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# *Solenopsis gutermannii* (Campanulaceae), a New Species from Kefalonia (Ionian Islands, Greece) †

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**Abstract:** A new species of *Solenopsis* (Campanulaceae), *S. gutermannii* is described and illustrated. It is endemic to Kefalonia island, Greece, where it is very rare and localized in flat clay surfaces that are periodically submerged. This species is a very small annual hygrophyte, characterized by rosulate leaves or with slightly caulescent stems, long-pedunculated flowers, bilabiate corolla, and papillate near the throat. It exhibits close affinities primarily with *S. minuta*, with which it was previously identified, and additionally with *S. antiphonitis*, due to similarities in habit and certain flower traits. Nevertheless, several relevant morphological features serve to distinguish it from these species. Its morphology, seed coat and pollen SEM micro-sculpturing, ecology, phenology, distribution, conservation status, and taxonomic relationships are also examined.

**Keywords:** Lobelioideae; Mediterranean region; morphology; pollen; seed testa; *Solenopsis*; taxonomy

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## 1. Introduction

Within the context of taxonomical investigations of *Solenopsis* C. Presl (Campanulaceae, Lobelioideae), a genus with a Mediterranean and Macaronesian distribution, a particularly unusual and rare population occurring on Kefalonia (Ionian Islands, Greece) was examined. Currently, *Solenopsis* includes 12 species [1–6], such as *S. antiphonitis* Hadjik. & Hand, *S. bacchettae* Brullo et al., *S. balearica* (E. Wimm.) Aldasoro, Castrov., Sales & Hedge, *S. bicolor* (Batt.) Greuter & Burdet, *S. bivonae* (Tineo) M. B. Crespo et al., *S. corriasii* Brullo et al., *S. corsica* (Meikle) M. B. Crespo et al., *S. laurentia* (L.) C. Presl, *S. limbarae* Brullo et al., *S. meikleana* Brullo et al., *S. minuta* (L.) C. Presl, and *S. mothiana* Brