plateau, 38°6'S, 176°4'E, .i.1884, *Cheeseman s.n.* (AK). NEW ZEALAND SOUTH I: Cass, 43°2'S, 171°45'E, 30.i.1978, *Lill s.n.* (AK); Castle Hill, Canterbury, 43°41'S,

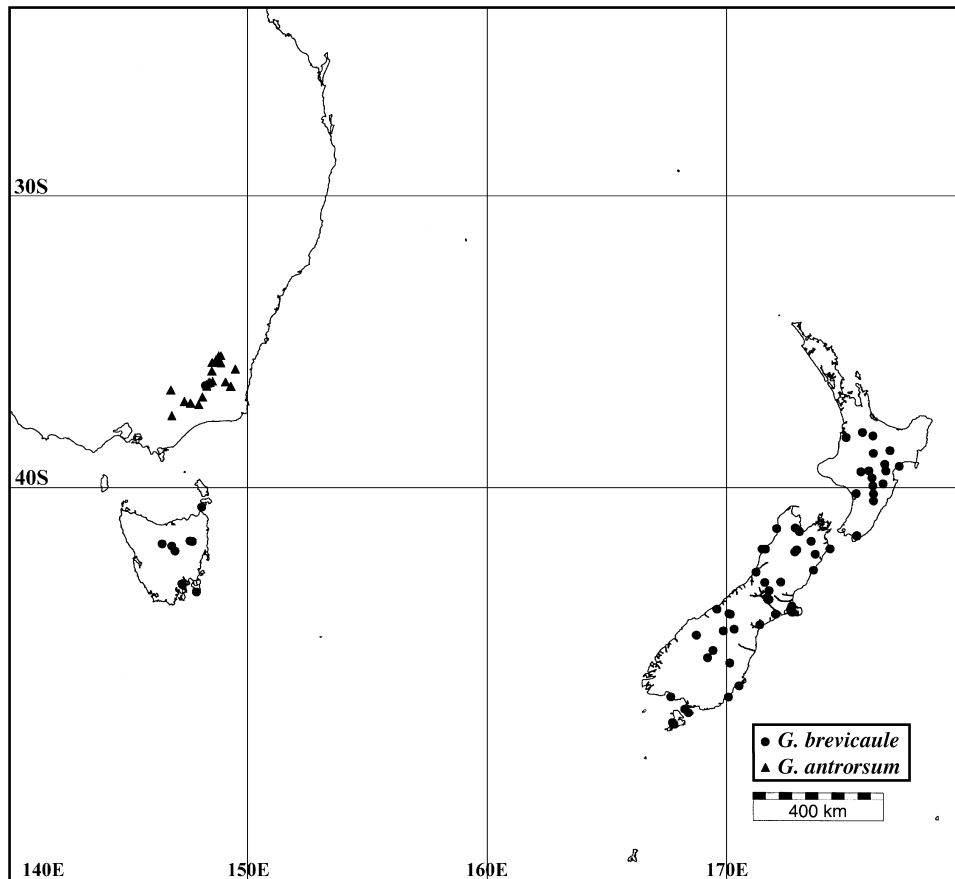


Figure 66. Area of distribution of *Geranium brevicaule* (dots) and *G. antrorsum* (triangles).

172°42'E, 31.xii.1957, *Wood s.n.* (AK); Christchurch, Port hills, 43°30'S, 172°42'E, .1936, *Lothian s.n.* (GH); Clutha Valley, Maori Point, near Tarras, 44°50'S, 169°25'E, 29.i.1974, *Johnson & Hubbard s.n.* (CHR); Cobb reservoir, NW Nelson, 41°6'S, 172°4'E, 2.xii.1978, *Gardner 2172* (L, CHR); Stewart Island, 46°59'S, 167°48'E, 16.xii.1962, *White s.n.* (AK).

3. *Geranium antrorsum* Carolin in Proc. Linn. Soc. New South Wales ser. 2, 89: 357, pl. 6 fig. 14, pl. 7 fig. 10 (1965)
Type: Australia. New South Wales, Kosciusko Hotel, 24.i.1959, *Carolin 778b* (holotype, NSW 66132; isotype, K!)

Herbs 5.5–15.3 cm tall. Rootstock 3.9–10.3 mm diam., without fusiform roots. Basal leaves in a persistent rosette; lamina 0.9–3.3 × 1.3–3.8 cm, polygonal in outline, cuneate to subtruncate (with basal leaf segments patent or upward), palmatifid (divided for 0.39–0.53 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 2.3–6.8 mm at the base (segment width at the base/segment length ratio = (0.16–)0.18–0.28), 3(–5)-lobed at the apex (second sinus length/middle-segment

length ratio = (0.12–)0.15–0.16(–0.20)); petioles to 7 cm long, with patent to antrorse, appressed, eglandular hairs 0.3–1.6 mm long; stipules 5.7–14.2 × 1.2–3.5 mm, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Inflorescence with cymules 1-flowered, solitary; peduncles 0–1.2(–1.8) cm long, with antrorse, appressed, eglandular hairs 0.3–1 mm long; bracteoles 3.5–7.1 × 0.8–1.2 mm, linear-lanceolate, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 0.65–3.7 cm long, with antrorse, appressed, eglandular hairs 0.2–0.9 mm long; pedicel not overtopping the subtending leaf. Sepals (4.3–)5.1–6.4(–8.2) × 1.7–3.2 mm, lanceolate (width/length ratio = (0.34–)0.38–0.43(–0.55)), with mucro (1.2–)1.3–1.9(–2.9) mm long (mucro length/sepal length ratio = (0.20–)0.23–0.36(–0.44)), with scarious margins 0.1–0.2 mm wide, with erect-patent, eglandular hairs 0.5–0.8 mm long on the abaxial side (patent hairs 1–1.4 mm long on the margin), glabrescent adaxially. Petals (3.6–)4.1–6.1(–8) × 1.2–4.4 mm, entire, without claw, glabrous, purplish. Filaments 2.4–3.6 mm long, yellowish, with eglandular hairs 0.2–0.3 mm long on the abaxial side and margin;

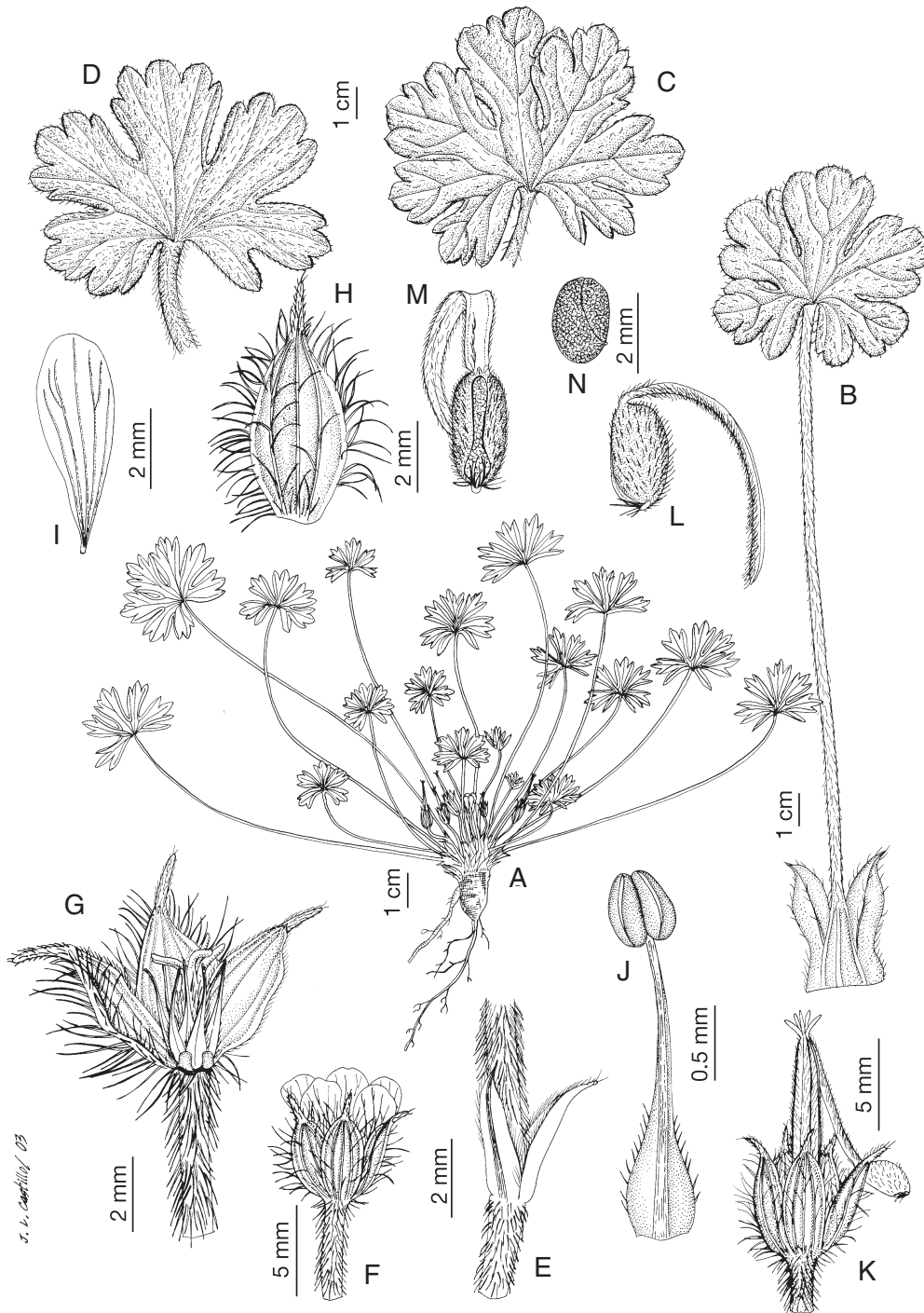


Figure 67. *Geranium brevicaule* Hook. f. A, habit; B–D, leaves; E, bracts; F, flower; G, flower without petals; H, sepal; I, petal; J, stamen; K, fruit; L–M, mericarps; N, seed [A, C–N: Morris 86146 (HO); B: Hynes s.n. (AK).]

anthers 0.6–0.9 × 0.4–0.7 mm, yellowish; pollen unknown colour. Nectaries glabrous. Gynoecium 2.5–4 mm long, purplish. Fruit 13.9–16.5 mm long; mericarps 2.6–3.9 × 1.3–1.9 mm, smooth, with erect-patent, eglandular hairs 0.3–0.8 mm long, brownish; rostrum 9–10.6 mm long, without a narrowed apex,

with erect-patent, eglandular hairs 0.2–0.9 mm long; stigmatic remains (1–)1.4–1.7(–2.2) mm long, with 5 hairy lobes. Seeds 2.1–2.9 × 1.2–1.7 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: South-east Australia (Fig. 66).

Habitat: Dry, grassland with dominant *Poa* tussocks, *Eucalyptus* open woodland, on granites; 1100–2000 m.
Phenology: Flowering December – January (April).

Illustration: Figure 68.

Notes: *Geranium antrorsum* is recognized by its patent or upward basal leaf segments, giving a

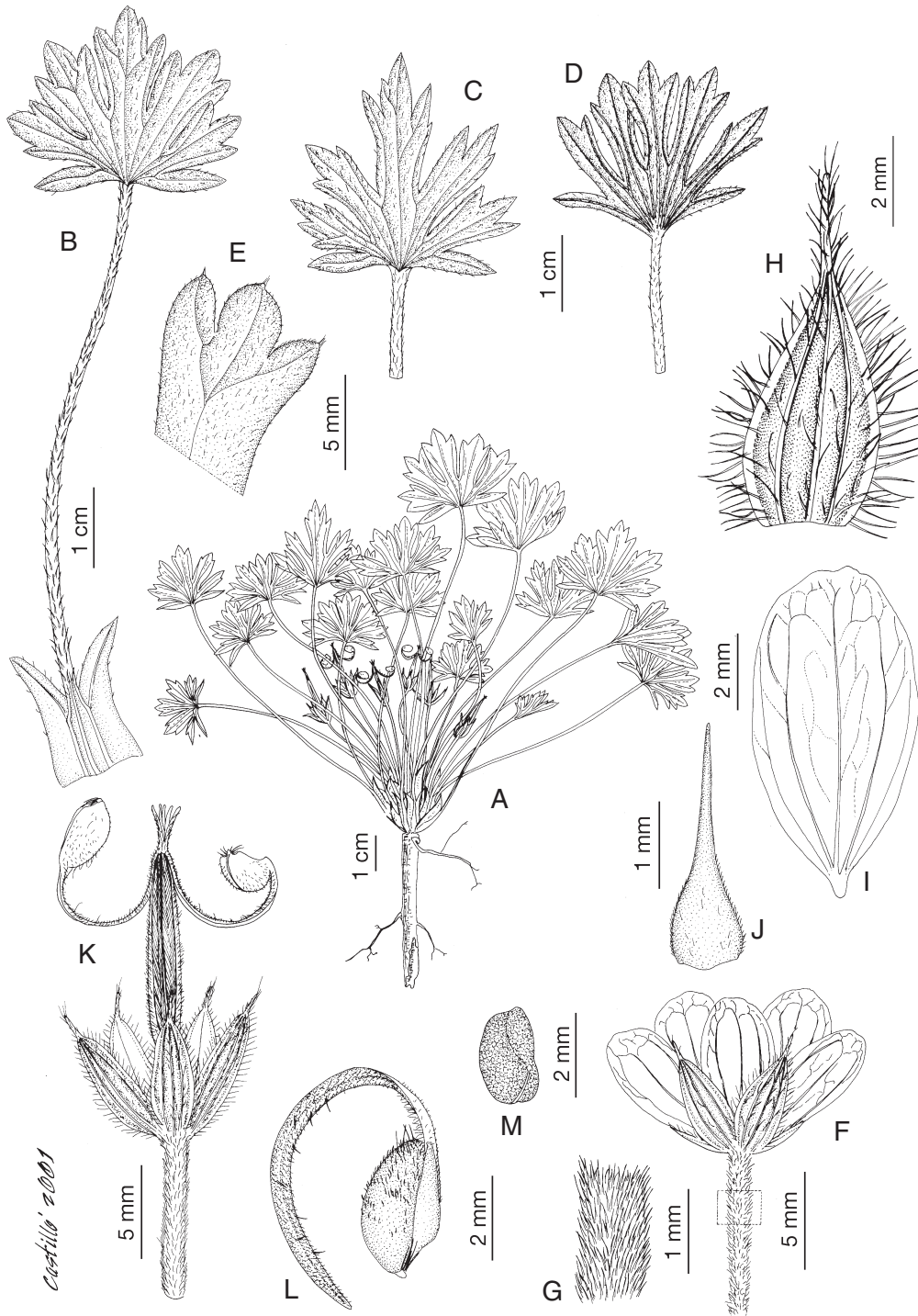


Figure 68. *Geranium antrorsum* Carolin A, habit; B–D, leaves; E, apex of leaf in adaxial view; F, flower; G, pedicel; H, sepal; I, petal; J, staminal filament; K, fruit; L, mericarp; M, seed [A, C, K–M: Carolin 798B (SYD); B, E: Eichler 13652 (SYD); D–F: Carolin s.n. (SYD); G–H, J: Adams 2493 (L); I: Beaglehole 33303 (SYD).].

cuneate to subtruncate aspect to the leaf. This species has antrorse, appressed, eglandular hairs on the pedicels. It has usually been considered as closely related to *G. brevicaule* and *G. sessiliflorum*. However, these species have cordate leaves and pedicels with patent to retrorse hairs. Additionally, *G. antrosum* has sepals with mucro (1.2–)1.37–2.9 mm long, which shows some overlap with *G. brevicaule* (with mucro (0.48–)0.9–1.30(1.94) mm long), and none with *G. sessiliflorum* (with mucro 0.3–0.7(1.1) mm long).

Representative specimens examined: AUSTRALIA. NEW SOUTH WALES: between Charlotte Pass and Snowy River, 5.5 km ENE of Mt. Kosciusko, 36°25'S, 148°19'E, 5.ii.1957, *Eichler 13652* (SYD); Cave Creek, 0.4 km N of the Blue Waterholes, 35°37'S, 148°39'E, 8.iv.1969, *Rodd 815* (NSW); Cooleman Plain, Currago, 35°37'S, 148°39'E, .xii.1962, *Walker 950* (K); Coopers Swamp, Gourcock Range, 25 mi S of Captains Flat, Monaro Shire, 35°56'S, 149°28'E, 11.xii.1969, *Adams 2493* (L); Cotter River District, between Jack's Creek and the Cotter River, 35°41'S, 148°50'E, 14.xii.1960, *Schodde 1220* (NSW); Nimmitable, 36°31'S, 149°16'E, 9.ii.1908, *Cabbage 1850* (NSW, SYD); summit of Mt. Franklin, 35°29'S, 148°46'E, 8.xii.1984, *Briggs 1760* (SYD). VICTORIA: Horsehair Plain, 34 km from Omeo, toward Hotham Heights, 37°2'S, 147°20'E, 8.i.1969, *Canning 1600* (L); Mt. Buffalo National Park, 1.6 km from The Horn turntable toward the Chalet, 36°39'S, 146°46'E, 14.i.1969, *Canning 1764* (L); Native Dog Plain, Benambra-Wulgulmerang road, East Gippsland, 37°4'S, 148°15'E, 7.i.1970, *Beaglehole et al. 33303* (SYD); Nunniong Plains, East Gippsland, 37°8'S, 147°56'E, 20.i.1971, *Beaglehole 36304* (SYD); Snowy Range, Holmes Plain, Mt. Wellington, 37°30'S, 146°48'E, 27.xii.1972, *Beaglehole 40759* (SYD).

4. *Geranium parodii* I.M. Johnst. in Contr. Gray Herb. 81: 92 (1928)

Type: Argentina. Córdoba, Sierra de Achala, 1–4.xii.1926, *Parodi 7514* (holotype, GH!)

Geranium sessiliflorum var. *glabriusculum* Kuntze, Revis. Gen. Pl. 3(2): 33 (1898)

Type: Argentina. Córdoba, Sierra Achala, Pies de los Gigantes, 3.xii.1878, *Hieronimus s.n.* (lectotype, here selected, NY!) [31°26'S, 64°48'W]

Geranium magellanicum var. *multifoliosum* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 70 (1912)

Type: Argentina. Córdoba, Sierra Achala, Cerro de los Potrerillos, 1.ii.1877, *Hieronimus 753* (lectotype, here designated, GOET!; isolectotype, F!)

Geranium magellanicum var. *pumilum* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 70 (1912)

Type: Argentina. Córdoba, Sierra Achala, Esquina, Quebrada de los Gigantes, 3.xii.1878, *Hieronimus s.n.* (lectotype, here designated, G!)

Herbs 3.3–21 cm tall. Rootstock 7–14.3 mm diam., without fusiform roots. Basal leaves in a persistent rosette; lamina 1.07–4.35 × 1.16–4.57 cm, polygonal in outline, cordate (with basal leaf segments downward), palmatifid (divided for 0.54–0.79 of its length), pilose, with appressed, eglandular hairs; segments 5–7, rhombic to obtriangular, 1.1–2.5 mm at the base (segment width at the base/segment length ratio = 0.08–0.17(–0.20)), 3–9-lobed in distal half (ratio second sinus length/middle-segment length = (0.27–)0.31–0.41(–0.44)); petioles to 13 cm long, with retrorse, ± appressed, eglandular hairs 0.2–0.5 mm long; stipules 5.1–15.3 × 1.21–2.2 mm, glabrous or with scattered eglandular hairs on both surfaces and on the margin. Inflorescence with cymules 1-flowered, solitary (rarely in aggregates of 2–4 flowers); peduncles 0–9.4(–13.5) cm long, with retrorse, ± appressed, eglandular hairs 0.1–0.4 mm long; bracteoles 2.3–5.8 × 0.8–1.3 mm, linear-lanceolate, with scattered eglandular hairs on both surfaces and on the margin; pedicels 1.45–6.20 cm long, with retrorse, ± appressed, eglandular hairs 0.2–0.4 mm long; pedicel and peduncle together usually not overtopping the subtending leaf. Sepals (5.2–)6.1–7.2(–7.7) × 1.8–3.4 mm, lanceolate (width/length ratio = (0.27–)0.33–0.42(–0.50)), with mucro (0.6–)0.62–0.98(–1.4) mm long (mucro length/sepal length ratio = (0.08–)0.10–0.15(–0.18)), with scarious margins 0.1–0.15 mm wide, with erect-patent, eglandular hairs 0.4–0.8 mm long. Petals (9.5–)11.5–15.7 × 3.2–9.4 mm, entire, without claw, hairy on margin and base of abaxial side, white. Filaments 4.3–5.9 mm long, unknown colour, with eglandular hairs 0.1–0.4 mm long on the abaxial side and margin; anthers 0.9–1.4 × 0.6–0.85 mm, unknown colour; pollen unknown colour. Nectaries with a tuft of hairs at the top, dorsally glabrous. Gynoecium 3.7–6.5 mm long, unknown colour. Fruit 16.2–20.4 mm long; mericarps 3.2–4.1 × 1.2–1.8 mm, smooth (sometimes with 1–2 transversal veins at the apex), with erect-patent, eglandular hairs 0.35–0.6 mm long, brownish; rostrum 9.57–13.6 mm long, with a narrowed apex 0.7–1.5 mm long, with erect-patent, eglandular hairs 0.2–0.5 mm long; stigmatic remains (1.7–)2–2.3(–2.5) mm long, with 5 glabrous lobes. Seeds 2.3–2.8 × 1.2–1.4 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Central Argentina (Córdoba and San Luis) (Fig. 64).

Habitat: Wet grasslands; 1800–2600 m.

Phenology: Flowering November – February.

Illustration: Figure 69.

Notes: This endemic taxon from Sierra de Achala has been described as a variety of *G. sessiliflorum* (once) or

G. magellanicum (twice). However, *G. parodii* shows some important characters that suggest that specific status is more appropriate. Petals in *G. parodii* are hairy on the abaxial side and on the margin, and



Figure 69. *Geranium parodii* I.M. Johnst. A–B, habit; C–D, leaves; E, bracts; F, flower; G, flower without petals; H, petal; I–J, stamens; K, fruit; L, mericarp; M, seed [A, C–D, F–M: Hunziker 9622 (BH); B: Parodi 7514 (GH); E: Hunziker 1384 (CORD)].

(9.5–)11.5–15.7 mm long. *G. sessiliflorum* and *G. magellanicum* have shorter petals (in the case of *G. sessiliflorum* with some overlap), with few cilia on the basal margin. Additionally, *G. parodii* has hairy nectaries, and a fruit rostrum with a narrowed apex 0.7–1.5 mm long, whereas *G. sessiliflorum* and *G. magellanicum* have glabrous nectaries and rostrum without narrowed apex. Sepals of *G. parodii* have usually a mucro longer than in *G. sessiliflorum* and *G. magellanicum*, and have a more homogeneous indumentum (without longer hairs on the margin). *Geranium parodii* has longer fruits, rostrum, pedicels, and gynoeceum than *G. sessiliflorum*.

This species shows some variation in plant size and cymule structure. Small specimens have short 1-flowered cymules, without peduncle. In contrast, more developed plants have cymules with longer peduncles, which can be 1-flowered or, sometimes, bear an aggregate of 2–4 flowers and a pair of opposite leaves. A continuum of intermediate forms suggests that these forms do not deserve taxonomic recognition.

Knuth (1912) described *G. magellanicum* var. *pumilum* using heterogeneous material. For instance, *Hieronymus* 449 is *G. core-core* and *Hieronymus* 585 is *G. leucanthum*.

Representative specimens examined: ARGENTINA. CÓRDOBA: Calamochita, pampa de San Miguel, 31°43'S, 64°47'W, 13.xii.1885, *Kurtz* 2944 (CORD); Calamochita, Sierra Grande, al pie del Cerro Champaquí, 31°59'S, 64°56'W, 15.i.1952, *Hunziker* 9622 (BH); Cruz del Eye, Sierra de Achala, entre Tanti y pampa de San Luis, 31°19'S, 64°35'W, 15.xii.1909, *Stuckert* 20629 (CORD); Pampa de Achala, El Condor, 31°35'S, 64°50'W, 19.xii.1949, *Meyer & Sleumer* 15544 (LIL); Pies de los Gigantes, 31°35'S, 64°49'W, 9.i.1884, *Galander s.n.* (NY); San Alberto, Sierra de Achala, Cuesta del Tránsito, 31°34'S, 64°50'W, 5.i.1895, *Kurtz* 8339 (CORD, NY); San Javier, Cerro Champaquí, 31°59'S, 64°56'W, 14.ii.1924, *Hosseus* 13 (CORD). SAN LUIS: El Monigote, 32°48'S, 66°13'W, 2.ii.1911, *Pastore* 36 (SI); Merlo, Cuesta M. Bayo, 32°21'S, 65°1'W, 27.xi.1910, *Pastore* 99 (SI).

II. *Geranium* sect. *Chilensia* R. Knuth in Engl., *Pflanzenr.* 54: 45, 68 (1912)

Type: *G. patagonicum* (lectotype, designated by R. Knuth, 1912: 45)

Perennial herbs with rootstock usually vertical, not tuberculate, turnip-shaped, with or without fusiform-swollen roots; aerial stem leaved, herbaceous, without vegetative stems or stolon. Leaf lamina polygonal in outline, cordate (with basal leaf segments downward), without abscission zone, palmatifid, hairy, not coriaceous, and with nerves not projected; segments 5–7, obtriangular or rhombic, 3–17-lobed in the distal half;

cauline leaves opposite; stipules lanceolate, free, papery, reddish, hairy. Inflorescence in monochasial cyme with 2-flowered cymules (rarely 1-flowered), solitary (usually on the aerial stem); peduncles and pedicels hairy; bracteoles lanceolate to linear-lanceolate, hairy; pedicel and peduncle together usually overtopping the subtending leaf. Sepals ovate, smooth, not accrescent, 3-nerved, mucronate, with scarious margins, hairy. Petals erect-patent, ± obovate, entire or emarginate, usually without claw, hairy, purplish to white. Stamens 10, both whorls bearing anthers; filaments not exerted, lanceolate, yellowish or white, hairy. Nectaries hemispherical, usually glabrous. Fruit of the seed-ejection type; mericarps smooth, without longitudinal rib, without basal beak, with a basal callus, without a basal prong, usually with eglandular hairs, brownish or blackish; rostrum with or without a narrowed apex; stigmatic remains with 5 hairy or glabrous lobes. Seeds ellipsoid, finely reticulate, brownish; hilum 1/4–1/6 as long as the perimeter. Cotyledons entire.

Notes: Species of *Geranium* sect. *Chilensia* are recognized by their aerial developed stem, turnip-shaped rootstock, and 2-flowered cymules. This morphological characterization is basically as Knuth (1912) proposed, although several taxa have been reduced to synonyms. Consequently this section includes nine species from South America and two species from Australia and New Zealand.

5. *Geranium bertereanum* Colla in *Nuovo Giorn. Lett., Sci.* 24: 143 (1832). *Geranium proximum* Bertero ex Steud. in *Flora* 39(28): 438 (1856)

Type: Chile. Valparaíso, Quillota 1829, *Bertero* 1020 (lectotype, here designated, BM!; isolectotype, P!) [32°54'N, 71°16'W]

Geranium intermedium Bertero ex Colla in *Nuovo Giorn. Lett., Sci.* 24: 143 (1832) [syn. subst.], nom. illeg., non E. James (1823). *Geranium collae* Aedo, Muñoz Garm. & Pando in *Anales Jard. Bot. Madrid* 56(2): 224 (1998)

Type: Chile. O'Higgins, Rancagua, *Bertero s.n.* (lectotype, here designated, SGO-51197!)

Geranium patagonicum Hook. f., *Fl. Antarct.* 2: 252 (1845). *Geranium dissectum* var. *patagonicum* (Hook. f) Speg. in *Revista Fac. Agron. Univ. Nac. La Plata* 3: 500 (1897)

Type: Chile. Patagonia, Port Famine, *King s.n.* (lectotype, here designated, K!) [53°38'S, 70°56'W]

Geranium apricum Phil. in *Linnaea* 28: 676 (1856). *Geranium bertereanum* var. *apricum* (Phil.) Reiche in *Anales Univ. Chile* 93: 578 (1895)

Type: Chile. Valdivia, San Juan, *Philippi s.n.* (lectotype, here designated, SGO-40601!; isolectotypes, LE!, W!)

Geranium submolle Steud. in Flora 39(28): 438 (1856)

Type: Chile. Rancagua, montis La Leona, *Bertero 294* (lectotype, here designated, P!; isolectotypes, G! MO!)

Geranium andinum Phil. in Anales Univ. Chile 82: 727 (1893)

Type: Chile. O'Higgins, Popeta, Las Leñas, Jan. 1881, *Philippi s.n.* (lectotype, here designated, SGO-51217!)

Geranium caespitosum Phil. in Anales Univ. Chile 82: 730 (1893) [syn. subst., nom. illeg., non E. James (1823)]. *Geranium berterooanum* var. *caespitosum* Reiche in Anales Univ. Chile 93: 578 (1895). *Geranium chilense* Aedo & Muñoz Garm. in Kew Bull. 52(3): 725 (1997)

Type: Chile. O'Higgins, baños de Cauquenes, ix.1879, *Philippi s.n.* (lectotype, here designated, SGO-51204!, photo P!)

Geranium hispidum Phil. in Anales Univ. Chile 82: 732 (1893) [syn. subst., nom. illeg., non L. f. (1782)]. *Geranium berterooanum* var. *hispidum* Reiche in Anales Univ. Chile 93: 578 (1895). *Geranium neo-hispidum* Aedo & Muñoz Garm. in Kew Bull. 52(3): 725 (1997)

Type: Chile. Santiago, Las Mercedes, October 1888, *Philippi s.n.* (lectotype, here designated, SGO-51214!, photo GH! photo P!)

Herbs 13.5–59 cm tall. Rootstock 5.8–20.4 mm diam., without fusiform roots. Stem erect to ascending, with patent, eglandular hairs 0.4–1.9 mm long and, sometimes, patent, glandular hairs 0.3–1.1 mm long. Basal leaves in a deciduous rosette; lamina 1.8–9 × 2.6–8.4 cm, polygonal in outline, cordate, palmatifid (divided for 0.57–0.82 of its length), pilose, with appressed, eglandular hairs, sometimes glabrous on the adaxial side; segments 5–7, obtriangular, 1.8–10.6 mm at the base (segment width at the base/segment length ratio = (0.11–)0.17–0.22(–0.31)), 3–11-lobed in distal half (second sinus length/middle-segment length ratio = (0.13–)0.24–0.38(–0.42)); petioles to 29.5 cm long, with patent, eglandular hairs 0.5–2 mm long, and sometimes, patent, eglandular hairs 0.3–0.9 mm long; stipules 4–9 × 0.6–3 mm, with eglandular hairs on both surfaces and on the margin. Inflorescence with cymules 2-flowered, solitary; peduncles (0.8–)1.7–4.5(–5.8) cm long, with patent, eglandular hairs 0.2–1.2 mm long and sometimes, patent, glandular hairs 0.3–1.1 mm long; bracteoles 2.5–6.7 × 0.4–1.1 mm, linear-lanceolate, with eglandular hairs on both surfaces and on the margin; pedicels 0.9–2.7 cm long, with patent, eglandular hairs 0.2–1.2 mm long and sometimes, patent, glandular hairs 0.3–1.1 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals

(4.4–)5.4–6.1(–7) × 2–3.4 mm, lanceolate (width/length ratio = (0.40)0.44–0.56(–0.68)), with mucro (0.35–)0.6–0.8(–0.9) mm long (mucro length/sepal length ratio = (0.07–)0.09–0.14(–0.16)), with scarious margins 0.2–0.4 mm wide, with erect-patent, eglandular hairs 0.7–1.8 mm long and sometimes, patent, glandular hairs 0.3–1.2 mm long. Petals (5.1–)6.5–8(–9) × 2.5–4.5 mm, entire or slightly notched, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 2.5–4.5 mm long, whitish to yellowish, with eglandular hairs 0.1–0.4 mm long on the abaxial side and margin; anthers 0.4–0.8 × 0.3–0.7 mm, whitish to pink; pollen yellow. Nectararies glabrous. Gynoecium 2.9–5.2 mm long, whitish to pink. Fruit 11.4–24.6 mm long; mericarps 2.3–4.2 × 1.1–2.3 mm, smooth, with erect-patent, eglandular hairs 0.4–1.5 mm long and, sometimes, patent glandular hairs 0.2–0.8 mm long, brownish; rostrum 8.5–18.1 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.4–1 mm long and, sometimes, patent glandular hairs 0.3–1.1 mm long; stigmatic remains (1.1–)1.3–1.7(–2.1) mm long, with 5 hairy lobes. Seeds 1.3–3.1 × 0.8–1.8 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Argentina and Chile (Fig. 70).

Habitat: Roadsides, dunes, meadows, shrubby areas, and *Acacia*, *Araucaria*, *Aristotelia* or *Nothofagus* forest; 0–3800 m.

Phenology: Flowering January – December.

Illustration: Figure 71.

Notes: *Geranium berterooanum* is distributed over a large area of more than 2800 km between the northernmost localities in Central Chile and the southernmost ones in Tierra de Fuego. This species varies in the presence of glandular hairs. Some specimens have only eglandular hairs while others also have glandular hairs widespread on the stem, inflorescence, sepals, rostrum and/or mericarps. These glandular forms have occasionally been misidentified as *G. fiebrigianum* (included in *G. fallax* in this study). *Geranium berterooanum* can be distinguished from *G. fallax* by its leaves with an obtriangular middle segment (not rhombic), and its rostrum fruit without a narrow apex.

Geranium skottsbergii is also a species with eglandular and glandular forms, partially sympatric with *G. berterooanum*, which can be distinguished by its longer petals and more deeply divided leaves. *Geranium solanderi* is endemic to Australia and New Zealand which strongly resembles *G. berterooanum*. Both species share pedicels with patent hairs, and

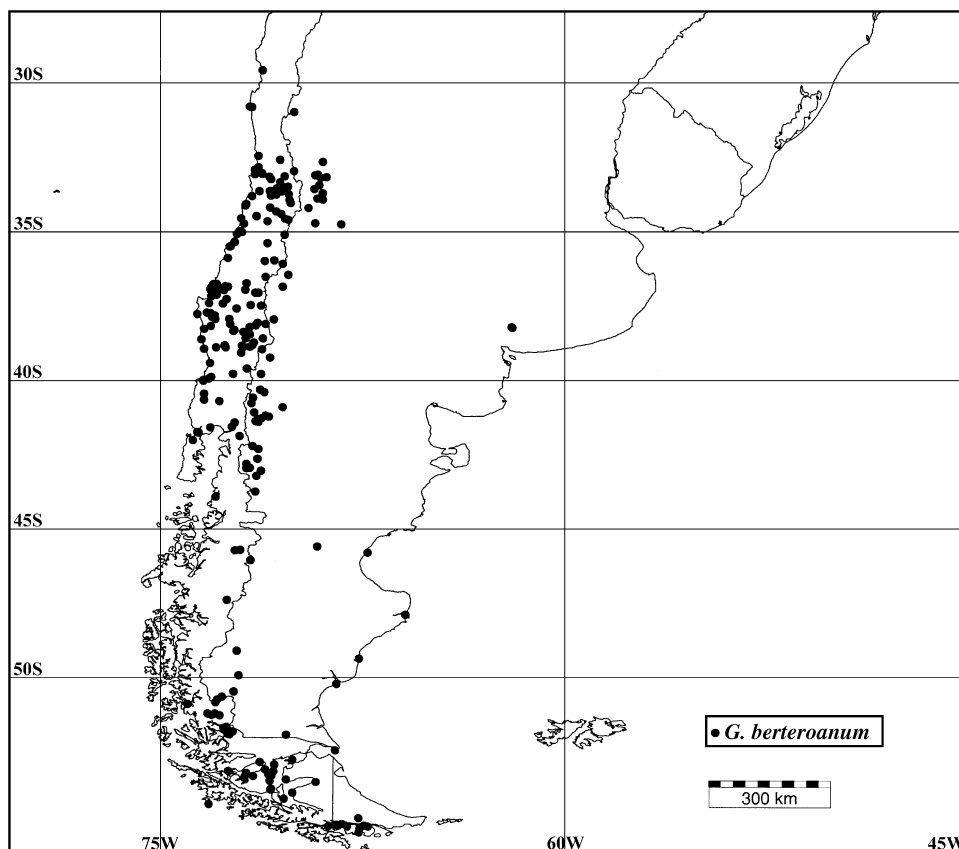


Figure 70. Area of distribution of *Geranium berterioanum*.

many quantitative characters (petal length, sepal mucro length, etc.) have a broad overlap. However, *G. berterioanum* has longer bracteoles, sepals and stigmatic remains than *G. solanderi*.

Colla (1832) described *G. berterioanum* using material collected by Bertero near Valparaíso, which was published as '*G. tuberosum* L.' by Bertero in a local newspaper (Bertero, 1829). Steudel (1856) published his *G. proximum* based on the same material, but indicating two concrete specimens (*Bertero 1019* and *Bertero 1020*). These specimens are heterogeneous, the first belonging to *G. skottsbergii* and the second to *G. berterioanum*. We searched at TO where Colla original herbarium is kept, but Dr Forneris kindly informed us that there is no syntype there. Thus we have selected *Bertero 1020* (kept at BM) as the lectotype of *G. berterioanum* and *G. proximum*. *Geranium submolle* was described by Steudel (1856) on a heterogeneous collection (*Bertero 294*). Most of specimens belong to *G. berterioanum*, but some material of P and G are *G. skottsbergii*, which must be excluded from the type.

Gay (1845) recorded *G. pyrenaicum* Burm. f. from Chile, indicating that there was only one specimen in his herbarium. Later, this species was included by

Marticorena & Quezada (1985) in their check-list of Chile. During the revision of sect. *Batrachioidea* W.D.J. Koehy, to which *G. pyrenaicum* belongs, no new data were provided (Aedo *et al.*, 1998a) as no specimen from Chile could be studied. Now the specimen supporting this record has been located at P (Colchagua, .ii.1831, Gay *s.n.*), and identified as *G. berterioanum*, which permits rejection of the presence of *G. pyrenaicum* in Chile.

According to Stuessy & Marticorena (1990) 'berterioanum' is the correct form to latinize this specific epithet, originally proposed as 'Berterianum'.

Representative specimens examined: ARGENTINA. BUENOS AIRES: Suerra de Ventana, Cerro el Abra, 38°3'S, 61°59'W, 17.xi.1969, *Roivainen 376* (H); Tornquist, Sierra de la Ventana, Cerro Ventana, 38°2'S, 62°0'W, s.d., *Proyecto Ventania 349b* (LP). CHUBUT: 43 km S of Cholila on route 258, into Parque Nacional Los Alerces, 42°48'S, 71°43'W, 3.xii.1984, *Stuessy et al. 6806* (LP); Cushamen, Cholila, 42°30'S, 71°26'W, 5.i.1901, *Illin 124* (G, BR, CORD, SP). MENDOZA: Las Heras, entre Villavicencio y Los Hornillos, 32°30'S, 69°1'W, 26.xii.1947, *Ruiz Leal 11083* (CORD, MERL); Luján, Cerro Cachenta, 33°2'S, 69°6'W, .v.1987, *Roig*

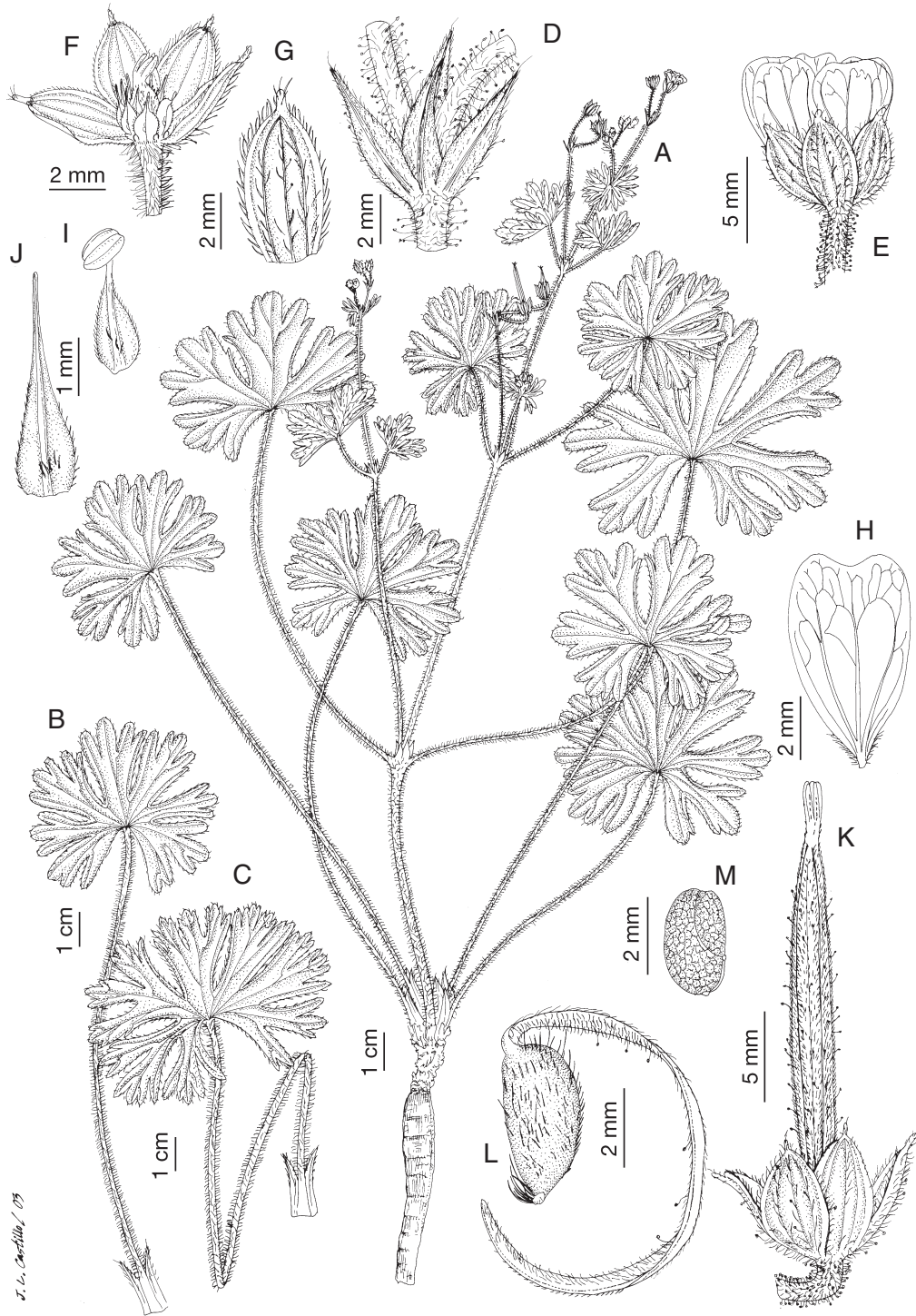


Figure 71. *Geranium bertereanum* Colla. A, habit; B–C, leaves; D, bracts; E, flower; F, flower without petals; G, sepal; H, petal; I–J, stamens; K, fruit; L, mericarp; M, seed [A–E, G–M: Aedo 7391 (MA); f: Aedo 6727 (MA).].

12619 (MERL). NEUQUÉN: Aluminé, Pulmarí, 39°5'S, 70°58'W, 8.xii.1981, *Cabrera et al.* 32920 (SI); El Cruce, villa La Angostura, 40°47'S, 71°40'W, 13.xii.1946, *Barba* 1197 (LIL). RÍO NEGRO: 6 km de Pilcaniyen,

camino de Bariloche, 40°45'S, 70°30'W, 28.i.1944, *Nicora* 3677 (SI); Arroyo Cascada, Cerro Catedral, 41°13'S, 71°30'W, 30.i.1945, *Barba* 146 (NY). SANTA CRUZ: Deseado, cañadón frente a la estación de Biología

Marina, 47°44'S, 65°56'W, .x.1970, *Crespo & Troncoso 1694* (SI); Estancia lago Roca, río Rico, 50°30'S, 72°44'W, 24.xii.1958, *James 380* (BM). TIERRA DE FUEGO: Fuegia, Lago Fagnano, Pumilio shore, 54°35'S, 67°40'W, 18.iii.1908, *Skottsberg 247* (S, UPS); Ushuaia, 54°50'S, 68°26'W, 13.ii.1953, *Ruiz Leal 14961* (CORD). CHILE. AISEN: Coihaique, 45°34'S, 72°4'W, 25.i.1934, *Espinosa s.n.* (SGO); Los Mallines, near Balmaceda, 45°55'S, 71°41'W, 24.i.1943, *Bruzzone 42* (LP). BIOBIO: Concepción, 36°50'S, 73°3'W, 18.xi.2001, *Aedo 6913* (MA); parque Hualpén, morro Pompón, 36°48'S, 73°10'W, 21.xi.2001, *Aedo 6931* (MA). COQUIMBO: cerros del Tofo, 68 km N of La Serena, 29°26'S, 71°15'W, 1.xi.1938, *Worth & Morrison 16297* (K, GH, UC); Ovalle, bosque de Talinay, S desembocadura del Limarí, 30°39'S, 71°43'W, 18.xi.1940, *Muñoz & Coronel 1267* (SGO). LA ARAUCANIA: 8 km al N de Yupehue, playa Casas de Piedra, 38°28'S, 73°30'W, 21.xii.2001, *Aedo 7185* (MA); camino entre Cherquenco y Melipeuco, 38°43'S, 71°57'W, 23.xii.2001, *Aedo 7243* (MA). LOS LAGOS: Llanacura, 40°18'S, 73°24'W, 11.i.1961, *Schlegel 3444* (CONC); Llanquihue, Cayutué, 41°16'S, 72°16'W, .i.1973, *Martínez s.n.* (CONC). MAGALLANES: Fuerte Bulnes, 53°37'S, 70°56'W, 25.iv.1951, *Cekalovic s.n.* (SGO); pr. Puerto Natales, 51°33'S, 72°40'W, 19.i.2002, *Aedo 7472* (MA). MAULE: Constitución, playa el Cable, 35°21'S, 72°27'W, 14.xii.2001, *Aedo 7154* (MA); Valdivia, Las Quinas, 35°12'S, 72°16'W, .i.1903, *Buchtien s.n.* (US). O'HIGGINS: Colchagua, Punta Lobos, 5 km al S de Pichilemu, 34°24'S, 72°2'W, 31.x.1973, *Stebbins 8774* (SGO); Hacienda de Cauquenes, cajón del Ciprés, 34°25'S, 70°25'W, .1875, *Philippi s.n.* (M). SANTIAGO: Colina, Baños de Colina, 33°11'S, 70°36'W, 8.xi.2001, *Aedo 6737* (MA); puente Manzanito, 33°20'S, 70°19'W, 12.xii.2001, *Aedo 7136* (MA). TIERRA DE FUEGO: Bahía Inutil, estancia Cameron, 53°22'S, 69°16'W, 19.iii.1964, *Moore 1064* (SGO); camino a Puerto Arturo, cabo Nose, 53°44'S, 70°8'W, 24.i.1994, *Pisano et al. 7727* (CONC). VALPARAÍSO: Aconcagua, Petorca, carretera panamericana, 4 km antes del puente Guaquén, 32°18'S, 71°24'W, 15.x.1971, *Martcorena et al. 1286* (CONC); Juncal, Uspallata pass, 32°49'S, 70°5'W, .ii.1903, *Buchtien s.n.* (US, BM, GH).

6. *Geranium solanderi* Carolin in Proc. Linn. Soc. New South Wales ser. 2, 89: 350 (1965) *Geranium pilosum* Sol. ex Willd., Sp. Pl. 3(1): 706 (1801) [syn. subst.], nom. illeg., non Cav. (1788). *Geranium dissectum* var. *pilosum* Hook. f., Fl. Tasman. 1: 56 (1855). *Geranium dissectum* var. *australe* Benth., Fl. Austral. 1: 296 (1863). *Geranium carolinianum* var. *australe* (Benth.) Fosberg in Occas. Pap. Univ. Hawaii 32: 6 (1937)
Type: New Zealand [without locality], *Forster 531* (lectotype, designated by Carolin, 1965: 351, K!)

Geranium dissectum f. *tasmanica* Gand. in Bull. Soc. Bot. France 47: 306 (1901)

Type: Australia. Tasmania, Stone Pit Chapel, December 1875, *Spicer 44* (lectotype, here designated, LY digital image!)

Geranium drummondii Carolin in Proc. Linn. Soc. New South Wales ser. 2, 89: 353, pl. 6 fig. 4 (1965)

Type: Australia. Swan River, *Drummond 4 bi* (holotype, K!; isotype, E!)

Herbs 12–100 cm tall. Rootstock 2.4–19.1 mm diam., without fusiform roots. Stem erect to ascending, with patent to retrorse, not appressed, eglandular hairs 0.4–1.8 mm long. Basal leaves in a ± deciduous rosette; lamina 1.2–4.5 × 1.4–5.7 cm, polygonal in outline, cordate, palmatifid (divided for 0.47–0.82 of its length), pilose, with ± erect, eglandular hairs; segments 5–7, obtriangular, 2.2–6.8 mm at the base (segment width at the base/segment length ratio = (0.12–)0.14–0.24(–0.30)), 3–10-lobed in distal half (second sinus length/middle-segment length ratio = (0.13–)0.20–0.35(–0.47)); petioles to 18 cm long, with patent, eglandular hairs 0.4–1.7 mm long; stipules 2.2–8 × 0.5–2.1 mm, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Inflorescence with cymules 2-flowered, solitary; peduncles (0.4–)1.8–4(–6.1) cm long, with patent to retrorse, not appressed, eglandular hairs 0.3–2 mm long; bracteoles 1.5–7.4 × 0.3–0.8 mm, lanceolate, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 0.8–3.4 cm long, with patent to retrorse, not appressed, eglandular hairs 0.2–2 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals (3.2–)4.2–5.2(–6.3) × 1.6–2.7 mm, lanceolate (width/length ratio = (0.38–)0.43–0.51(–0.62)), with mucro (0.2–)0.4–0.7(–0.9) mm long (mucro length/sepals length ratio = (0.04–)0.08–0.13(–0.25)), with scarios margins 0.1–0.2 mm wide, with eglandular hairs 0.1 mm long on the abaxial side (and eglandular hairs 0.4–1.8 mm long on the margin), glabrous adaxially. Petals (3–)4.7–6(–8.1) × 1.4–4.2 mm, entire, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 2.4–4.5 mm long, yellowish, glabrous on both sides, ciliate on the basal margin, with hairs up to 0.1–0.3 mm long; anthers 0.4–0.8 × 0.2–0.7 mm, yellowish; pollen unknown colour. Nectaries glabrous. Gynoecium 2.5–4.8 mm long, yellowish. Fruit 13.1–20.6 mm long; mericarps 2.2–3.2 × 1.1–1.8 mm, smooth, with erect-patent, eglandular hairs 0.1–1.5 mm long, usually blackish; rostrum 8.8–15.1 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.1–1.1 mm long; stigmatic remains (0.6–)1–1.4(–1.6) mm long, with 5 hairy lobes. Seeds 1.6–2.2 × 0.9–1.6 mm, reticulate; hilum 1/6 as long as the perimeter.

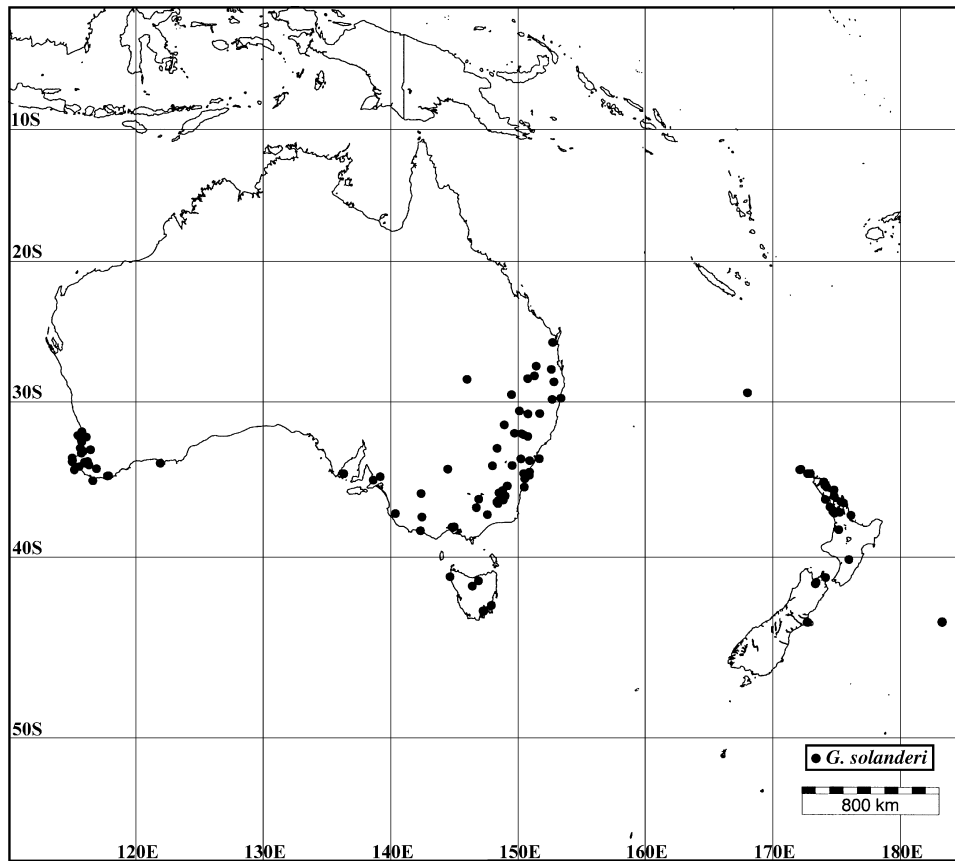


Figure 72. Area of distribution of *Geranium solanderi* (Californian localities are not shown).

Area: Australia (Norfolk I, south-west Australia, south-east Australia and Tasmania), and New Zealand (North I, South I and Chatham Is); introduced in USA. (California) (Fig. 72).

Habitat: Dunes, lava tongues, river gorges, moist grassy areas, shrublands, and *Acacia*, *Agonis*, *Callitris*, *Eucalyptus* or *Melaleuca* forest; 0–1960 m.

Phenology: Flowering January – December.

Illustration: Figure 73.

Notes: Gardner (1984) studied the variability of *G. solanderi* in New Zealand, and recognized two forms based mainly on petal length, and indumentum, named 'large petals' and 'coarse hairs'. However, this author found that intermediate character states or a combination of the features diagnostic of each form were common in Australian material, which has been confirmed in this study. All these data suggest that such forms do not deserve taxonomic recognition.

Carolin (1965) described *G. drummondii* based on three specimens from south-west Australia. These

specimens are characterized by a dense and entangled indumentum especially on pedicels, sepals and mericarps. However intermediate forms are common in this area and in other Australian localities. Considering these data and the great variability of *G. solanderi* throughout its whole area we prefer to subsume *G. drummondii* as a synonym of *G. solanderi*.

Geranium solanderi strongly resembles *G. berterioanum*, which is an endemic from the Andes. The differences are discussed under the second species. Additionally, it should be indicated that among the studied material of *G. solanderi* no specimen with glandular hairs has been found, whereas in *G. berterioanum* specimens with glandular hairs are common.

Representative specimens examined: AUSTRALIA. NEW SOUTH WALES: 37 km from Corrong Victoria, toward Omeo, 34°11'S, 144°28'E, 4.i.1969, *Canning 1415* (GH); Armidale, university grounds, 33°30'S, 151°39'E, 5.xi.1958, *Paterson s.n.* (G); Bowral, 34°28'S, 150°25'E, 2.ii.1959, *Carolin 829* (L); Bungonia state recreation reserve, 34°48'S, 150°30'E, 13.ix.1978, *Canning 4396* (CANB); Canberra, 35°16'S, 149°9'E,

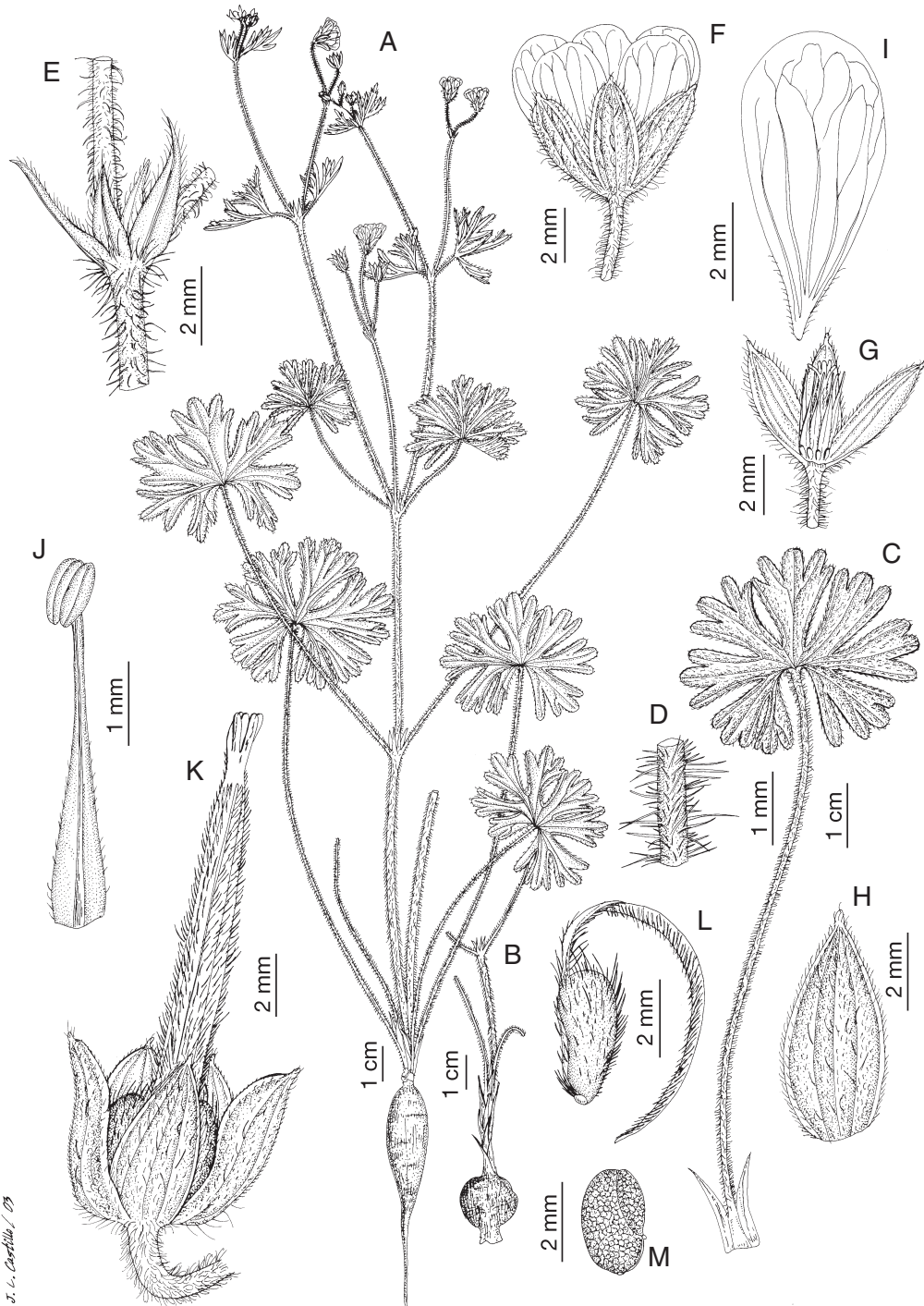


Figure 73. *Geranium solanderi* Carolin. A, habit; B, rootstock; C, leaf; D, peduncle; E, bracts; F, flower; G, flower without petals; H, sepal; I, petal; J, stamen; K, fruit; L, mericarp; M, seed [A–M: *Keighery & Gibson 436* (PERTH).].

12.xi.1962, *McKee 9665* (L, BM). QUEENSLAND: Darling Downs District, 3 miles SE of Blaxland, 27°12'S, 151°24'E, 13.x.1940, *Smith & Everist 799* (GH); Lockyer valley, 27°25'S, 152°36'E, 11.v.1943, *Clemens 42/65* (GH); Maryborough, Mary river, 25°32'S, 152°42'E,

14.x.1930, *Hubbard 4367* (L); Millmerran, 27°52'S, 151°16'E, 15.iii.1931, *Hubbard 5848* (K, L); Pale Creek, 28°17'S, 152°48'E, 1.vi.1959, *Carolin 1023* (G). SOUTH AUSTRALIA: 8 km S of Lucindale, 37°2'S, 140°21'E, 19.xii.1985, *Gibbons 506* (HO); Adelaide,

34°55'S, 138°36'E, s.d., *Whittaker s.n.* (K); Moreton Bay, 34°30'S, 136°17'E, s.d., *Mueller s.n.* (E); Mt. Lofty range, Saunders Creek, 34°42'S, 139°9'E, 26.vii.1969, *Blaylock 1313* (AK). TASMANIA: Ball Bay, 41°8'S, 146°52'E, .xii.1955, *Curtis s.n.* (HO); Hobart town, 42°52'S, 147°19'E, 13.xii.1839, *Le Guillou s.n.* (P); Marrawak, Green Point, 40°54'S, 144°39'E, 26.i.1969, *Canning 1850* (L); Mt. Wellington, 42°54'S, 147°14'E, .1971, *Allan s.n.* (HO); Spring beach, Prosser Bay, 42°34'S, 147°54'E, 19.xii.1952, *Melville 2538* (K, GH, PERTH). VICTORIA: 21 km from Omeo, toward Mitta Mitta, 37°5'S, 147°35'E, 6.i.1969, *Canning 1525* (US); Altona, at the mouth of Skeleton Creek, 37°52'S, 144°49'E, 21.xi.1967, *Cullimore 100* (PERTH); Gramphians mts., 37°15'S, 142°26'E, .xii.1912, *Tilden s.n.* (U); Hume highway, km 31 from Chiltern-Beechworth exit to Wodonga, 36°7'S, 146°53'E, 7.x.1978, *Canning 4410* (L); Port Phillip, 37°51'S, 144°58'E, .1839, *Duncan s.n.* (E). WESTERN AUSTRALIA: 1.7 km S intersection of Sollya road and Brockman highway, 34°5'S, 115°34'E, 20.i.1997, *Godden & Day 72.4* (PERTH); 2.2 km E of Caves road along Moses rock road, 33°46'S, 115°0'E, 5.xii.1996, *Casson & Annels 39.2* (PERTH); 3 km N of Yallingup, 33°41'S, 115°2'E, 1.x.1989, *Keighery s.n.* (PERTH); along Balladonia road, S of Mt Rogged, E of Esperance, 33°51'S, 121°53'E, 5.xii.1971, *Royce 10150* (PERTH); Ballingup, 33°47'S, 115°59'E, 28.x.1946, *Royce 1330* (PERTH). NEW ZEALAND. CHATHAM IS: Lake Huro, Mangape Stream Outlet, 43°56'S, 176°31'W, 29.iii.1996, *Lange 225* (AK); NEW ZEALAND NORTH I: Aorangi Island, Arid Point, 35°29'S, 174°45'E, 24.x.1995, *Lange 3154* (AK); Auckland city, mount Wellington, 36°5'S, 174°5'E, 3.v.1978, *Gardner 1944* (AK); Bay of Islands County, Opito Bay, 35°12'S, 174°3'E, 9.x.1972, *Orchard 3486* (AK); Cavalli Island group, Haraweka Island, 34°58'S, 173°58'E, 3.i.1979, *Wright 3008* (AK); Great Barrier I., Broken Islands, Mahuki Island, 36°14'S, 175°18'E, 2.i.1985, *Wright 6887* (AK). NEW ZEALAND SOUTH I: Botanical Hill, Nelson, 41°16'S, 173°18'E, 17.xi.1980, *Gardner 2777* (AK); Christchurch city, Saint Albans, 43°30'S, 172°39'E, 1.xii.2001, *Sykes s.n.* (AK); Mackay's Bluff, 41°11'S, 173°22'E, 16.xi.1980, *Gardner 2775* (AK); Te Kakaho Island, 40°54'S, 174°6'E, 26.iii.1984, *Wright 6371* (AK). USA. CALIFORNIA: Humboldt Co., Trinidad, 41°3'N, 124°8'W, 11.vi.1911, *Tracy 3238* (UC).

7. *Geranium limae* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 74 (1912)

Type: Peru. Lima, San Lorenzo, July 1836, *Gaudichaud 4* (lectotype, here designated, P!; isolectotypes, G!, US!)

Herbs 8–55 cm tall. Rootstock 8.7–24.4 mm diam., without fusiform roots. Stem erect to ascending, with

patent to retrorse, not appressed, eglandular hairs 0.5–1.2 mm long. Basal leaves in a deciduous rosette; lamina 1.3–5.5 × 1.7–6.6 cm, polygonal in outline, cordate, palmatifid (divided for 0.46–0.78 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 3.6–9 mm at the base (segment width at the base/segment length ratio = (0.20–)0.24–0.32(–0.42)), 3–11-lobed in distal half (second sinus length/middle-segment length ratio = (0.14–)0.24–0.29(–0.34)); petioles to 20 cm long, with patent to retrorse, appressed, eglandular hairs 0.5–1.4 mm long; stipules 2.5–9 × 0.7–3.4 mm, with eglandular hairs on both surfaces and on the margin. Inflorescence with cymules 2-flowered, solitary; peduncles (1.1–)2–3.7(–6.8) cm long, with patent to retrorse, eglandular hairs 0.4–1.6 mm long; bracteoles 2–5.9 × 0.5–1.9 mm, linear-lanceolate, with eglandular hairs on both surfaces and on the margin; pedicels 0.7–2.2 cm long, with patent to retrorse, eglandular hairs 0.4–1.6 mm long; pedicel and peduncle together usually not overtopping the subtending leaf. Sepals (3.5–)4.5–5.5(–6.3) × 1.7–4.2 mm, lanceolate (width/length ratio = (0.36–)0.52–0.65(–0.89), with mucro (0.2–)0.3–0.4(–0.5) mm long (mucro length/sepal length ratio = (0.03–)0.05–0.07(0.09)), with scarious margins 0.1–0.25 mm wide, with erect-patent, eglandular hairs 0.3–1.7 mm long. Petals (5–)5.6–7.5(–8.2) × 2–4.6 mm, entire, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 2.6–4.9 mm long, yellowish, with eglandular hairs 0.1–0.4 mm long on the abaxial side and margin; anthers 0.4–0.8 × 0.3–0.6 mm, unknown colour; pollen unknown colour. Nectaries usually with a tuft of hairs at the top, dorsally glabrous. Gynoecium 3–5 mm long, unknown colour. Fruit 11–21.1 mm long; mericarps 2.7–3.5 × 1.3–2 mm, smooth, with erect-patent, eglandular hairs 0.4–1.1 mm long, brownish; rostrum 7.5–15.4 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.3–1.3 mm long; stigmatic remains 1.1–1.5(–1.8) mm long, with 5 hairy lobes. Seeds 1.8–2.5 × 1.1–1.6 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Peru (Fig. 74).

Habitat: Coastal desert, on hillsides in sandy or rocky areas; 0–2800 m.

Phenology: Flowering (April) July – November.

Illustration: Figure 75.

Notes: *Geranium limae* shares with *G. albicans* and *G. berterioanum* patent hairs on peduncles and pedicels. The differences between *G. limae* and *G. albicans* are indicated under the first species. In

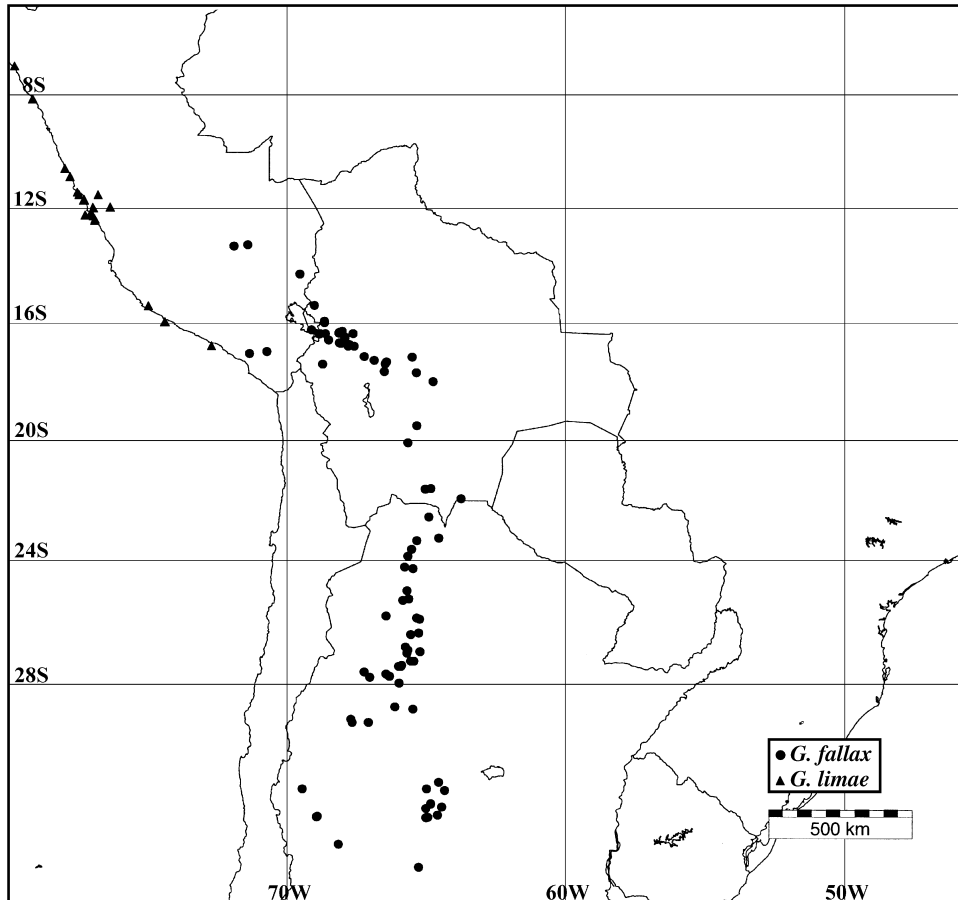


Figure 74. Area of distribution of *Geranium limae* (triangles) and *G. fallax* (dots).

addition, the ranges of *G. limae* and *G. albicans* are completely nonoverlapping. *Geranium limae* has sepals shorter and with a shorter mucro than *G. berterioanum* and hairs of the rostrum are longer than in *G. berterioanum*. The base of the middle segment is wider in *G. limae* than in *G. berterioanum*, and the main sinus of the middle segment is not as deep as in *G. berterioanum*, which gives a less deeply divided appearance to *G. limae* leaves. In *G. limae* nectaries usually have a tuft of hairs at the top, whereas they are always glabrous in *G. berterioanum*. Glandular hairs are always lacking in *G. limae*, whereas they can be present in *G. berterioanum*.

Knuth (1912) indicated, probably by mistake, that Gaudichaud collected the original material of *G. limae* in 1841. Gaudichaud acted as botanist to *La Bonite* during its circumnavigation of the globe in 1836–1837, and the label of the type specimen clearly states ‘Juillet 1836’.

Representative specimens examined: PERU. ANCASH: Santa, lomas de La Chay, 40 km N of Barranca, 10°26’S, 77°57’W, 18.ix.1938, *Stork et al.* 9207 (UC,

GH). AREQUIPA: Camana, ravine N of Atiquipa, 15°47’S, 74°22’W, 20.ix.1938, *Worth & Morison* 15665 (UC, GH); lomas de Atiquipa, cerca de Chala, entre Nazca y Chala, 15°48’S, 74°22’W, 20.x.1946, *Ferreyra* 1493 (MA, GH, US). LA LIBERTAD: cerro Campana, km 565 cerca de Trujillo, 8°0’S, 79°7’W, 18.viii.1952, *Ferreyra* 8620 (MA). LAMBAYEQUE: Chiclayo, Cerro Reque, 6°50’S, 79°46’W, 29.vii.1979, *Llatos* 497 (NY, GH). LIMA: 6 km E of Pachacamac, 12°13’S, 76°52’W, 6.ix.1953, *Saunders* 187 (BM, UC); Amancaes, 12°1’S, 77°1’W, 23.ix.1940, *Asplund* 13754 (S, G, GH); Atocongo, 12°7’S, 76°56’W, 10.xi.1946, *Ferreyra* 1539 (MA); Chancay, 11°33’S, 77°15’W, 24.ix.1952, *Ferreyra* 8750 (MA); Huarochiri, Viso, 11°48’S, 76°19’W, 23.iv.1939, *Goodspeed et al.* 11526 (UC, GH); isla de San Lorenzo, 12°5’S, 77°13’W, .1838, *Wilkes s.n.* (US); lomas de Amancaes, 12°1’S, 77°1’W, 8.x.1955, *Böcher et al.* 349 (C, G, GH); lomas de Lachay, 11°17’S, 77°30’W, 30.x.1976, *Cerrate* 6407 (MA); Lurín, 12°16’S, 76°52’W, 18.viii.1953, *Ferreyra* 9557 (MA); Mangomarca, 24 km NE de Lima, 11°50’S, 76°56’W, 22.vii.1956, *Ferreyra* 11797 (MA).

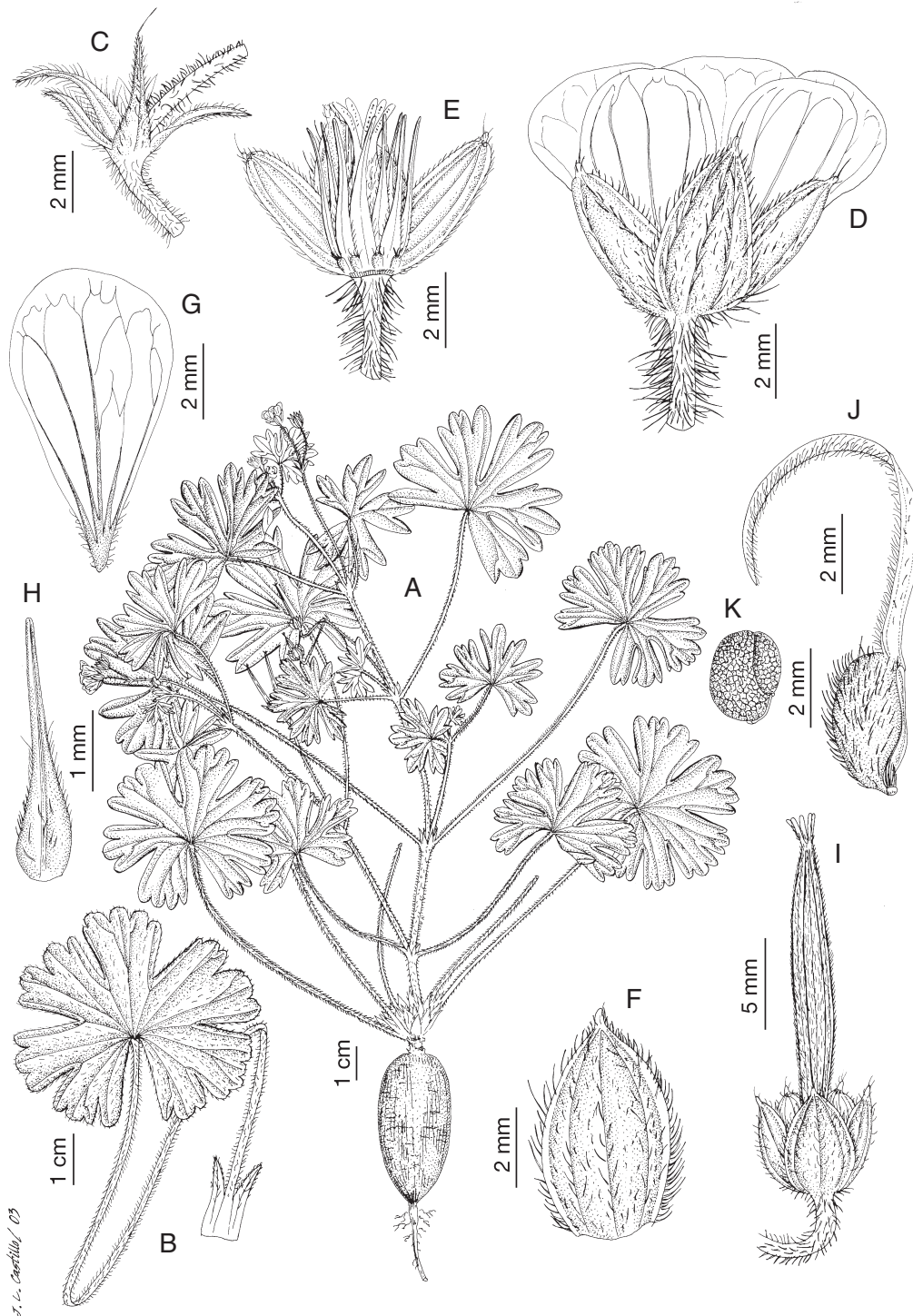


Figure 75. *Geranium limae* R. Knuth. A, habit; B, leaf; C, bracts; D, flower; E, flower without petals; F, sepal; G, petal; H, staminal filament; I, fruit; J, mericarp; K, seed [A–C, I–K: *Asplund 13774* (S); D–H: *Ferreyra 2445* (US).].

8. *Geranium magellanicum* Hook. f., *Fl. Antarct.* 2: 251 (1845)

Type: Chile. Strait of Magalhaens, Elisabeth Island, *Darwin s.n.* (lectotype, here designated, K!)

Herbs 8–34 cm tall. Rootstock 5.9–14.1 mm diam., without fusiform roots. Stem decumbent, with patent to retrorse, appressed, eglandular hairs 0.3–1.4 mm long. Basal leaves in a \pm persistent rosette; lamina

1.12–4.38 × 1.3–4.4 cm, polygonal in outline, cordate, palmatifid (divided for 0.51–0.86 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 1.9–5.2 mm at the base (segment width at the base/segment length ratio = (0.10–)0.17–0.23(–0.28)), 3–9-lobed in distal half (second sinus length/middle-segment length ratio = (0.17–)0.25–0.34(–0.43)); petioles to 14 cm long, with patent to retrorse, appressed, eglandular hairs 0.4–1.4 mm long; stipules 3.6–10.5 × 0.9–3 mm, with eglandular hairs on both surfaces and on the margin. Inflorescence with cymules (1–)2-flowered, solitary (cymules of the basal part of the stem usually 1-flowered, a part of them arise directly from the rootstock, and cymules of the upper part 2-flowered); peduncles (1.3–)2.8–4(–6.9) cm long, with patent to retrorse, appressed, eglandular hairs 0.5–1.2 mm long; bracteoles 3.1–7.2 × 0.6–1.8 mm, linear-lanceolate, with eglandular hairs on both surfaces and on the margin; pedicels 0.54–4.89 cm long, with patent to retrorse, appressed, eglandular hairs 0.5–1.2 mm long; pedicel and peduncle together usually overtopping the subtending leaf Sepals 4.7–6(–6.5) × 1.9–3.4 mm, lanceolate (width/length ratio = (0.33–)0.44–0.51(–0.62)), with mucro (0.2–)0.4–0.5(–1) mm long (mucro length/sepal length ratio = (0.03–)0.07–0.10(–0.16)), with scarious margins 0.2–0.3 mm wide, with erect-patent, eglandular hairs 0.4–1.9 mm long (usually the longest on the margin). Petals (3.9–)6.2–8(11.7) × 2–5.45 mm, entire, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 2.2–4.3 mm long, whitish to yellowish, with eglandular hairs 0.2–0.5 mm long on the abaxial side and margin; anthers 0.4–1 × 0.4–0.8 mm, yellowish; pollen yellow. Nectaries glabrous. Gynoecium 2.9–5 mm long, pinkish. Fruit 15.3–22.2 mm long; mericarps 3–4 × 1.4–2.1 mm, smooth, with erect-patent, eglandular hairs 0.4–1.3 mm long, brownish; rostrum 10.4–16.5 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.2–0.7 mm long; stigmatic remains (1–)1.3–1.7(–2.1) mm long, with 5 hairy lobes. Seeds 2–2.6 × 1.2–1.8 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: South Chile and South Argentina (Fig. 76).

Habitat: Bogs with *Acaena* or *Gunnera*, open grassy slopes, and *Nothofagus* or *Araucaria* forest; 0–1200 m.

Phenology: Flowering November – April.

Illustration: Figure 77.

Notes: *Geranium magellanicum* is easily recognizable by its decumbent habit and its particular inflorescence arrangement. The cymules of the basal part of the

stem are usually 1-flowered, and some of them arise directly from the rootstock. On the middle and upper part of the decumbent stems the cymules are 2-flowered. This inflorescence structure suggests that *G. magellanicum* has a close relationship to *G. sessiliflorum*, and could be a link between sect. *Andina* and sect. *Chilensia*. However, *G. sessiliflorum* never has 2-flowered cymules as *G. magellanicum* does. Additionally, *G. magellanicum* has longer fruits, rostrum, peduncles, pedicels and pedicel indumentum than *G. sessiliflorum*.

The indumentum of *G. magellanicum* on stems, petioles, peduncles and pedicels varies from patent to retrorse appressed, but no specimens with glandular hairs have been found. Moore (1983) included *G. patagonicum* as a synonym of *G. magellanicum*, and consequently considered that *G. magellanicum* can have glandular hairs. Barboza & Correa (1988) and Barboza (1996) excluded glandular specimens from the *G. magellanicum* concept, which is in accordance with the view of this study. *Geranium berteroanum* (which included *G. patagonicum*) can easily be distinguished from *G. magellanicum* by its erect to ascending stems with only 2-flowered cymules, and by its longer sepal mucro. Additionally, Barboza (1996) recognized *G. magellanicum* var. *pumilum*, which is considered here as a different species (*G. parodii*). The differences are discussed under the second species.

Representative specimens examined: ARGENTINA. CHUBUT: río Senguerr, alrededores del lago Blanco, 45°54'S, 71°15'W, .1903, *Koslowsky 12445* (CTES); valle de la Laguna Blanca, 45°52'S, 71°15'W, 12.i.1902, *Koslowsky 71* (Z, BM, CORD, K). RÍO NEGRO: San Carlos de Bariloche, 41°9'S, 71°18'W, 20.ii.1905, *Buchtien 1332* (GH). SANTA CRUZ: Güer-Aike, río Turbio, 51°36'S, 72°17'W, 16.ii.1993, *Roig et al. 14738* (MERL); lago Argentino, ruta nacional 40, 18 km NW del ACA Tres Lagos, orillas río Shehuen, 49°37'S, 71°30'W, 10.ii.1975, *Boelcke et al. 16271* (UC); río Gallegos, Cerro Los Conventos, 51°54'S, 69°21'W, 14.iv.1950, *Sleumer 971* (LIL, G). TIERRA DE FUEGO: Ushuaia, camino de Fique, 54°54'S, 68°13'W, 31.i.1962 (SI); Estancia Cullen, arroya Beta, 52°44'S, 68°33'W, 5.i.1972, *Moore & Goodall 347* (C, SI). CHILE. AISÉN: cerca río Coyhaique, 45°33'S, 72°4'W, 11.ii.1974, *Navas s.n.* (CONC). LA ARAUCANIA: Cautín, Victoria, along the road to the Termas, 400 m from hotel Tolhuaca, 38°13'S, 72°20'W, 14.iii.1939, *Morrison & R. Wagenknecht 17516* (BH, G, GH, MO, S, UC); volcán Llaima, estación de esquí Las Araucarias, 38°41'S, 71°50'W, 22.xii.2001, *Aedo 7224* (MA, CONC). LOS LAGOS: Quilquico, 42°28'S, 73°42'W, 15.xii.1944, *Acevedo s.n.* (SGO). MAGALLANES: Elisabeth Island, 52°52'S, 70°43'W, *Thomson s.n.* (E); Patagonia, isla Contramaestre, 52°57'S, 70°21'W, 17.xii.1970, *Pisano*

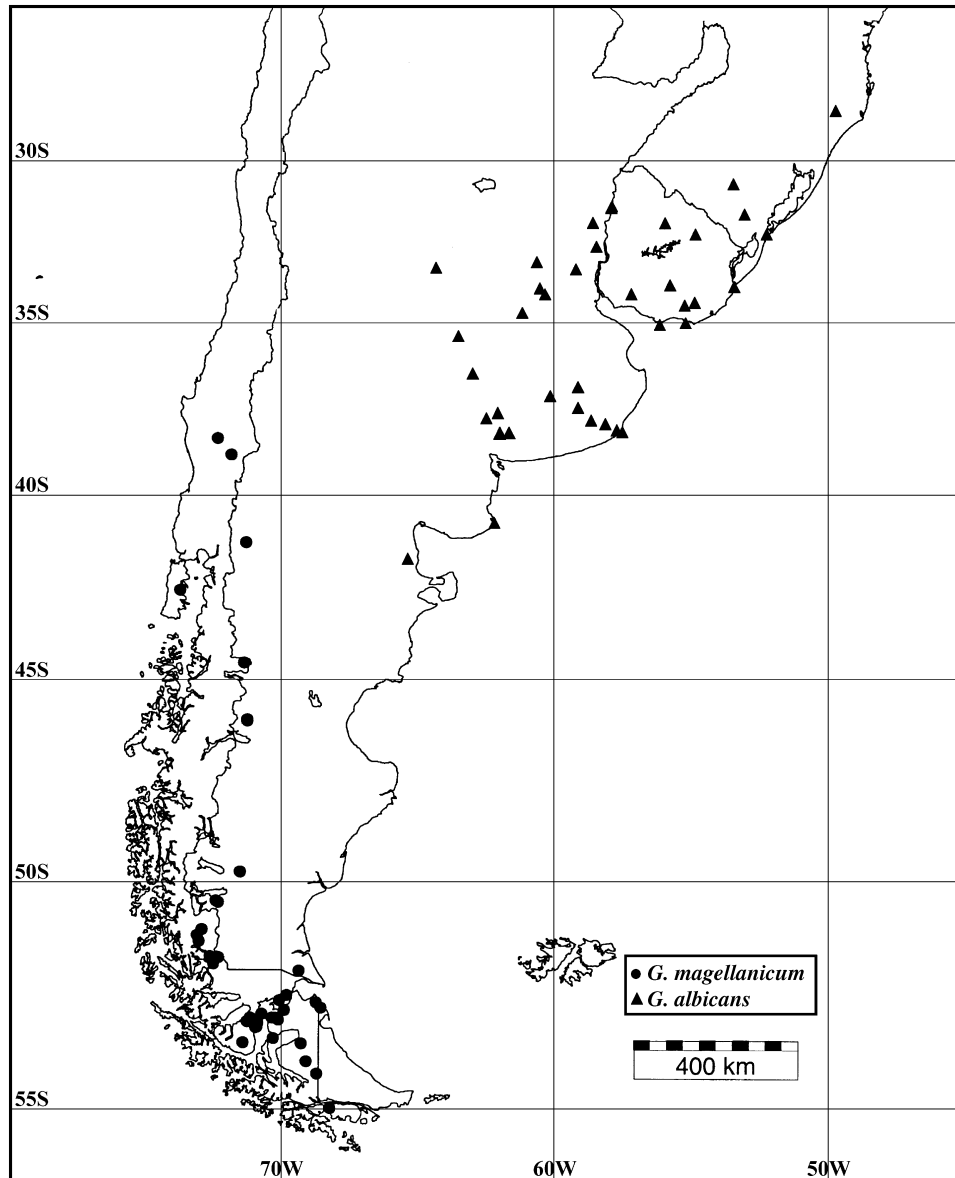


Figure 76. Area of distribution of *Geranium magellanicum* (dots) and *Geranium albicans* (triangles).

2907 (MO, CONC); península de Brunswick, camino del Club Andino, 53°30'S, 71°24'W, 8.i.1980, *Dollenz 635* (GH); pr. Puerto Natales, 51°35'S, 72°36'W, 19.i.2002, *Aedo 7471* (MA, CONC); Puerto Natales, P.N. Torres del Paine, hostería Pehoe, 51°6'S, 73°4'W, 4.xi.1990, *Rico 7242* (MA); Río Seco, en la playa, 53°4'S, 70°52'W, 29.i.1964, *Álvarez 50* (CONC); río Tres Paragos al S of Punta Arenas, 53°9'S, 70°57'W, 1.iii.1917, *Bonarelli s.n.* (SI); Sandy Point, 53°10'S, 70°56'W, 16.iii.1872, *Blake s.n.* (GH). TIERRA DE FUEGO: bahía de San Gregorio, 52°27'S, 69°48'W, 17.i.2002, *Aedo 7449* (MA, CONC); Barrancas del Carmen Sylva, 53°54'S, 69°5'W, 5.ii.1896, *Dusén 455* (UPS, LD, S); pr. Porvenir, puente Barguetto, 53°0'S,

70°7'W, 17.i.2002, *Aedo 7445* (MA); río Santa María a 60 km, camino S, 53°24'S, 70°18'W, 10.ii.1972, *Pisano 3540* (GH, CONC).

9. *Geranium albicans* A. St.-Hil., Fl. Bras. Merid. 1: 83 (1825)

Type: Brazil. Rio Grande do Sul, Giribatubà, *Saint Hilaire 1897 bi* (lectotype, here designated, P!)

Geranium rotundifolium var. *americanum* A. St.-Hil. & Naudin in Ann. Sci. Nat., Bot. (Paris) ser. 2, 18: 25 (1842)

Type: Brazil. Rio Grande do Sul, Giribatubà, *Saint Hilaire 1895* (lectotype, here designated, P!)

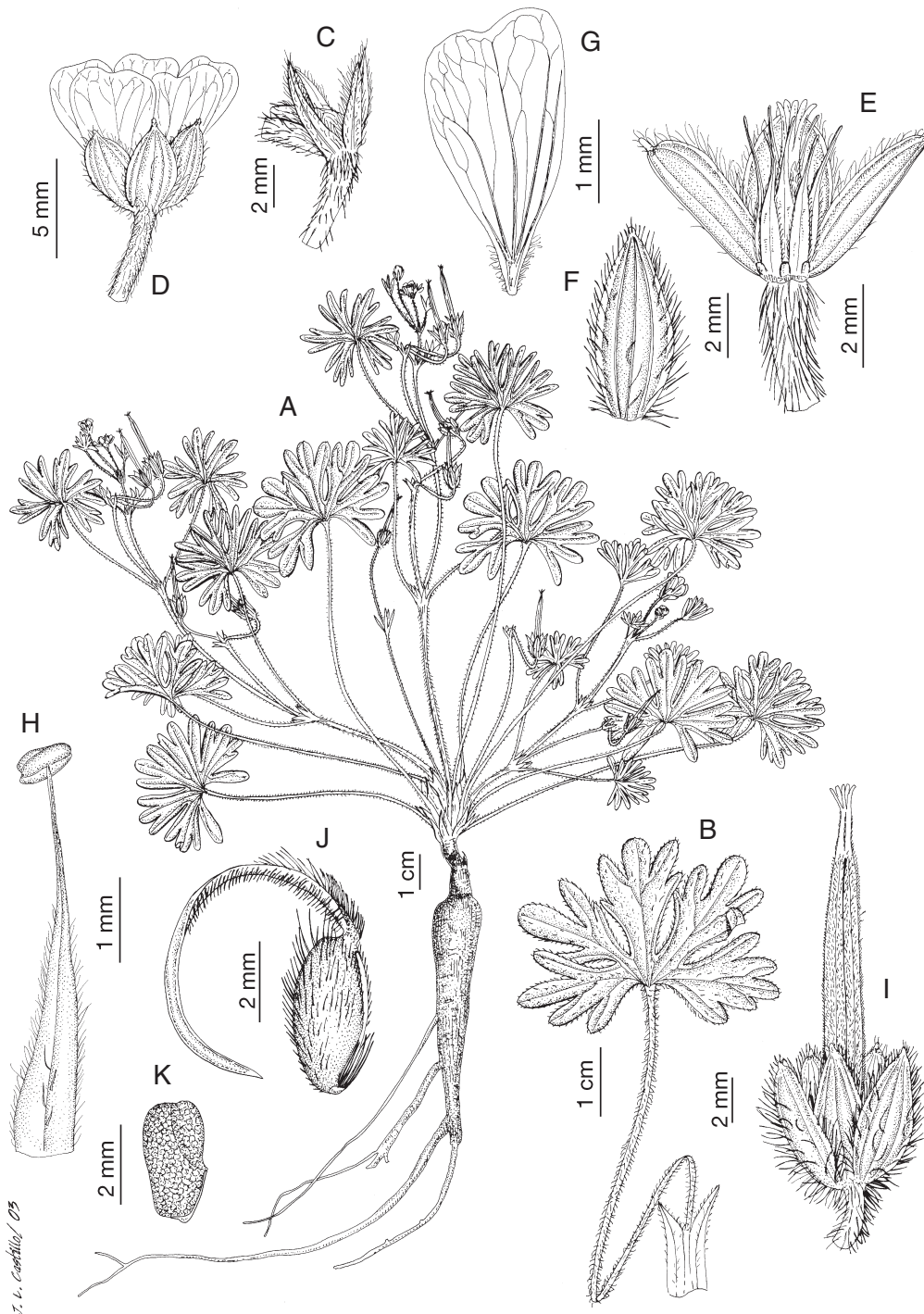


Figure 77. *Geranium magellanicum* Hook. f. A, habit; B, leaf; C, bracts; D, flower; E, flower without petals; F, sepal; G, petal; H, stamen; I, fruit; J, mericarp; K, seed [A–K: Högborg s.n. (S).].

Geranium selloi Aedo & Muñoz Garm., Kew Bull. 52(3): 726 (1997). *Geranium senecioides* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 73 (1912) [syn. subst.], nom. illeg., non Dump. Course. (1802) Type: Brazil. [without locality] Sellow 4022 (lecto-type, here designated, S!; isolectotype, LE!)

Herbs 18–41 cm tall. Rootstock 5.9–17.4 mm diam., without fusiform roots. Stem erect to ascending, with patent, eglandular hairs 1–2.2 mm long. Basal leaves in a ± persistent rosette; lamina 1.6–4.2 × 1.8–5 cm, polygonal in outline, cordate, palmatifid (divided for 0.49–0.77 of its length), pilose, with ± appressed,

eglandular hairs; segments 5–7, rhombic, 2.1–8 mm at the base (segment width at the base/segment length ratio = 0.16–0.24(–0.29)), 7–12-lobed in distal half (second sinus length/middle-segment length ratio = (0.25–)0.32–0.41); petioles to 12 cm long, with patent, eglandular hairs 0.9–2.2 mm long; stipules 2–7 × 0.3–1.5 mm, with eglandular hairs on both surfaces and on the margin. Inflorescence with cymules 2-flowered, solitary; peduncles (0.36–)0.65–1.8(–3.1) cm long, with patent, eglandular hairs 0.7–1.9 mm long; bracteoles 1.6–4.8 × 0.4–1 mm, linear-lanceolate, with scattered eglandular hairs on both surfaces and on the margin; pedicels 0.5–3.6 cm long, with patent, eglandular hairs 0.7–1.9 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals (4.2–)5–5.6(–6.5) × 2.3–3.8 mm, lanceolate (width/length ratio = 0.50–0.61(–0.66)), with mucro (0.2–)0.25–0.40(–0.6) mm long (mucro length/sepal length ratio = (0.03–)0.04–0.08(–0.11)), with scarios margins 0.1–0.2 mm wide, with erect-patent, eglandular hairs 0.5–1.5 mm long. Petals (4–)4.5–5.1(–6.1) × 1.7–3 mm, entire or slightly notched, without claw, glabrous on both sides, ciliate on the basal margin, purplish, sometimes white. Filaments 2–3.8 mm long, yellowish, with eglandular hairs 0.2–0.3 mm long on the abaxial side and margin; anthers 0.4–0.7 × 0.3–0.5 mm, unknown colour; pollen of unknown colour. Nectaries glabrous. Gynoecium 2.5–4.3 mm long, unknown colour. Fruit 14–18.9 mm long; mericarps 2.5–3.3 × 1.4–1.9 mm, smooth, with erect-patent, eglandular hairs 0.4–1.4 mm long, brownish; rostrum 9.6–14.8 mm long, without a narrowed apex, with patent, eglandular hairs 0.4–1.3 mm long; stigmatic remains 1–1.4(–2) mm long, with 5 hairy lobes. Seeds 1.2–2.2 × 1–1.4 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: South Brazil, Uruguay and north-east Argentina (Fig. 76).

Habitat: Roadsides, open, sandy grounds, or grasslands; 50–940 m.

Phenology: Flowering September – December.

Illustration: Figure 78.

Notes: *Geranium albicans* is characterized by its peduncles and pedicels with eglandular patent hairs, its short petals and its short sepal mucro. Leaves are densely hairy and the main leaf segment has a rhombic outline. *Geranium albicans* is sometimes confused with eglandular forms of *G. berterioanum*. However, *G. berterioanum* has longer petals and an obtriangular main leaf segment, as well as a longer sepal mucro and shorter hairs on the peduncles and pedicels.

G. core-core, a species also present in the area of *G. albicans*, has shorter hairs on the stem, relatively wider sepals and retrorse-appressed hairs on pedicels.

Representative specimens examined: ARGENTINA. BUENOS AIRES: along road to Balcarce, 10 km N of Mar del Plata, 38°0'S, 57°32'W, 11.xii.1938, *Eyerdam et al.* 23628 (GH, UC); Junín, 34°30'S, 61°12'W, 15.x.1929, *Lahitte & Clos* 241 (FI); laguna de los Padres, 37°57'S, 57°44'W, .xi.1913, *Valentini* 32 (SI); Pellegrini, Salliquedó, estancia Los Gossos, 36°19'S, 63°0'W, 10.xi.1943, *Cabrera* 8017 (LP, SI); Pigüé, 37°28'S, 62°5'W, 10.xi.1932, *Burkart* 4707 (SI). CÓRDOBA: Río Cuarto, 33°8'S, 64°21'W, 10.xii.1908, *Stuckert* 19428 (CORD). ENTRE RÍOS: Concordia, arroyo Ayui, 31°16'S, 57°57'W, 23.ix.1977, *Troncoso et al.* 2090 (NY); Gualeguay, Estancia San Ambrosio, 33°10'S, 59°14'W, 21.x.1949, *Burkart* 18089 (CTES); Villaguay, Jubileo, 31°44'S, 58°37'W, 24.x.1961, *Pedersen* 6313 (US, C, L). LA PAMPA: Chapaleufu, 35°12'S, 63°32'W, 30.xi.1983, *Steibel & Troiani* 7716 (CORD). RÍO NEGRO: San Antonio, extremo N de Sierra Grande, frente a Pueblo Viejo, 41°35'S, 65°22'W, 21.x.1979, *Correa et al.* 7111 (UC). SANTA FE: Arroyo Frias, 32°57'S, 60°40'W, 15.i.1949, *Morello* 4027 (SI). BRAZIL. RIO GRANDE DO SUL: 4 km E de Piratini, 31°27'S, 53°5'W, 11.x.1972, *Lindeman et al.* 20673 (U, CTES); near Caçapava do Sul, 30°30'S, 53°30'W, 9.xi.1977, *Pedersen* 11965 (L, C, GH); Quinta, pr. Rio Grande, 32°4'S, 52°16'W, 8.xi.1901, *Malme* 269 (S). SANTA CATARINA: 9 km N de Cruzeiro, 26 km NE de Sao Joaquim, 28°9'S, 49°45'W, 25.xii.1982, *Krapovicás & Schinini* 38296 (CTES). URUGUAY. CERRO LARGO: Cerro Largo, Río Negro, Palleros, 32°5'S, 54°52'W, .xii.1937, *Gallinal et al.* 1343 (F). FLORIDA: Timote, Santa Clara, 33°39'S, 55°47'W, 8.x.1943, *Gallinal et al.* 5290 (MA, MO, US, U). LAVALLEJA: estancia Pororó, 34°10'S, 54°54'W, 2.xii.1955, *Pedersen* 3588 (C). MALDONADO: ruta 12, entre Pan de Azucar y Minas, 34°47'S, 55°14'W, 12.x.1963, *Arrillaga et al.* 1616 (F). MONTEVIDEO: Montevideo, 34°50'S, 56°10'W, *Saint Hilaire s.n.* (MPU). SORIANO: Juan Jackson, Monzón-Heber, 33°55'S, 57°12'W, .x.1943, *Gallinal et al.* 5354 (MA, NY).

10. *Geranium skottsbergii* R. Knuth in Repert. Spec. Nov. Regni Veg. 34: 143 (1933)

Type: Chile. Coquimbo, estancia Fray Jorge, 13 Aug. 1917, *Skottsberg* 752 (holotype, B†; isotype, S!) [30°40'S, 71°37'W]

Geranium ciliatum Phil. in Anales Univ. Chile 82: 727 (1893) [syn. subst.], nom. illeg., non Cav. (1787). *Geranium berterioanum* var. *ciliatum* Reiche in Anales Univ. Chile 93: 578 (1895). *Geranium philippii* J.F. Macbr. in Candollea 6: 7 (1934). *Geranium berterioanum* var. *philippii*

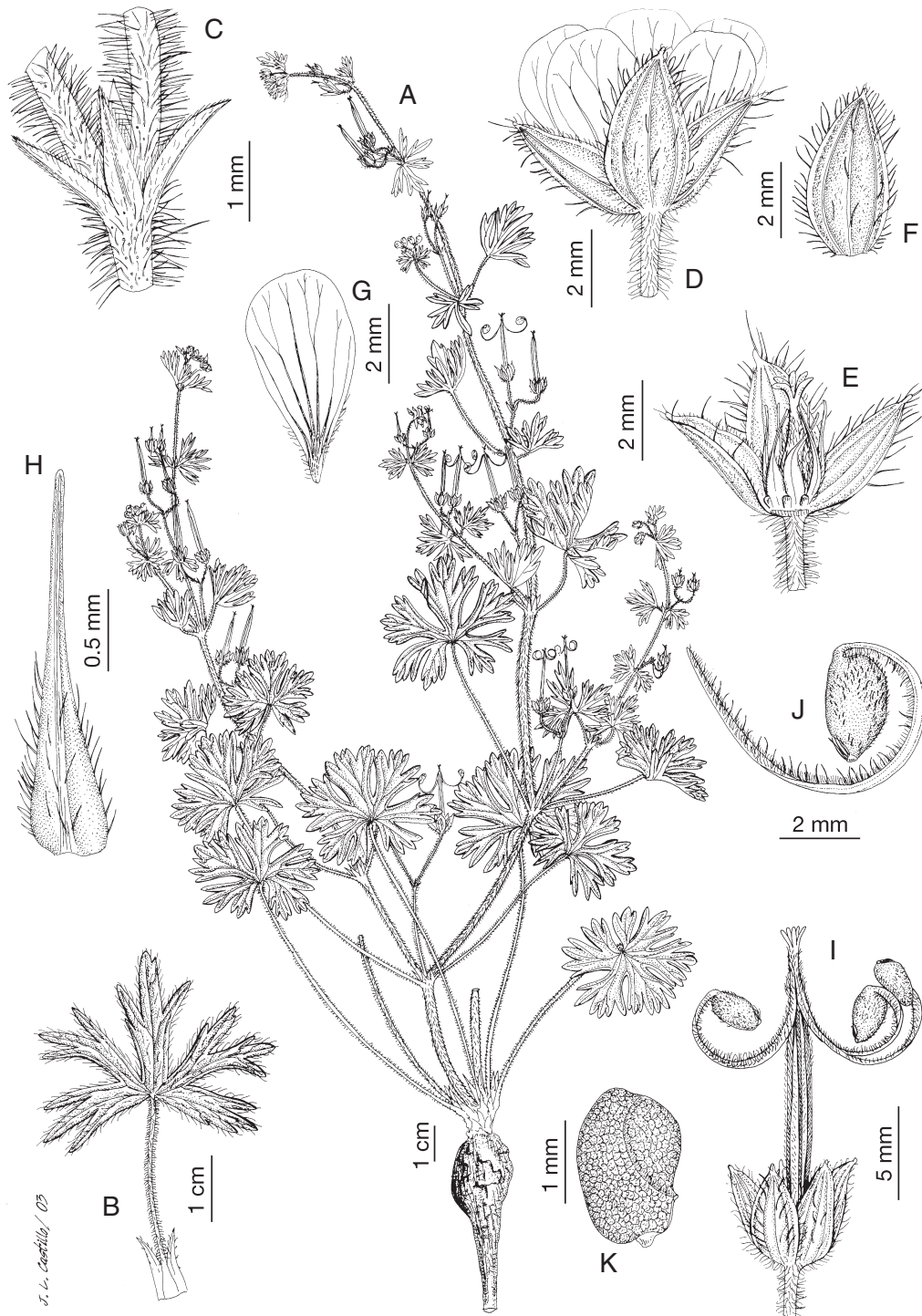


Figure 78. *Geranium albicans* A. St.-Hil. A, habit; B, leaf; C, bracts; D, flower; E, flower without petals; F, sepal; G, petal; H, staminal filament; I, fruit; J, mericarp; K, seed [A–C, I–K: Wall & Sparre 209 (S); D–H: Pedersen 4756 (C)].

(J.F. Macbr.) L.E. Navas, Fl. Cuenca Santiago Chile 2: 230 (1976)

Type: Chile. Santiago 1856, *Philippi s.n.* (lectotype, here designated, MA!; isolectotypes, K!, W!)

Herbs 33–70 cm tall. Rootstock 7–17 mm diam., without fusiform roots. Stem erect to ascending, with patent to retrorse, appressed, eglandular hairs 0.3–1.7 mm long, and, sometimes, patent, glandular

hairs 0.3–1.2 mm long. Basal leaves in a \pm deciduous rosette; lamina 2.5–7.2 \times 2.7–8.2 cm, polygonal in outline, cordate, palmatifid (divided for 0.6–0.9 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 2.4–7.2 mm at the base (segment width at the base/segment length ratio = (0.06–)0.10–0.19(–0.23)), 3–10-lobed in distal half (second sinus length/middle-segment length ratio = (0.31–)0.40–0.53(–0.57)); petioles to 38 cm long, with patent to retrorse, appressed, eglandular hairs 0.4–2 mm long, and, sometimes, patent, glandular hairs 0.3–1.2 mm long; stipules 3.6–9 \times 0.6–2 mm, with eglandular hairs on both surfaces and on the margin. Inflorescence with cymules 2-flowered, solitary; peduncles (0.7–)1.8–4(–5.5) cm long, with patent to retrorse, appressed, eglandular hairs 0.4–1.5 mm long, and, sometimes, patent, glandular hairs 0.3–1.4 mm long; bracteoles 2.3–6.1 \times 0.5–1.1 mm, linear-lanceolate, with eglandular hairs on both sides and on the margin; pedicels 1–3.1 cm long, with patent to retrorse, appressed, eglandular hairs 0.4–1.5 mm long, and, sometimes, patent, glandular hairs 0.3–1.4 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals 5–6(–8) \times 2.1–3.8 mm, lanceolate (width/length ratio = (0.37–)0.43–0.57(–0.63)), with mucro (0.4–)0.7–0.9(–1.2) mm long (mucro length/sepal length ratio = (0.08–)0.11–0.16(–0.22)), with scarios margins 0.1–0.15 mm wide, with erect-patent, eglandular hairs 1.1–2.2 mm long (usually the longest on the margin), and sometimes, patent, glandular hairs 0.3–1.4 mm long. Petals (7–)7.9–10.2(–14) \times 4–7.2 mm, entire or slightly notched, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 3.1–4.5 mm long, whitish to yellowish, with eglandular hairs 0.2–0.4 mm long on the abaxial side and margin; anthers 0.4–1.1 \times 0.4–0.9 mm, yellowish or purplish; pollen yellow. Nectaries glabrous. Gynoecium 3–7 mm long, whitish to pink. Fruit 15.3–20.1 mm long; mericarps 2.5–3.3 \times 1.3–2 mm, smooth, with erect-patent, eglandular hairs 0.3–1.2 mm long, brownish; rostrum 10.4–15.3 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.3–1.5 mm long, and, sometimes patent glandular hairs 0.2–1.3 mm long; stigmatic remains 1–1.6(–2.3) mm long, with 5 hairy lobes. Seeds 1.7–2.5 \times 1.1–2 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Central Chile (Fig. 79).

Habitat: Dunes, dry grassy slopes, shrublands, and *Peumus* forests; 0–1300 m.

Phenology: Flowering January – December.

Illustration: Figure 80.

Notes: *Geranium skottsbergii* is easily distinguished by its deeply divided leaves with narrow lobes and relatively long petals. Some specimens have only eglandular hairs on the stem, petioles and pedicels, sometimes retrorse and appressed, sometimes more or less patent. There are also specimens with particularly long hairs on the sepal margin. Additionally, plants with glandular and eglandular hairs are present over the entire area of this species. *Geranium skottsbergii* is endemic to central Chile, where it may be confused with *G. berterioanum*, which has shorter petals and less divided leaves. *Geranium core-core*, which is also present in this area, has leaves that are less divided than *G. skottsbergii*, stems with shorter hairs, a shorter gynoecium and relatively wider sepals.

Representative specimens examined: CHILE. AISEN: Chile australis, Los Sauces, 8.viii.1896, *Dusén 319* (S). COQUIMBO: Cuesta de Cavilolén, 31°45'S, 71°19'W, 11.xi.2001, *Aedo 6842* (MA); Limarí, P.N. Fray Jorge, Quebrada El Mineral, 30°40'S, 71°38'W, 9.viii.1948, *Jiles 682* (CONC); Llanos, Quebrada el Teniente, 32°8'S, 71°39'W, 10.ix.1942, *Muñoz & Pisano 3385* (SGO); Pichidangui, 32°9'S, 71°30'W, 11.xi.2001, *Aedo 6832* (MA). LA ARAUCANIA: Cautín, Cunco, 38°55'S, 72°2'W, .i.1931, *Barros 24699* (CONC); Cautín, Temuco, 38°44'S, 72°36'W, .xii.1946, *Gunckel 36602* (CONC); Purén, 38°1'S, 73°5'W, 1.xi.1945, *Montero 4679* (CONC); Traiguén, 38°15'S, 72°40'W, 2.xi.1952, *Salazar s.n.* (CONC). MAULE: Baños de Cauquenes, 35°58'S, 72°21'W, .1875, *Dessauer s.n.* (M); Constitución, 35°20'S, 72°25'W, .ix.1958, *Barnier 286* (CONC); Zarral, Linares, Villanueva, Cerro Alto de Caliboro, 35°51'S, 71°36'W, 12.x.1955, *Aravena 16* (CONC). O'HIGGINS: montis La Leona, Rancagua, 34°30'S, 71°4'W, .v.1818, *Bertero 294* (P); San Fernando, Centinela, 34°20'S, 71°28'W, .x.1929, *Montero 1599* (CONC); San Fernando, cerro Echaurreina, 34°32'S, 71°1'W, 22.x.1929, *Montero 1597* (CONC). SANTIAGO: cerro de Renca, Santiago, 33°24'S, 70°45'W, .ix.1878, *Philippi s.n.* (SGO); Cerro Manquehue, 33°21'S, 70°36'W, 10.ix.1949, *Rodríguez s.n.* (CONC); Cerro San Cristobal, 33°25'S, 70°39'W, 16.ix.1917, *Skottsberg 974* (S); El Tabo, Quebrada Córdoba, 33°27'S, 71°41'W, .x.1964, *Gunckel 42784* (CONC); entre Culiprán y Melipilla, 33°48'S, 71°18'W, .x.1958, *Bailey s.n.* (SGO). VALPARAÍSO: 3 km al S de Papudo, 32°31'S, 71°28'W, 10.xi.2001, *Aedo 6824* (MA); Aconcagua, bei Zapallar, 32°34'S, 71°27'W, 29.viii.1971, *Zöllner 5164* (L); Cachagua, Quebrada El Tigre, 32°37'S, 71°26'W, 27.ix.1971, *Covarrubias s.n.* (SGO); Catapilco, 32°33'S, 71°16'W, .ix.1865, *Philippi s.n.* (SGO); Concón, 32°55'S, 71°32'W, .x.1884, *Philippi s.n.* (SGO).

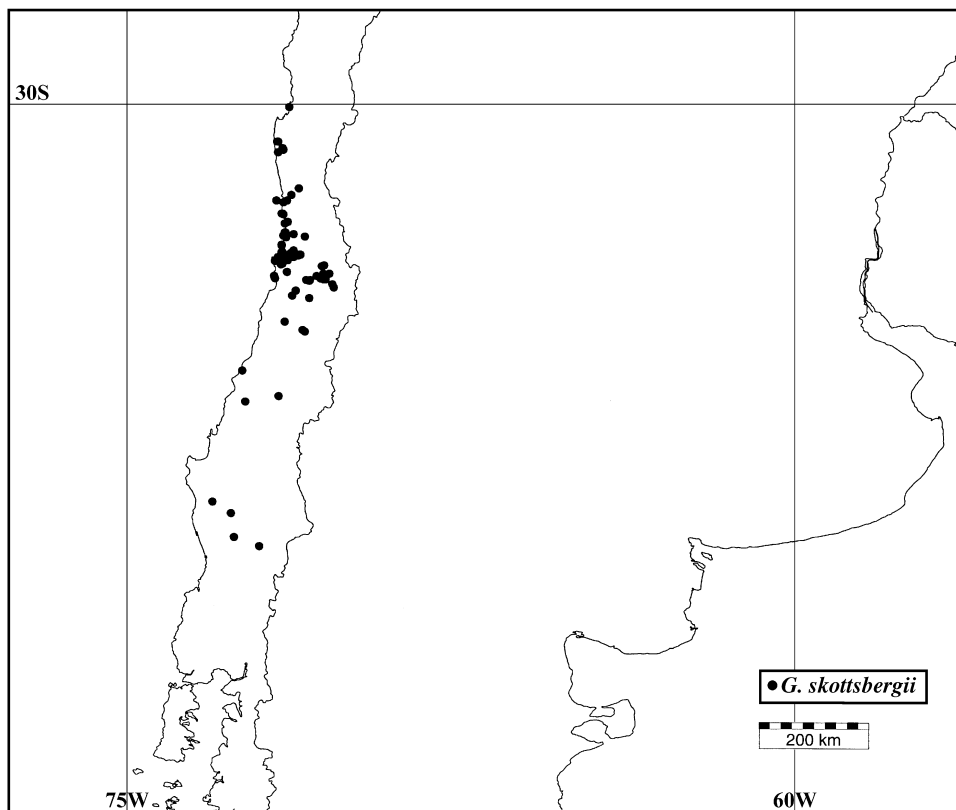


Figure 79. Area of distribution of *Geranium skottsbergii*.

11. *Geranium core-core* Steud. in Flora 39(28): 438 (1856), *nom. cons. prop.*
 Type: Chile. Quillota, *Bertero 1018* (lectotype, designated by Aedo, 2004; P!; isolectotype, G! MO!)
Geranium rapulum A. St.-Hil. & Naudin in Ann. Sci. Nat., Bot. (Paris) ser. 2, 18: 25 (1842), *nom. rej. prop.*
 Type: Brazil. Rio Grande do Sul, *Gaudichaud 1204* (lectotype, designated by Aedo, 2004; P!; isolectotype, K!)
Geranium commutatum Steud. in Flora 39(28): 439 (1856)
 Type: Chile. prope urbem Valdivia, *Lechler 259* (lectotype, here designated, W!; isolectotype, FI photo! K! LE! P!)
Geranium ochsenii Phil. in Linnaea 28: 676 (1856). *Geranium commutatum* var. *ochsenii* (Phil.) Reiche in Anales Univ. Chile 93: 577 (1895)
 Type: Chile. Los Lagos, Valdivia, San Juan, *Philippi s.n.* (lectotype, here designated, W!; isolectotypes, LE!, SGO-51240!, photo P!)
Geranium moorei Phil. in Anales Univ. Chile 82: 728 (1893)
 Type: Chile. Maule, Curicó, Todos los Santos, September 1882, *E. Moore s.n.* (lectotype, here designated, SGO-40572!, photo P!)

- Geranium squamosum* Phil. in Anales Univ. Chile 82: 733 (1893)
 Type: Chile. BíoBío, Talcahuano, pr. San Vicente, *Philippi s.n.* (lectotype, here designated, SGO-51249!)
Geranium melanopotamicum Speg. in Anales Mus. Nac. Hist. Nat. Buenos Aires ser. 2, 4: 254 (1902)
 Type: Argentina. Río Negro, Carmen de Patagones, Feb. 1898, *Spegazzini s.n.* (lectotype, here designated, LP digital image!; isolectotype, LPS photocopy!)
Geranium argentinum R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 77 (1912)
 Type: Argentina. Córdoba, San Francisco 1871, *Lorentz 271* (lectotype, here designated, CORD digital image!; photograph of B specimen, F! G! GH!)
Geranium subsericeum R. Knuth. in Engl., Pflanzenr. IV.129 (Heft 53): 49 (1912)
 Type: Argentina. Río Negro, 21.xi.1874, *Berg 39* (lectotype, here designated, LP digital image!)
Geranium herrerae R. Knuth in Repert. Spec. Nov. Regni Veg. 28: 1 (1930)
 Type: Peru. Moquegua, Torata, 17–18.iii.1925, *Weberbauer 7479* (neotype, here designated, F!; isotypes, G! K! NY! S!)

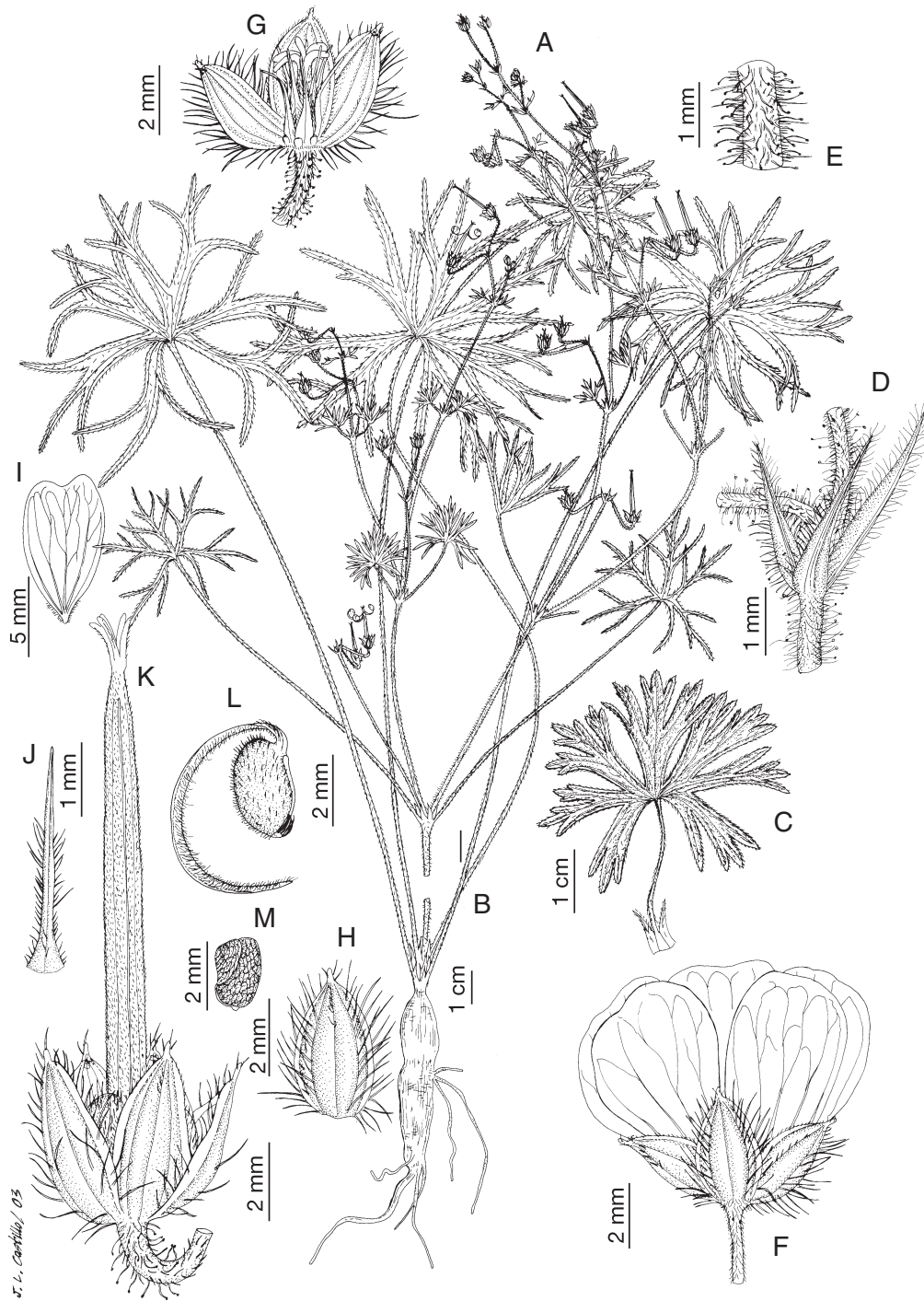


Figure 80. *Geranium skottsbergii* R. Knuth. A–B, habit; C, leaf; D, bracts; E, peduncle; F, flower; G, flower without petals; H, sepal; I, petal; J, staminal filament; K, fruit; L, mericarp; M, seed [A, F, H–J, L–M: Aedo 6807 (MA); B: Aedo 6832 (MA); C–E, G, K: Aedo 6839 (MA)].

Herbs 15–75 cm tall. Rootstock 4–18.1 mm diam., without fusiform roots. Stem erect to ascending, with retrorse, appressed, eglandular hairs 0.2–0.5 mm long. Basal leaves in a deciduous rosette; lamina 1.56–

4.75 × 1.7–5.6 cm, polygonal in outline, cordate, palmatifid (divided for 0.57–0.79 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 2–8.5 mm at the base (segment width at the base/

segment length ratio = (0.14–)0.18–0.27(–0.31)), 3–11-lobed in distal half (second sinus length/middle-segment length ratio = (0.18–)0.25–0.37(–0.39)); petioles to 17 cm long, with retrorse, appressed, eglandular hairs 0.2–0.5 mm long; stipules 3.5–8.2 × 0.5–2.5 mm, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Inflorescence with cymes 2-flowered, solitary; peduncles (0.6–)1.3–2.8(–5.1) cm long, with retrorse, appressed, eglandular hairs 0.2–0.6 mm long; bracteoles 2–4.5 × 0.4–0.9 mm, linear-lanceolate, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 1.1–3.1 cm long, with retrorse, appressed, eglandular hairs 0.2–0.6 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals 3–4.2(–5.5) × 2–4.3 mm, ovate (width/length ratio = (0.60–)0.62–0.76(–0.84)), with mucro (0.4–)0.6–0.9(–1.1) mm long (mucro length/sepals length ratio = (0.07–)0.13–0.20(–0.32)), with scarious margins 0.1–0.2 mm wide, with antrorse, ± appressed, eglandular hairs 0.1–1.1 mm long on the abaxial side, glabrous adaxially. Petals (3.1–)4.1–6(–7.1) × 1.7–3.5 mm, entire or slightly notched, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 1.8–3.7 mm long, whitish, glabrous on both sides, ciliate on the basal margin, with hairs up to 0.1–0.2 mm long; anthers 0.3–0.8 × 0.3–0.6 mm, whitish to pink; pollen yellow. Nectaries glabrous. Gynoecium 2.3–4 mm long, whitish. Fruit 9.5–19 mm long; mericarps 2.6–3.2 × 1.2–2.3 mm, smooth, with erect-patent, eglandular hairs 0.2–1.4 mm long, brownish; rostrum 9.1–14.5 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.1–0.7 mm long; stigmatic remains (0.9–)1.1–1.2(–1.5) mm long, with 5 hairy lobes. Seeds 1.8–2.9 × 1–1.6 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Ecuador, Peru, Bolivia, South Brazil, Chile and Argentina; introduced in Great Britain and USA (California) (Fig. 81).

Habitat: Roadsides, cultivated grounds, beaches, grassy hillsides, along water courses, or shrublands; 0–4000 m.

Phenology: Flowering January – December.

Illustration: Figure 82.

Notes: *Geranium core-core* is a species native to South America and readily distinguishable by its peduncles and pedicels with retrorse-appressed, eglandular hairs, by its leaves not deeply divided and short petals. It is quite similar to *G. retrorsum*, a species from Australia and New Zealand. The most noticeable differ-

ence is the sepal shape: *G. retrorsum* has lanceolate sepals (low width/length ratio), whereas *G. core-core* has broadly ovate sepals (high width/length ratio). Additionally, *G. core-core* has longer fruits and a longer rostrum than *G. retrorsum*.

Two sheets with original material (*Bertero 1018*) of *G. core-core* are kept at G. One of them is *G. core-core*, and the other is *G. skottsbergii*. Following our typification the first becomes the isolectotype of *G. core-core*, while the second should be excluded from the type concept of this species. The type of *G. herrerae* was destroyed during World War II, and no duplicate of this collection has been found. Thus we have selected as the neotype a collection by Weberbauer also from south Peru, which was handwritten by Knuth as *G. herrerae*. *Geranium rapulum* was published 14 years before *G. core-core*, but was never used in major publications. On the contrary, *G. core-core* has been used in many floristic publications from Chile and Argentina. Therefore it has been proposed that the name *G. core-core* be conserved in order to maintain nomenclatural stability (Aedo, 2004).

Representative specimens examined: ARGENTINA. BUENOS AIRES: Villarino, 60 km W de Pedro Luso, 39°0'S, 62°45'W, .xii.1964, *Fabris 5614* (LP). CHUBUT: de Esquel a Trevelín, 43°4'S, 71°28'W, 57.ii.1944, *Nicora 3843* (SI); Los Rápidos, 42°10'S, 71°39'W, 24.i.1945, *Castellanos 151* (K). Córdoba: Calamochita, río San Miguel, camino a Yacanto, 31°43'S, 64°47'W, 22.i.1969, *Krapovickas & Cristobal 14672* (SI); El Salto, cañada del río Los Chorrillos, Sierras de Córdoba, 32°7'S, 64°13'W, 27.xi.1939, *Bridasoli 264* (LP). MENDOZA: Capital, 32°53'S, 68°49'W, 29.x.1933, *Ruiz Leal s.n.* (MERL); Chacras de Coria, 33°0'S, 68°52'W, 12.iv.1954, *Ruiz Leal 643* (MERL). NEUQUÉN: Aluminé, 39°13'S, 70°56'W, 4.xii.1979, *Söyrinki s.n.* (H); Huiliches, Quilquihue, 40°3'S, 71°7'W, 9.ii.1966, *Ruiz Leal 24635* (CORD). RÍO NEGRO: Bariloche, lago Nahuel Huapí, 41°2'S, 71°8'W, .1926, *Edwards s.n.* (BM); Choele Choel, 39°18'S, 65°39'W, .ii.1948, *Burkart 15905* (SI). SAN JUAN: Calingasta, 31°20'S, 69°24'W, .xi.1941, *Rodrigo 3038* (LP); Zonda, Estancia Maradona, Puesto La Ciénaga, 31°32'S, 68°44'W, 22.i.1986, *Guaglianone et al. 1407* (SI). SANTA CRUZ: Puesto San Julián, 49°17'S, 67°43'W, .vii.1925, *Blake 33* (BM, K). BOLIVIA. COCHABAMBA: between monte Puncu and Sehuencas, 17°31'S, 65°13'W, 4.ii.1995, *Wood 9304* (LPB); Pocona, 16°19'S, 70°43'W, 10.xi.1978, *Steinbach 8669* (K, BM, E, G, GH, NY, S). LA PAZ: Calacoto, 16°31'S, 68°5'W, 1.i.1957, *Cañigüeral 229* (LPB); Inquisivi, Quime Lower Bridge, near the lower bridge in Quime about 0.5 km W of Hospital San Antonio, 16°59'S, 67°13'W, 23.xi.1987, *Lewis 871073* (LPB, MO). BRAZIL. without locality, .1815, *Sellow* (BM). CHILE. AISÉN: Chile

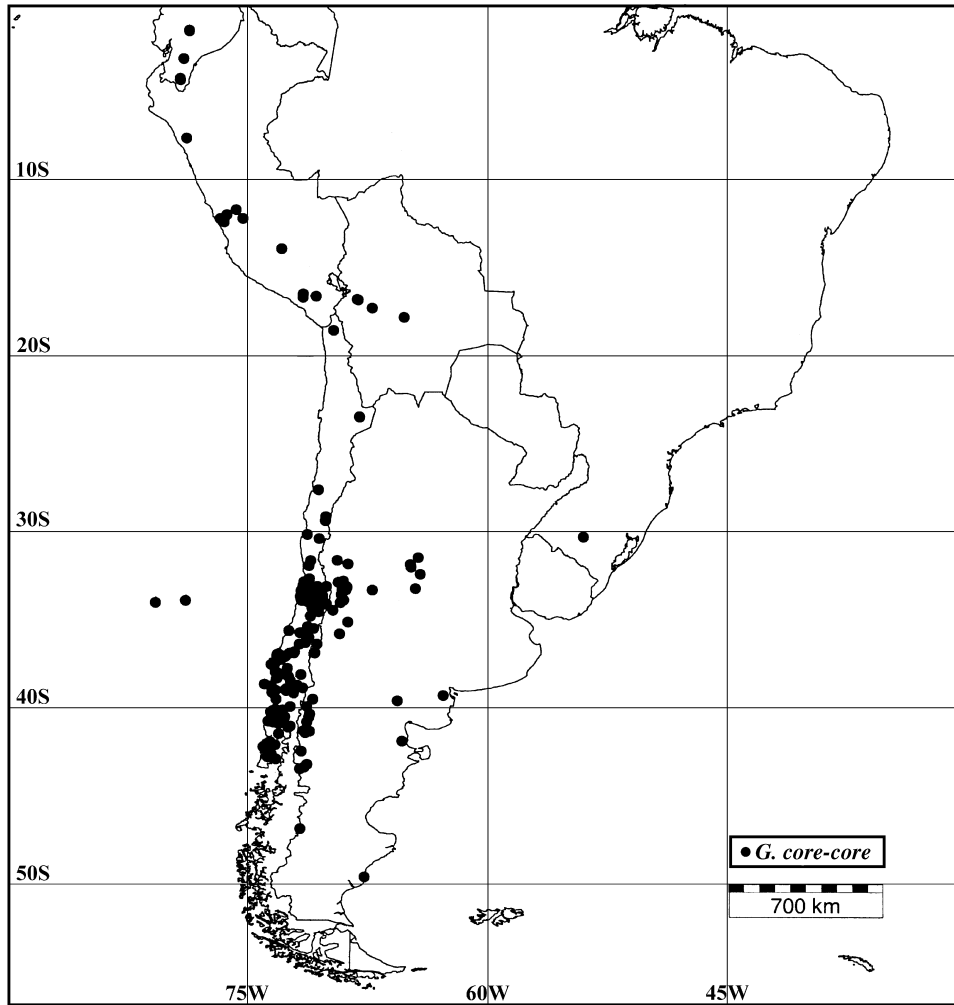


Figure 81. Area of distribution of *Geranium core-core* (Californian and European localities are not shown).

Chico, 46°33'S, 71°44'W, 12.xii.1954, *Pfister s.n.* (CONC). ANTOFAGASTA: Toconao, 23°11'S, 68°0'W, 28.xi.2001, *Aedo 7006* (MA). ATACAMA: Huasco, río Laguna Grande, entre la Junta de Valeriano y Las Papas, 28°51'S, 70°7'W, 18.i.1983, *Marticorena et al. 83303-A* (CONC); km 8 río Chollay, 29°5'S, 70°8'W, 17.i.1994, *Arancio et al. 94114* (CONC). BIOBÍO: Concepción, Mirador Alemán, 36°50'S, 73°2'W, 4.xi.2001, *Aedo 6728* (MA); Talcahuano, 36°43'S, 73°6'W, 3.xi.2001, *Aedo 6722* (MA). COQUIMBO: Choapa, Illapel, 31°38'S, 71°10'W, .xi.1989, *Chuminato 23* (CONC); Illapel, Cuesta Espino, 31°21'S, 71°3'W, 19.x.1945, *Biese 2011* (S, BM, NY). JUAN FERNÁNDEZ IS.: Isla de Más a Fuera, quebrada de La Colonia, 33°45'S, 80°46'W, 27.xi.1965, *Muñoz & Sierra 7028* (CONC); Isla de Más a Tierra, plazoleta del Yunque, 33°38'S, 78°52'W, 28.xii.1954, *Skottsberg 33* (S). La Araucanía: Coi-Coi, La Lobería, 38°50'S, 73°28'W, 21.xii.2001, *Aedo 7197* (MA); Puerto Saavedra,

38°42'S, 73°15'W, 22.xii.2001, *Aedo 7203* (MA). LOS LAGOS: Chiloe, playa Puñihuil, 41°55'S, 74°1'W, 6.i.2002, *Aedo 7387* (MA); pr. Futaleufú, 43°10'S, 71°45'W, 5.i.2002, *Aedo 7375* (MA). MAULE: Paso Nevado, 35°43'S, 71°10'W, 13.xii.2001, *Aedo 7153* (MA); Constitución, 35°20'S, 72°25'W, 17.x.1919, *Holway 123* (US). O'HIGGINS: Baños de Cauquenes, 34°15'S, 70°34'W, .1872, *Reed s.n.* (CONC); Rancagua, 34°30'S, 71°4'W, .1828, *Bertero s.n.* (SGO). SANTIAGO: puente Manzanito, 33°20'S, 70°19'W, 12.xii.2001, *Aedo 7130* (MA); Aguas Negras, El Volcan, 33°50'S, 70°12'W, .ii.1967, *Richter s.n.* (CONC). TARAPACÁ: Arica, quebrada de Socoroma, 18°15'S, 69°38'W, 5.v.1972, *Ricardi et al. 152* (CONC). VALPARAÍSO: Aconcagua, La Ligua, 32°27'S, 71°13'W, .i.1970, *Martínez s.n.* (CONC); Aconcagua, Zapallar, 32°33'S, 71°28'W, .ii.1899, *Johow s.n.* (CONC). ECUADOR. AZUAY: Cuenca, 2°52'S, 78°58'W, 17.ix.1918, *Rose et al. 22876* (US, GH, NY). LOJA: Cajanuma, 16 km al

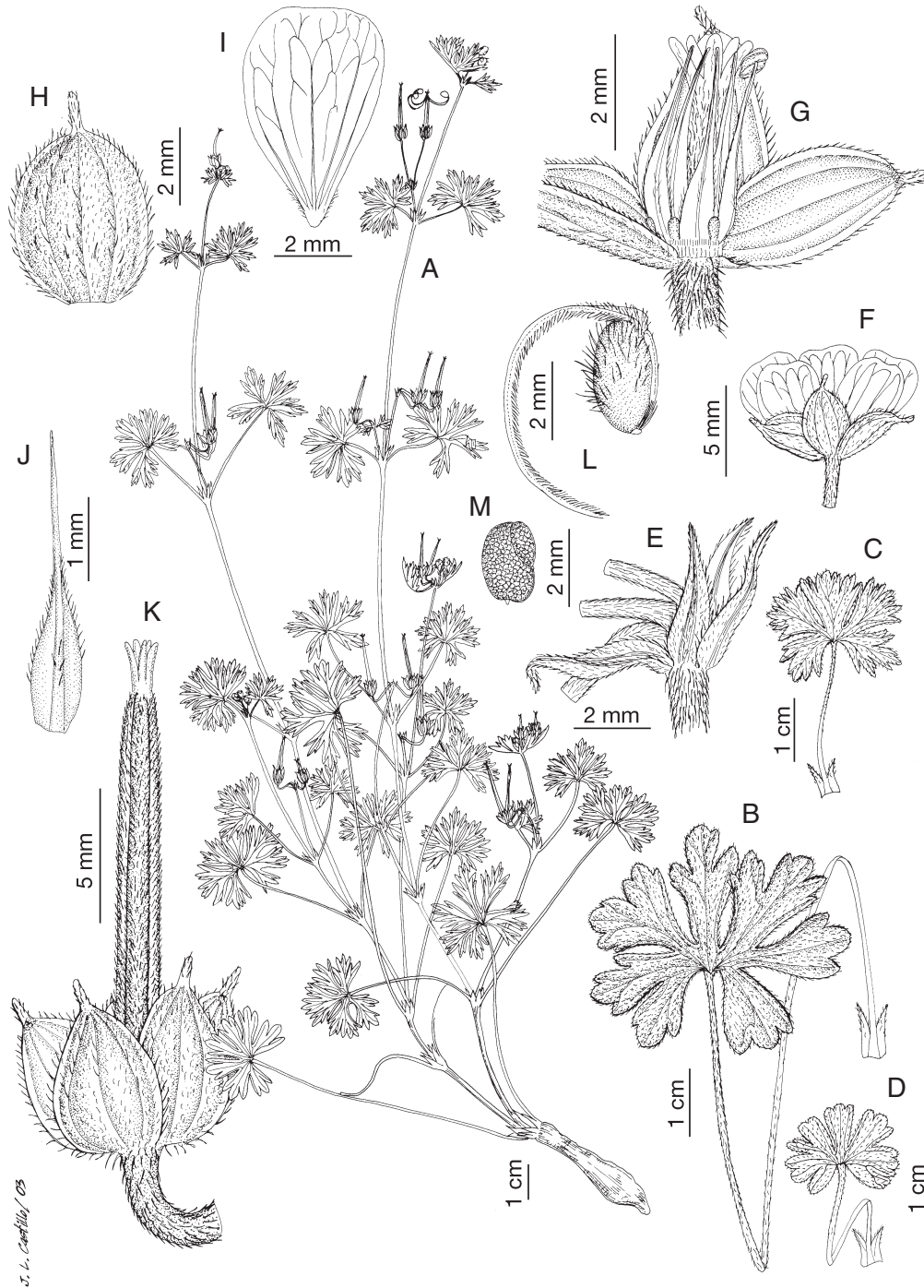


Figure 82. *Geranium core-core* Steud. A, habit; B–D, leaves; E, bracts; F, flower; G, flower without petals; H, sepal; I, petal; J, staminal filament; K, fruit; L, mericarp; M, seed [A, C, E–M: *Aedo* 7387 (MA); B: *Aedo* 7006 (MA); D: *Aedo* 7375 (MA).]

S de Loja, 4°4'S, 79°11'W, 16.vii.1947, 1635 (NY); Loja, 3°59'S, 79°12'W, 14.vi.1946, *Espinosa* 562 (NY). TUNGURAHUA: Ambato a Huachi, 1°17'S, 78°37'W, 29.x.1944, *Acosta Solís* 8884 (F); entre Casigana y El Sueño, al SW de Ambato, 1°15'S, 78°37'W, 14.xii.1944,

Acosta Solís 9303 (F). GREAT BRITAIN. Kent, Bracken Hill, near Sevenoaks, garden of Mc Clintock, 51°15'N, 0°12'E, .ix.1979, *Mc Clintock s.n.* (P). PERU. APURIMAC: Abancay, Ampuy, 13°38'S, 72°52'W, 12.ii.1939, *Stork et al.* 10628 (G). AREQUIPA: Arequipa,

16°23'S, 71°32'W, 15.viii.1923, *Guenther & O. Buch-tien 691* (HBG); S slopes of Chachani mountain, 16°11'S, 71°31'W, .iii.1920, *Hinkley 66* (US, GH, NY). JUNÍN: 19 km NE of Tarma on road to San Ramon, 11°25'S, 75°41'W, 17.xii.1978, *Dillon & Turner 1331* (C, F); Contumazá, Singarrán, El Molino-San Martín, 7°22'S, 78°48'W, 1.xi.1979, *Sagástegui 9343* (NY). LIMA: Huarochiri, Chicla, 11°42'S, 76°16'W, 6.vi.1940, *Asplund 11455* (S); Langa, 12°7'S, 76°26'W, 15.vii.1838, *Barclay 2356* (BM). USA. CALIFORNIA: Alameda Co., San Leandro Bay Shoreline, Oakland, 37°48'N, 122°16'W, 25.viii.1991, *Ertter 10725* (UC); Contra Costa Co., Mount Diablo Regional Park, Pine Pond, 37°51'N, 121°55'W, 8.iv.1987, *Ertter 17410* (MA).

12. *Geranium retrorsum* L'Hér. ex DC., Prodr. 1: 644 (1824). *Geranium dissectum* var. *retrorsum* (L'Hér. ex DC.) Hook. f., Fl. Nov. – Zel. 1: 39 (1852). *Geranium pilosum* var. *retrorsum* (L'Hér. ex DC.) Jeps., Man. Fl. Pl. Calif. 589 (1925)

Type: New Zealand. [without locality], *Banks s.n.* (lectotype, designated by Carolin, 1965: 349, G; isolectotype, BM!)

Geranium australe Nees in Lehm., Pl. Preiss. 1: 162 (1845), nom. illeg., non Dum. Cours. (1805).

Geranium pilosum var. *australe* (Nees) Ostenf. in Biol. Meddel. Kongel. Danske Vidensk. Selsk. 3: 721 (1921)

Type: Australia. [without locality], *Preiss 1907* (lectotype designated by Carolin, 1965: 349, LE!)

Geranium dissectum var. *patulum* Sol. ex Hook. f., Handb. N. Zeal. Fl. 36 (1864). *Geranium pilosum* var. *grandiflorum* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 75 (1912), nom. illeg.

Type: New Zealand. [without locality], *Banks & Solander s.n.* (lectotype, here designated, BM!)

Herbs 12–39 cm tall. Rootstock 4.9–15.7 mm diam., without fusiform roots. Stem erect to ascending, with retrorse, appressed, eglandular hairs 0.2–0.9 mm long. Basal leaves in a ± deciduous rosette; lamina 0.99–4.08 × 1.6–5.3 cm, polygonal in outline, cordate, palmatifid (divided for 0.56–0.84 of its length), pilose, with appressed, eglandular hairs; segments 5–7, obtriangular, 1.2–5.6 mm at the base (segment width at the base/segment length ratio = (0.07–)0.14–0.21(–0.34)), 3–9-lobed in distal half (second sinus length/middle-segment length ratio = (0.24–)0.31–0.37(–0.45)); petioles to 23 cm long, with retrorse, appressed, eglandular hairs 0.2–0.9 mm long; stipules 2–6.5 × 0.5–1.5 mm, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Inflorescence with cymules 2-flowered, solitary; peduncles (0.6–)1.3–3.1(–8.4) cm long, with retrorse, appressed, eglandular hairs 0.2–0.6 mm long; bracteoles 1.4–4.2 × 0.3–0.9 mm, linear-lanceolate, with eglandular hairs on

abaxial surface and on the margin, glabrous adaxially; pedicels 0.6–3.7 cm long, with retrorse, appressed, eglandular hairs 0.2–0.6 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals (3.2–)4.9–5.5(–6.3) × 1.5–3.5 mm, lanceolate (width/length ratio = (0.26–)0.44–0.59(–0.65)), with mucro (0.2–)0.4–0.6(–0.9) mm long (mucro length/sepal length ratio = (0.05–)0.07–0.11(0.16)), with scarious margins 0.1–0.2 mm wide, with antrorse, ± appressed, eglandular hairs 0.1–1.1 mm long on the abaxial side, glabrous adaxially. Petals (2.9–)3.5–5.3(–9.2) × 1.4–4.5 mm, entire or slightly notched, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 2.2–4.7 mm long, whitish, glabrous on both sides, ciliate on the basal margin, with hairs up to 0.1–0.15 mm long; anthers 0.4–1 × 0.2–0.6 mm, yellowish; pollen unknown colour. Nectaries glabrous. Gynoecium 2–4.5 mm long, yellowish. Fruit 11–18 mm long; mericarps 2.5–3.5 × 1.3–1.7 mm, smooth, with erect-patent, eglandular hairs 0.3–1.2 mm long, brownish; rostrum 7.8–13.2 mm long, without a narrowed apex, with erect-patent, eglandular hairs 0.1–0.7 mm long; stigmatic remains (0.6–)0.9–1.1(–1.3) mm long, with 5 hairy lobes. Seeds 1.5–2.3 × 1–1.4 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: Australia (south-west Australia, south-east Australia and Tasmania), and New Zealand; introduced in USA (Hawaii) (Fig. 83).

Habitat: Roadsides, dry rocky or sandy grasslands, dunes, shrublands and open forest with *Eucalyptus*, *Acacia* or *Agonis*; 0–1280 m.

Phenology: Flowering January – December.

Illustration: Figure 84.

Notes: As previously stated *G. retrorsum* is quite similar to *G. core-core*. The differences between the two species have been indicated under the second species. *Geranium retrorsum* is sympatric to *G. solanderi*, from which it can be distinguished by its retrorse-appressed hairs on pedicels. Additionally, *G. retrorsum* has shorter hairs on stem, petioles, pedicels and sepals than *G. solanderi*.

Geranium retrorsum was recorded in California (Aedo, 2001b; previous authors there indicated) by mistake. Most of the specimens supporting this record were re-examined and are now identified as *G. core-core*, as they have broadly ovate sepals. *Geranium retrorsum* was also reported as introduced in Europe (Channel Islands) (Kent, 1959; Lousley, 1962). Yeo (2002) re-identified specimens from this area as *G. herrerae*. We essentially agree with this

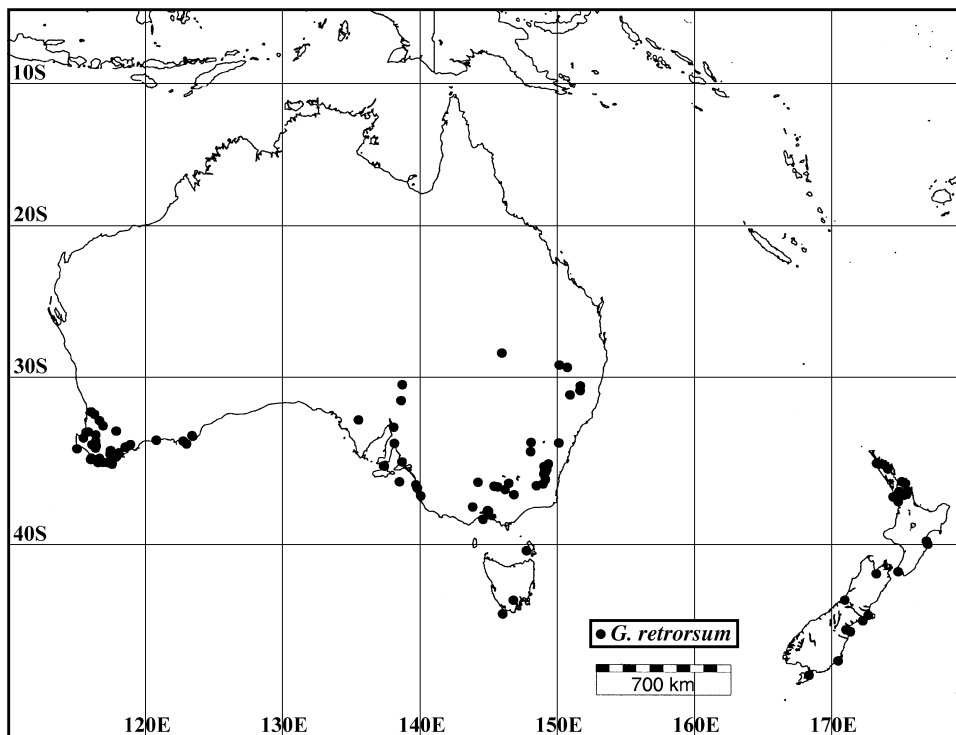


Figure 83. Area of distribution of *Geranium retrorsum* (Hawaiian localities are not shown).

opinion, although the prior name for this taxon is *G. core-core*.

Representative specimens examined: AUSTRALIA. NEW SOUTH WALES: 15 miles E of Guyra, on Ebor road, 30°12'S, 151°40'E, 9.i.1958, *Vickery 42756* (K); 21.6 km from Grenfell on road to Forbes, 33°44'S, 148°6'E, 27.ix.1978, *Moore 8013* (CANB); Armidale, 30°30'S, 151°39'E, .iii.1907, *Stopford s.n.* (BM). QUEENSLAND: Gilruth Plains, C'mulla, 28°7'S, 145°58'E, 9.x.1941, *Allen s.n.* (CANB); Stanforth, .xi.1943, *Clemens s.n.* (GH). SOUTH AUSTRALIA: 2 km SW of Evondale Homestead on the Coorong road, 36°29'S, 139°48'E, 1.x.1982, *Donner 9045* (L); 25 km E of Kingston, Reedy Creek Range, 36°57'S, 140°3'E, 7.x.1982, *Donner 9203* (GOET). TASMANIA: Hedgero, Launceston, 43°30'S, 146°2'E, 27.x.1943, *Curtis s.n.* (K); Prime Seal island, Furneaux group, 40°3'S, 147°45'E, s.d., *Whinray 393* (CANB). VICTORIA: Buckland river, Nelson's Creek, 36°51'S, 146°51'E, 1.xii.1972, *Canning 3276* (CANB); Dookie Agricultural College, hill 4 km S of Mt Major, 36°24'S, 145°41'E, 26.viii.1992, *Crawford 1807* (CANB). WESTERN AUSTRALIA: along Esperance Ravensthorpe road, 33°40'S, 120°47'E, 25.ix.1968, *Wilson 7862* (PERTH); 1 km along Nun Road from junction with Don Road, NE of Busselton, 33°21'S, 116°24'E, 5.x.1996, *Crowley 661* (PERTH); 16 km NE of Jerramungup, 33°56'S,

118°55'E, 18.viii.1974, *Newbey 4298* (PERTH). NEW ZEALAND. NEW ZEALAND NORTH I.: Auckland Ecological Region, Inner Gulf Islands Ecological district, Tiritiri Matangi Island, 36°36'S, 174°53'E, 15.x.1971, *Esler & Scott s.n.* (AK); Aupouri Ecological region, Rangaunu Heads, 34°57'S, 173°15'E, .x.1897, *Matthews s.n.* (AK); Coromandel Co., southernmost of Ngamotukaraka Island, 36°42'S, 175°23'E, 28.viii.1983, *Wright 5709* (AK, G). NEW ZEALAND SOUTH I.: Aniseed valley, Nelson, 41°17'S, 173°14'E, 15.xi.1980, *Gardner 2772* (AK); Braeview Crescent, Dunedin city, 45°53'S, 170°28'E, .ii.1979, *Esler s.n.* (AK); Canterbury Land District, Canterbury Plains, Leeston, 43°49'S, 172°15'E, 10.xii.1994, *Nielsen 10091* (C). USA. HAWAII: Hawaii I, Humuula, saddle between Mauna Lea & Mauna Kea, 19°42'N, 155°30'W, 12.vi.1950, *Rose 50H8* (CAS); Waimea, 20°1'N, 155°39'W, 4.iv.1948, *Hosaka 3590* (P).

13. *Geranium tablasense* R. Knuth in Meded. Rijks-Herb. 27: 68 (1915)
Type: Bolivia. Cochabamba, Tablas, .v.1911, *Herzog 2181* (lectotype, here selected, L!; isolectotype, S!) [17°05'S, 65°59'W]

Herbs 37–55 cm tall. Rootstock 8–8.2 mm diam., with fusiform roots. Stem erect, with patent to retrorse, not appressed, eglandular hairs 0.3–1.2 mm long, and

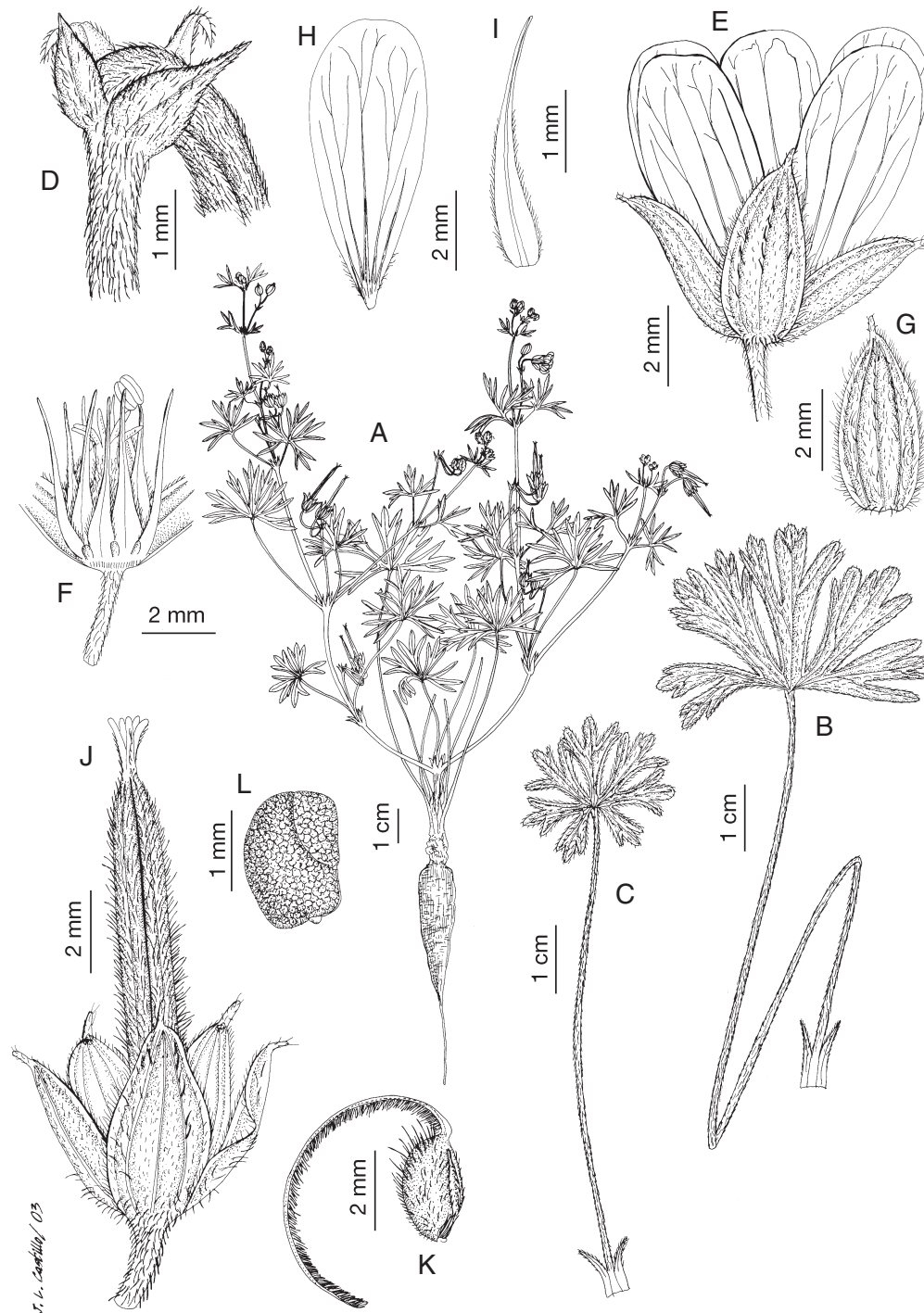


Figure 84. *Geranium retrorsum* L'Hér. ex DC. A, habit; B–C, leaves; D, bracts; E, flower; F, flower without petals; G, sepal; H, petal; I, staminal filament; J, fruit; K, mericarp; L, seed [A, D–L: Mueller s.n. (NY); B: Wright 5709 (AK); C: Carter 22 (K).]

patent, glandular hairs 0.4–0.9 mm long. Basal leaves in a \pm deciduous rosette; lamina 3.6–5.4 \times 5.1–6.2 cm, polygonal in outline, cordate, palmatifid (divided for 0.52–0.61 of its length), pilose, with appressed, eglan-

dular hairs (young leaves sericeous abaxially); segments 5–7, rhombic, 3.2–4.6 mm at the base (segment width at the base/segment length ratio = 0.09–0.12(–0.14)), 10–14-lobed in distal half (second sinus

length/middle-segment length ratio = (0.24–)0.27–0.37(–0.42)); petioles to 8.2 cm long, with patent, eglandular hairs 0.3–1.3 mm long; stipules 7.5–9.8 × 2.7–3.2 mm, glabrous or with scattered eglandular hairs on abaxial surface and on the margin, glabrous adaxially. Inflorescence with cymules 2-flowered, solitary; peduncles (3.7–)4–7(–8) cm long, with patent to retrorse, not appressed, eglandular hairs 0.2–0.6 mm long, and patent, glandular hairs 0.4–0.9 mm long; bracteoles 2.5–6.7 × 0.6–1.8 mm, lanceolate, with scattered eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 2.8–4.6 cm long, with patent to retrorse, not appressed, eglandular hairs 0.2–0.6 mm long, and patent, glandular hairs 0.4–1.3 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals 7.4–8 × 2.4–3.3 mm, lanceolate (width/length ratio = 0.32–0.38(–0.41)), with mucro (0.7–)0.75–1.3(–1.4) mm long (mucro length/sepal length ratio = (0.09–)0.10–0.16(–0.17)), with scarios margins 0.3–0.4 mm wide, with erect-patent, eglandular hairs 0.5–1.4 mm long, and patent, glandular hairs 0.4–1 mm long on the abaxial side, glabrous adaxially. Petals (11.4–)13.4–16.4(–16.9) × 7.4–8.2 mm, emarginate, notch 1.5–1.9 mm deep, with a claw 1–3.5 mm long, glabrous, rarely with few cilia on the basal margin, purplish. Filaments 6.5–8 mm long, yellowish, glabrous on both sides, ciliate on the basal margin, with

hairs up to 0.1–0.2 mm long; anthers 1.1–1.8 × 0.8–1.2 mm, unknown colour; pollen unknown colour. Nectaries glabrous. Gynoecium 7–8.2 mm long, unknown colour. Fruit 24.2–27.7 mm long; mericarps 3.2–4 × 1.6–1.8 mm, smooth, with erect-patent, eglandular hairs 0.3–0.9 mm long, brownish; rostrum 17–21.1 mm long, with a narrowed apex (2–)2.3–3.8(–5) mm long, with erect-patent, eglandular hairs 0.4–0.9 mm long; stigmatic remains (2.6–)2.8–3.4(–3.8) mm long, with 5 glabrous lobes. Seeds 2.1–2.2 × 1.1–1.5 mm, finely reticulate; hilum 1/4 as long as the perimeter.

Area: Central Bolivia (Fig. 85).

Habitat: Rocky and wet slopes; 2800–3400 m.

Phenology: Flowering March – May.

Illustration: Figure 86.

Notes: *Geranium tablasense* shares with *G. venturianum* and *G. fallax* leaves with rhombic segments and rostrum with a narrowed apex. It can be recognized by its longer petals, which shows some overlap with *G. venturianum* but none with *G. fallax*. Additionally, petals of *G. tablasense* are glabrous or rarely with few cilia on the basal margin, while they are hairy on the basal margin in *G. venturianum* (and base of the abax-

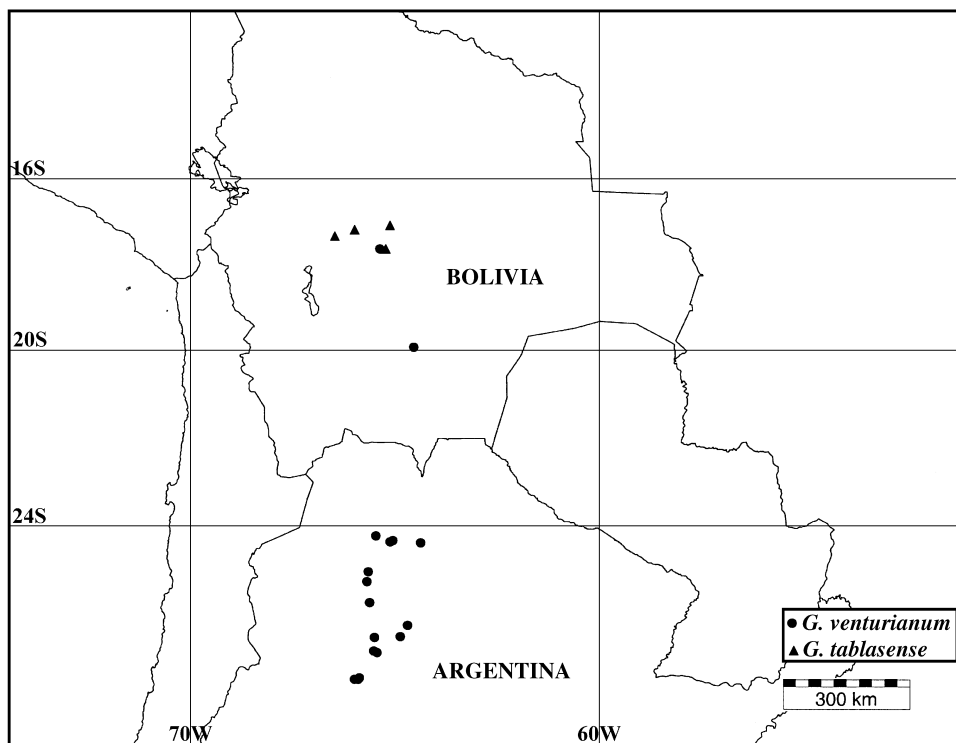


Figure 85. Area of distribution of *Geranium venturianum* (dots) and *G. tablasense* (triangles).

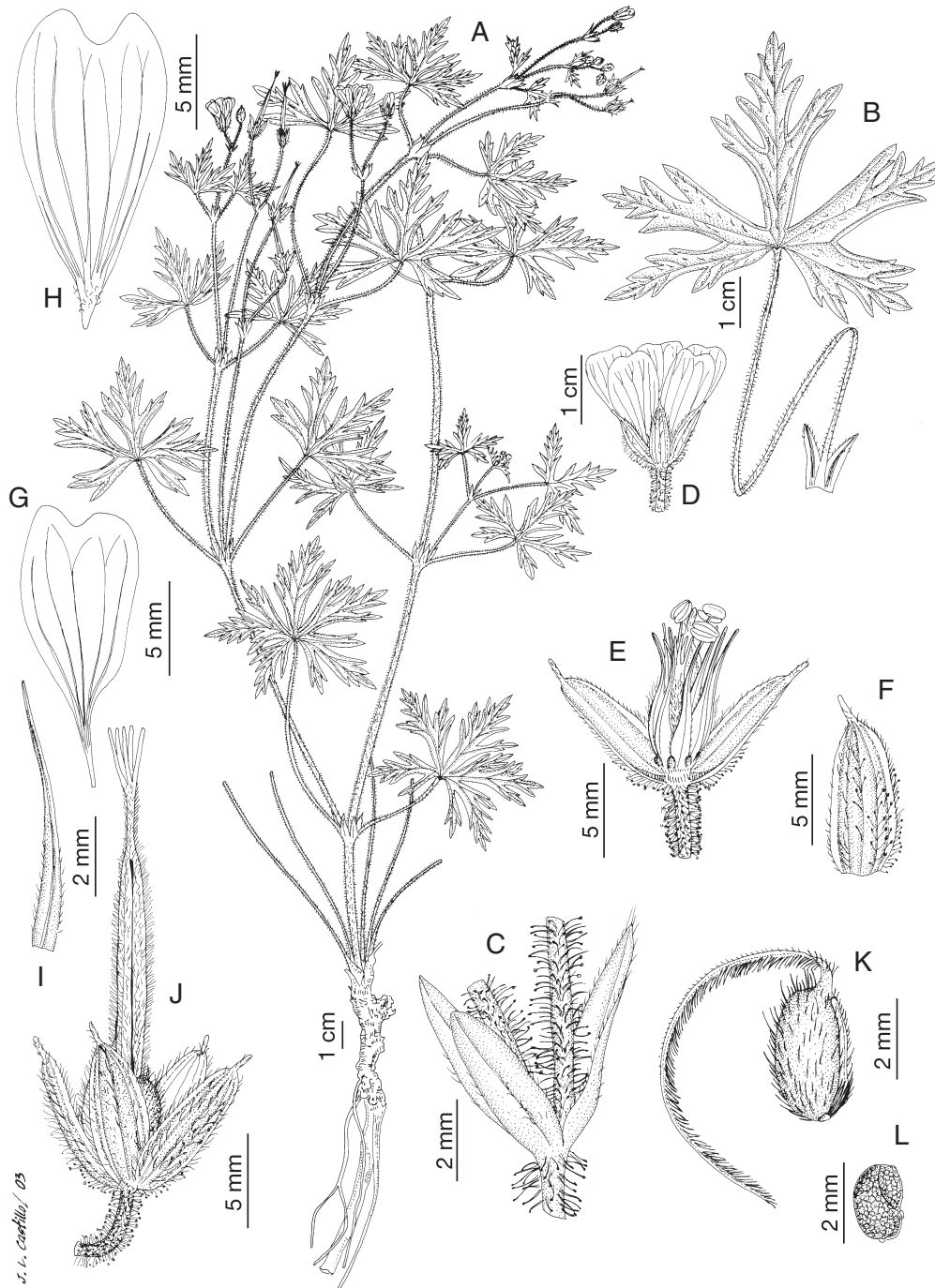


Figure 86. *Geranium tablasense* R. Knuth. A, habit; B, leaf; C, bracts; D, flower; E, flower without petals; F, sepal; G–H, petals; I, staminal filament; J, fruit; K, mericarp; L, seed [A, C–I: *Steinbach 9576* (PH); B: *Steinbach 9576* (U); J–L: *Herzog 2181* (L).].

ial side) and *G. fallax*. *Geranium venturianum* has longer peduncles and shorter staminal filaments and rostrum with a shorter narrowed apex than *G. tablasense*. *Geranium tablasense* also has leaves with narrow segments at the base, and longer fruits than *G. venturianum* and *G. fallax*.

Representative specimens examined: BOLIVIA. COCHABAMBA: Chapare, La Aduana, 17°32'S, 65°13'W, 10.iii.1929, *Steinbach 9576* (E, NY, PH, S, U); Incachaca, 17°14'S, 66°28'W, .iii.1941, *Cárdenas 2180* (GH, PH, S, U); km 80 road to Chimoré-Cochabamba, 16°59'S, 65°7'W, .iv.1939, *Cárdenas 758* (US).

14. *Geranium venturianum* R. Knuth, Repert. Spec. Nov. Regni Veg. 40: 218 (1936)
 Type: Argentina. Tucumán, Cerro del Campo, 15 Dec. 1928, *Venturi 7723* (lectotype, here designated, S!; isolectotypes, BM! K! MO! SI)

Herbs 27–88 cm tall. Rootstock 6.9–13.6 mm diam., with fusiform roots. Stem erect, with patent, eglandular hairs 0.1–0.9 mm long, and, sometimes, patent, glandular hairs 0.2–0.7 mm long. Basal leaves in a ± deciduous rosette; lamina 3.2–7.5 × 4–9.98 cm, polygonal in outline, cordate, palmatifid (divided for 0.50–0.66 of its length), pilose, with appressed, eglandular hairs (young leaves sericeous abaxially); segments 5–7, rhombic, 2.4–12.6 mm at the base (segment width at the base/segment length ratio = (0.08–)0.14–0.23(–0.30)), 8–16-lobed in distal half (second sinus length/middle-segment length ratio = (0.23–)0.25–0.31(–0.49)); petioles to 16.5 cm long, with patent, eglandular hairs 0.2–1 mm long, and sometimes, patent, glandular hairs 0.2–0.7 mm long; stipules 3.2–16.7 × 1–5 mm, with eglandular, and sometimes glandular, hairs on both surfaces and on the margin. Inflorescence with cymules 2-flowered, solitary; peduncles (5.9–)8.2–15.1(–25.1) cm long, with patent, eglandular hairs 0.2–0.7 mm long, and sometimes, patent, glandular hairs 0.2–0.8 mm long; bracteoles 2.6–8.9 × 0.5–1.2 mm, lanceolate, with eglandular, and sometimes glandular, hairs on both surfaces and on the margin; pedicels 1.25–4.66 cm long, with patent, eglandular hairs 0.2–0.7 mm long, and sometimes, patent, glandular hairs 0.2–0.8 mm long; pedicel and peduncle together usually overlapping the subtending leaf. Sepals (5.5–)6.5–8.2(–8.9) × 1.8–3.7 mm, lanceolate (width/length ratio = (0.27–)0.35–0.43(–0.49)), with mucro (0.6–)1–1.5(–2.1) mm long (mucro length/sepal length ratio = (0.10–)0.12–0.22(–0.26)), with scarious margins 0.2–0.3 mm wide, with erect-patent, eglandular hairs 0.3–0.8 mm long, and sometimes, erect-patent, glandular hairs 0.2–0.8 mm long. Petals (10–)11–11.8(–14.3) × 5–10.7 mm, entire, without claw, hairy on margin and base of abaxial side, purplish. Filaments 4–7.1 mm long, yellowish, with eglandular hairs 0.2–0.3 mm long on the abaxial side and margin; anthers 0.5–1.7 × 0.4–1 mm, unknown colour; pollen unknown colour. Nectaries usually glabrous. Gynoecium 4.5–7 mm long, unknown colour. Fruit 19.4–26.7 mm long; mericarps 3–3.7 × 1.3–2.2 mm, smooth, with erect-patent, eglandular hairs 0.3–1.1 mm long and, sometimes, patent glandular hairs 0.2–0.7 mm long, brownish; rostrum 12.8–19.3 mm long, with a narrowed apex 1–2.4 mm long, with erect-patent, eglandular hairs 0.3–0.8 mm long and, sometimes, patent glandular hairs 0.2–0.7 mm long; stigmatic remains (3–)3.2–3.6(–5) mm long, with 5 hairy lobes. Seeds

1.9–2.4 × 1.2–1.5 mm, finely reticulate; hilum 1/4 as long as the perimeter.

Area: Bolivia, and North Argentina (Fig. 85).

Habitat: Meadows, grassy slopes, and shrublands; 1000–3200 m.

Phenology: Flowering October – April.

Illustration: Figure 87.

Notes: *Geranium venturianum* is easily recognizable by its longer peduncles, which decrease in length towards the apex of the inflorescence. Thus, in the description of *G. venturianum* and key we consider peduncles of the basal part of the inflorescence. Although a small overlap in peduncle length exists between *G. venturianum* and *G. tablasense*, length of petals, staminal filaments, fruit and rostrum apex permits a satisfactory discrimination between the species. *Geranium venturianum* varies in the presence of glandular hairs. Some specimens have only eglandular hairs while others also have glandular hairs widespread on stem, inflorescence, sepals, rostrum and/or mericarps. These glandular forms have occasionally been misidentified as *G. fiebrigianum* (included in *G. fallax* in this study) or *G. patagonicum* (included in *G. berterioanum* in this study). *Geranium venturianum* can be distinguished from *G. berterioanum* by its leaves with a rhombic middle segment (not obtriangular) and its rostrum fruit with a narrow apex. The best way to distinguish *G. venturianum* from *G. fallax* is the length of peduncles, clearly longer in the first species. Additionally, *G. venturianum* has longer fruits, narrow apex of the rostrum, stigmatic remains, bracteoles, sepals and petals than in *G. fallax*.

Representative specimens examined: ARGENTINA. CATAMARCA: Andalgalá, Esquina Grande, 27°17'S, 65°59'W, 12.ii.1910, *Jørgensen 1562* (US, S); C. och Tucuman, 27.xi.1946, *Wall s.n.* (S); Chabarilla, .iv.1952, *Brücher 9440* (M). JUJUY: Capital, cerro Zapla, camino de la antena, 24°15'S, 65°7'W, 21.xi.1986, *Ahumada 5283* (CTES, LIL); Capital, lagunas de Yala, 24°7'S, 65°28'W, 26.iii.1979, *Cabrera et al. 30670* (SI); Capital, Sierra de Zapla, Mina 9 de Octubre, subida a la antena, 24°15'S, 65°7'W, 23.i.1975, *Zuloaga & Deginani 197* (LP); Santa Bárbara, subida al Centinela, 24°16'S, 64°22'W, 11.xii.1983, *Rotman 935* (CTES, LIL, SI). SALTA: Capital, quebrada de San Lorenzo, 26°6'S, 64°41'W, 13.x.1926, *Venturi 5070* (US, S, SI); Chicoana, Cuesta del Obispo, 26°6'S, 64°41'W, 10.iv.1982, *Novara 2660* (CORD, S); Chicoana, Quebrada de Escoipe, cerca de Agua Negra, 25°8'S, 65°41'W, 2.xii.1960, *Ruiz Leal 21231* (CORD, MERL);

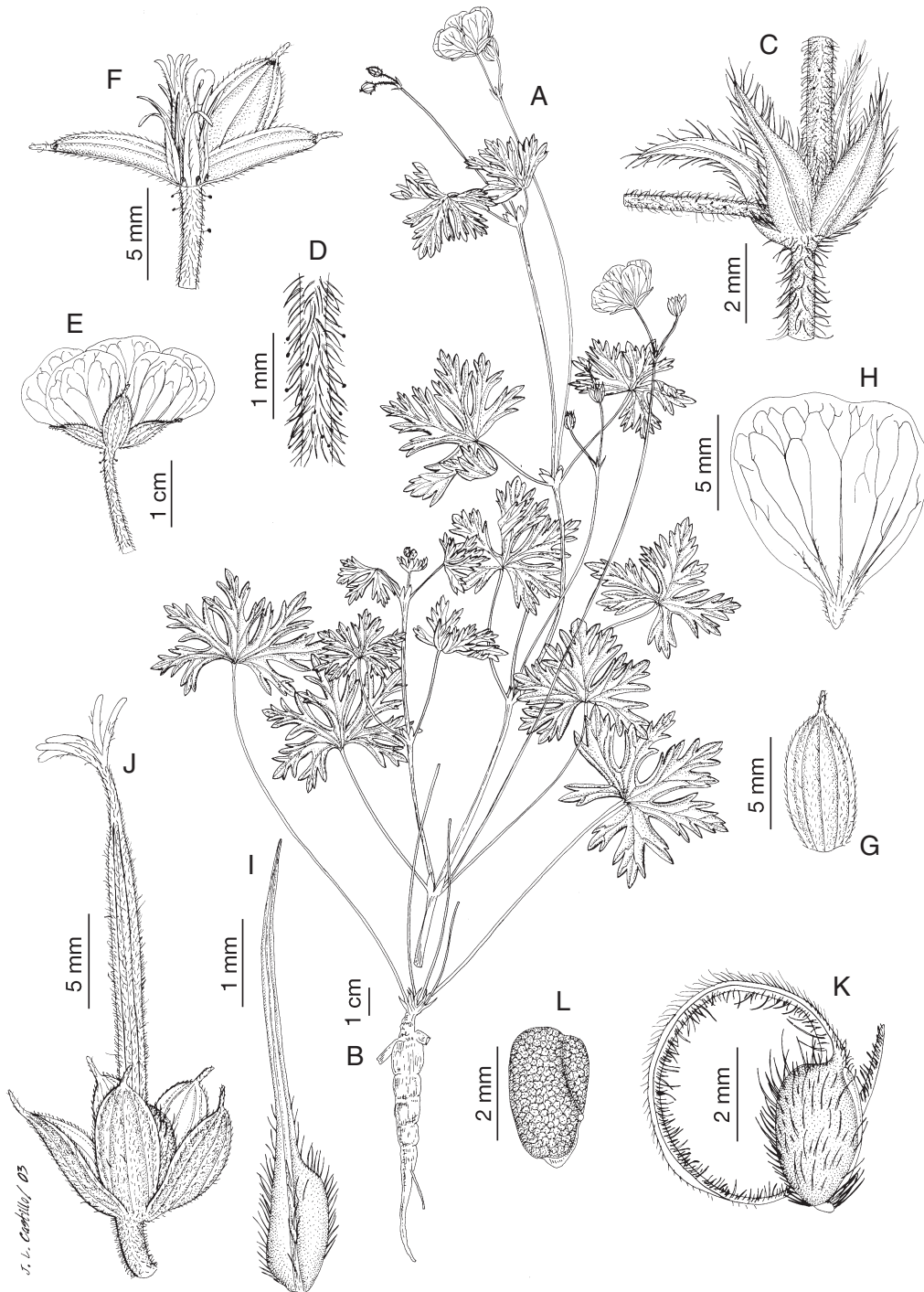


Figure 87. *Geranium venturianum* R. Knuth. A–B, habit; C, bracts; D, peduncle; E, flower; F, flower without petals; G, sepal; H, petal; I, staminal filament; J, fruit; K, mericarp; L, seed [A, C–I: Wood *et al.* 15287 (LPB); B: Burkart *et al.* 30494 (CORD); J–L: Venturi 2667 (S).].

Guachipas, Alemania, 25°36'S, 65°37'W, 6.xii.1929, Venturi 9848 (NY, K, MO, S); Rosario de Lerma, quebrada del Toro, ruta 51, km 28, unos 3 km al W de Campo Quijano, 24°55'S, 65°39'W, 26.iv.1987, Novara

6575 (G). Tucumán: Burrayacú, Alto de Medina, 26°22'S, 65°30'W, .i.1924, Venturi 2667 (S); Chichigasta, La Alvaresada, 26°42'S, 65°26'W, 27.xi.1946, Sparre 938 (S); Chichigasta, Las Pavas, 27°15'S,

65°52'W, 22.xi.1926, *Venturi 4650* (GH, BR, CAS, NY, S, W); La Banderita, 27°17'S, 65°54'W, .ii.1950, *Brücher 9396* (M); Tafi, La Hoyada, 26°40'S, 65°31'W, .i.1923, *Venturi 1979* (MA, GH); Tafi, Sierra de Tucumán, Cuesta de Siambón, 26°42'S, 65°26'W, 18.iii.1872, *Lorentz s.n.* (CORD). BOLIVIA. CHUQUISACA: Azurduy, on descent from Cordillera de los Sombreros towards Tarvita, 19°49'S, 64°32'W, 4.xii.1999, *Wood et al. 15287* (LPB). COCHABAMBA: between Lopez Mendoza and Montepuncu, 17°32'S, 65°22'W, 16.xii.1994, *Wood 8955* (LPB, S).

15. *Geranium fallax* Steud. in *Flora* 39(28): 439 (1856)
Type: Peru. Puno, Tabina & *Lechler 1907* (lectotype, here designated, P!; isolectotypes, GOET! K!) [14°8'S, 69°32'W]

Geranium fiebrigianum R. Knuth in *Bot. Jahrb. Syst.* 37: 560 (1906)

Type: Bolivia. Tarija, Calderillo, *Fiebrig 2631* (lectotype, here designated, P!; isolectotypes, BM! E! G! GOET! K! M! US! W!) [21°48'S, 63°45'W]

Geranium titicacaense R. Knuth in *Repert. Spec. Nov. Regni Veg.* 45: 60 (1938)

Type: Peru. Moquegua, Carumas, 21.ii.–6.iii.1925, *Weberbauer 7307* (holotype, B†; isotypes, BM! G! K! S!) [16°49'S, 70°43'W]

Herbs 18–85(–100) cm tall. Rootstock 4.2–12.7 mm diam., with fusiform roots. Stem erect to ascending, with patent, eglandular hairs 0.4–1.4 mm long, and, sometimes, patent, glandular hairs 0.4–0.7 mm long. Basal leaves in a deciduous rosette; lamina 2.4–8.1 × 1.9–8.9 cm, polygonal in outline, cordate, palmatifid (divided for 0.43–0.67 of its length), pilose, with appressed, eglandular hairs; segments 5–7, rhombic, 3.2–10.6 mm at the base (segment width at the base/segment length ratio = (0.10–)0.13–0.18(–0.24)), 4–17-lobed in distal half (second sinus length/middle-segment length ratio = (0.17–)0.21–0.28(–0.32)); petioles to 16.5 cm long, with patent, eglandular hairs 0.4–1.6 mm long, and sometimes, patent, glandular hairs 0.4–0.8 mm long; stipules 3.6–13.4 × 0.9–5 mm, with eglandular hairs on abaxial surface and on the margin (rarely glabrous), glabrous adaxially. Inflorescence with cymules 2-flowered, solitary; peduncles (1.5–)3.1–5.1(–10) cm long, with patent, eglandular hairs 0.3–1.1 mm long, and usually, patent, glandular hairs 0.4–1.2 mm long; bracteoles 2–5.5 × 0.5–1.48 mm, linear-lanceolate, with eglandular hairs on abaxial surface and on the margin, glabrous adaxially; pedicels 2.6–4.2 cm long, with patent, eglandular hairs 0.3–1.1 mm long, and patent, eglandular hairs 0.4–1.2 mm long; pedicel and peduncle together usually overtopping the subtending leaf. Sepals (5.2–)5.7–6.5(–8.2) × 2.2–3.7 mm, lanceolate (width/length ratio = (0.32–)0.42–0.49(–0.59)),

with mucro (0.3–)0.7–0.9(–1.3) mm long (mucro length/sepal length ratio = (0.05–)0.09–0.15(–0.22)), with scarious margins 0.1–0.2 mm wide, with erect-patent, eglandular hairs 0.4–0.9 mm long, and patent, glandular hairs 0.4–1.2 mm long on the abaxial side, glabrous adaxially. Petals (4–)4.7–7.5(–9.9) × 1.9–6.3 mm, entire or slightly notched, without claw, glabrous on both sides, ciliate on the basal margin, purplish. Filaments 2–5.3 mm long, yellowish, with eglandular hairs 0.2–0.3 mm long on the abaxial side and margin; anthers 0.4–1.2 × 0.4–0.9 mm, unknown colour; pollen unknown colour. Nectaries glabrous. Gynoecium 2.2–5 mm long, unknown colour. Fruit 18.1–23.8 mm long; mericarps 2.8–4 × 1.3–2 mm, smooth, with erect-patent, eglandular hairs 0.4–0.9 mm long and, patent glandular hairs 0.4–0.9 mm long, brownish to blackish; rostrum 13.2–17.4 mm long, with a narrowed apex (0–)0.9–1.1(1.9) mm long, with erect-patent, eglandular hairs 0.2–0.9 mm long and, patent glandular hairs 0.4–1.2 mm long; stigmatic remains (1.2–)1.4–1.7(–4) mm long, with 5 hairy lobes. Seeds 1.9–2.7 × 0.9–1.5 mm, finely reticulate; hilum 1/6 as long as the perimeter.

Area: South Peru, Bolivia and north and central Argentina (Fig. 74).

Habitat: Roadsides, cultivated grounds, rocky and grassy slopes, river shores, shrublands and *Alnus*, *Eugenia*, *Podocarpus* or *Polylepis* forest; 1200–4000 m.

Phenology: Flowering October – May.

Illustration: Figure 88.

Notes: *Geranium fallax*, as previously mentioned, is quite similar to *G. venturianum* and *G. tablasense*. However, this species always has glandular hairs, sometimes restricted to pedicels, sepals and fruits, but usually spread over all the inflorescence and stem. In *G. fallax* petals are shorter than in *G. venturianum* and *G. tablasense*, and glabrous on both sides, with cilia on the basal margin, while they are glabrous in *G. tablasense*, and hairy on the margin and base of the abaxial side in *G. venturianum*. Additionally, *G. fallax* has a narrowed apex of the rostrum that is shorter than *G. venturianum* and *G. tablasense*.

The specimens from Bolivia were usually identified as *G. fiebrigianum*, which is considered in this study as a synonym of *G. fallax*. Other specimens have occasionally been misidentified as *G. patagonicum* (included in *G. berterioanum* in this study), which has leaves with obtriangular segments (not rhombic).

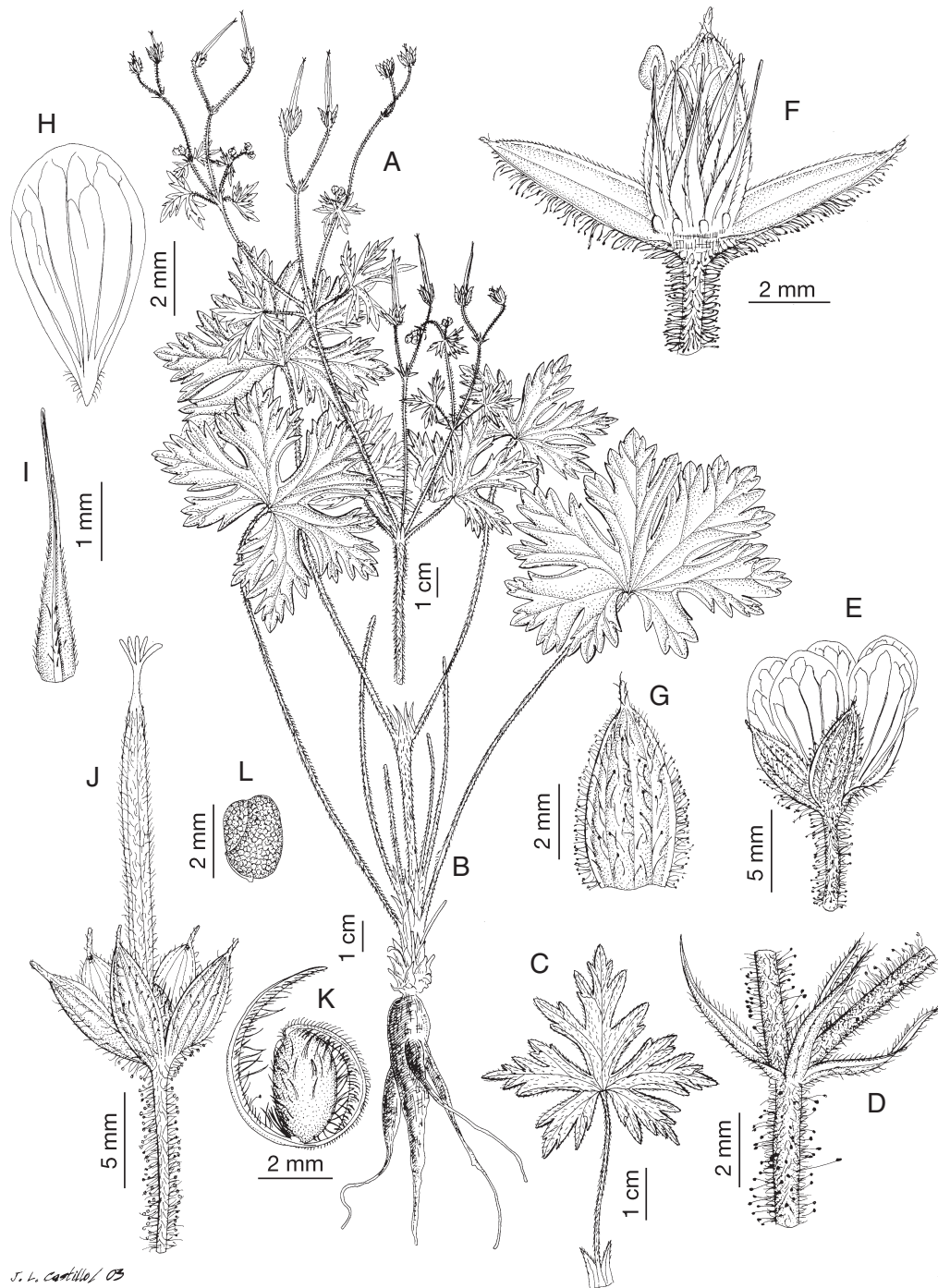


Figure 88. *Geranium fallax* Steud. A–B, habit; C, leaf; D, bracts; E, flower; F, flower without petals; G, sepal; H, petal; I, staminal filament; J, fruit; K, mericarp; L, seed [A, C–L: Beck 13831 (MA); B: Troncoso 11307 (CORD).].

Representative specimens examined: ARGENTINA. CATAMARCA: Ambato, Los Varela, 1 km W, camino a Humaya, 27°49'S, 65°58'W, 28.ii.1996, Saravia et al. 13733 (CTES); Andalgalá, 27°36'S, 66°19'W, .v.1915, Jörgensen 1194 (SI, MO); cerca Belen, 27°38'S, 67°1'W, .1879, Schickendantz 138 (CORD); El Rodeo,

Sierra de Ambato, 28°34'S, 66°7'W, 12.i.1957, Calderón 1282 (SI); las Granadillas, 27°28'S, 67°13'W, .ii.1872, Lorentz 572 (GOET). CÓRDOBA: Alta Gracia, Cascada Grande, 31°40'S, 64°26'W, 31.i.1944, Pierotti s.n. (U); Calamochita, Sierra Grande, al pie del Cerro Champaqui, 31°59'S, 64°56'W, 14.i.1952, Hunziker

9610 (BH); Pampa de Achala, 31°35'S, 64°50'W, 2.iv.1944, *Rentzell 15162* (SI, GH); Pumilla, Cruz Grande, 7.i.1951, *Santa 3657* (LIL). JUJUY: Capital, entre León y Nevado de Chañi, Mesada, 24°4'S, 65°46'W, .iii.1963, *Fabris et al. 4212* (LP); Humahuaca, 23°12'S, 65°20'W, 7.ii.1941, *Hunziker 1302* (NY); Tilcara, quebrada de Huichaira, 23°29'S, 65°31'W, 14.ii.1959, *Fabris & Marchionni 1873* (LP); Tumbaya, Volcán, ladera E al S del pueblo, 23°43'S, 65°39'W, 13.ii.1985, *Kiesling et al. 5142* (SI). LA RIOJA: Famatina, Rodeo de las Vacas, 29°4'S, 67°39'W, .ii.1913, *Flossdorf s.n.* (SI); Famatina, Sierra Famatina, cueva de Noronha, 28°58'S, 67°42'W, .ii.1980, *Cei s.n.* (MERL); Velazco, 29°4'S, 67°4'W, 6.iii.1944, *Soriano 932* (SI). SALTA: Cerro del Cajón, La Laguna, 25°46'S, 65°14'W, 20.i.1914, *Rodríguez 1272a* (SI); Chicoana, 14 km SW of San Fernando de Escoipe along the road to Cuesta del Obispo, 3 km W of San Martín, 25°10'S, 65°50'W, 10.ii.1993, *Till 10174* (WU); Guachipas, arroyo Querusillas, 25°44'S, 65°20'W, 7.ii.1983, *Novara & Neumann 3194* (LP); Las Juntas, 23°7'S, 64°33'W, .xii.1896, *Bruch s.n.* (LP). SAN JUAN: Jachal, Bella Vista, El Salto, 31°8'S, 69°27'W, 1.ii.1987, *Kiesling & Megioli 6680* (SI); Sarmiento, río Bachongo, 31°58'S, 68°54'W, 23.i.1986, *Guaglianone et al. 1479* (SI); Sarmiento, río Santa Rosa, a 5 km desembocadura río Los Leones, 31°59'S, 68°56'W, 24.i.1986, *Guaglianone et al. 1497* (SI). SAN LUIS: Pringles, Carolina, 32°49'S, 68°9'W, 5.ii.1984, *Del Vitto & Wittenstein 644* (MERL); San Francisco, 33°30'S, 65°16'W, 4.xi.1958, *Ruiz Leal s.n.* (MERL); sierra del Morro, 32°53'S, 64°59'W, .1913, *Pastore 23* (SI). TUCUMÁN: camino de Acheral a Tafi del Valle, 27°7'S, 65°26'W, .i.1944, *O'Donnell 1390* (U); La Banderita, 27°17'S, 65°54'W, .ii.1950, *Brücher 9394* (M); La Ciénaga, 26°46'S, 65°39'W, 14.ii.1905, *Lillo 4031* (UC). BOLIVIA. COCHABAMBA: Ayopaya, 10 km NW de Independencia, 17°7'S, 66°52'W, 7.v.1988, *Beck & Seidel 14427* (MA, GH, PH, UC); Calomi, 17°0'S, 65°30'W, 8.i.1949, *Brooke 5081* (BM, GH, PH, UC); Chapare, Incachaca, 17°14'S, 66°28'W, 28.ii.1929, *Steinbach 9509* (MO, E, GH, NY, PH, UC); Quillacollo, 17°30'S, 66°30'W, 25.iii.1990, *Hensen 702* (MA, GH, PH, UC). LA PAZ: Inquisivi, cliffs 0.5 km SE of Jardín Botánico de Quime, 16°59'S, 67°13'W, 17.ii.1990, *Lewis 37100* (LPB); Larejaca, Sorata cerro del Imimapi, 15°46'S, 68°39'W, .ii.18??, *Mandon 778* (W, S); Murillo, 1 km NW of Ovejuyo, 16°32'S, 68°3'W, 2.iv.1982, *Solomon 7422* (LPB, MO, NY); Omasuyos, de Huarina unos 10 km hacia Tiquina, 16°12'S, 67°37'W, 3.v.1999, *Beck 22987* (MA); Sud Yungas, 19 km E of pass between Mururata and Illimani, 16°34'S, 67°45'W, 14.iii.1986, *Solomon 15121* (LPB, G, MO, NY, U). POTOSÍ: Quijarro, camino de Potosí a Khucho Ingenio, 5 km antes de llegar a Khucho Ingenio, 19°55'S, 65°39'W, 16.i.1988, *Schulte 92* (MA);

Saavedra, Cantón, Tuero Saavedra, Comunidad Despensa, 19°20'S, 65°20'W, s.d., *Romero 74* (LPB). Tarija: Cercado, 10 km NW of Tomatas, 5 km N of Tarija, on road through Erquis, Angosturas de Erquis, 21°28'S, 64°50'W, 9.v.1983, *Solomon 10592* (MO, NY); Cercado, Cuesta de Sama, 21°29'S, 65°2'W, 22.ii.1986, *Bastión 796* (U); Méndez, Sama, 21°29'S, 65°1'W, 22.ii.1986, *Ehrich 139* (LPB). PERU. Arequipa: Arequipa, 16°53'S, 71°20'W, 4.iv.1937, *Stafford 625* (K, BN). CUZCO: inter oppidum Calca et pagum Huaman (Choqqe), 13°18'S, 71°43'W, 20.v.1934, *Hammarlund 615* (NY). PUNO: Pillahuata, cerro de Cusilluyoc, 13°7'S, 71°24'W, 3.v.1925, *Pennell 14133* (F).

EXCLUDED OR DUBIOUS NAMES

Geranium albicans var. *glanduliferum* Hieron., nom. nud., in sched. (CORD!)

Geranium brevipes L'Hér. ex DC., Prodr. 1: 639 (1824), nom. nud., pro syn.

Geranium core Kostel., Allg. Med.-Pharm. Fl. 1900 (1836)

Type: Feuillé, Journal des Observations Physiques, Mathématiques et Botaniques 3: tab. 16 (1725) (lectotype, here designated)

According to Knuth (1912) this name should be considered as a synonym of *G. rotundifolium* L. Dr J. Hadinec has gone carefully through Kosteletzky's herb. material of *Geranium*. He kindly informed us that there is no specimen at PRC with any indication that it could serve as type material of *G. core* Kostel. The name is also absent from the first list of PRC material made after the incorporation of Kosteletzky's herbarium into PRC. Thus the drawing by Feuillé becomes the only original element. This drawing shows a perennial species with turnip-shaped rootstock, which probably belongs to sect. *Chilensia*. However, there is no other feature which permits a more exact identification.

Geranium dissectum var. *tuberosum* F. Muell. ex R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 75 (1912), nom. nud., pro syn. (and in sched., W!)

Geranium geissei R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 70 (1912)

Type: Chile. [without more exact location specification, *Geisse s.n.* (holotype, B†; photo F! G! GH! NY!)]

The type of this species was destroyed during World War II. Unfortunately, no duplicate of this collection has been found. We located some specimens collected by Geisse at SGO, none connected to this name. Photographs of the type kept at some herbaria do not permit a clear identification, but strongly suggest that *G. geissei* could be a synonym of *G. berterioanum*.

Geranium herrerae R. Knuth in Herrera, Chlor. Cuzco. 151 (1926), nom. nud.

Geranium magellanicum var. *typicum* R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 70 (1912), nom. inval.

Geranium neesianum Carolin in Jessop, List Vasc. Pl. South Australia: 35 (1983), nom. nud.

Geranium patulum Sol. in G. Forst., Fl. Ins. Austr. 91 (1786), nom. nud.

Geranium pilosum Sol. in G. Forst., Fl. Ins. Austr. 91 (1786), nom. nud.

Geranium proximum Bertero ex Steud., Nomencl. Bot. ed. 2, 1: 679 (1840), nom. inval., sine descr.

Geranium rotundifolium var. *affine* Bertero ex R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 76 (1912), nom. nud.

Geranium rotundifolium var. *minor* Bertero ex R. Knuth in Engl., Pflanzenr. IV.129 (Heft 53): 76 (1912), nom. nud.

Geranium santacruzense R. Knuth in Repert. Spec. Nov. Regni Veg. 18: 289 (1922)

Type: Argentina. Santa Cruz 1902, Cáceres 12395 (holotype, B⁺; isotype, CORD)

Unfortunately we can not examine the type of the species. Barboza (1996) synonymized *G. santacruzense* to *G. sessiliflorum*, which seems suitable considering Knuth's description.

Geranium sessiliflorum var. *typicum* R. Knuth in Bot. Jahrb. Syst. 37: 565 (1906), nom. inval.

Geranium sessiliflorum f. *albiflorum* Kuntze, Revis. Gen. Pl. 3(2): 33 (1898), nom. nud., in sched. (NY!)

Geranium solanderi var. *grandis* Carolin in Proc. Linn. Soc. New South Wales ser. 2, 89: 353 (1965)

Type: Australia. Ebor Gorge, New England, 2.i.1959, *Carolin* 766 (holotype, NSW)

Unfortunately we cannot examine the type of this variety. Carolin (1965) stated that var. *grandis* has a tap-root not napiform, which suggest that it could belong to another section.

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The accepted names are in bold type, while taxa that are not treated here or are synonyms are not in bold type.

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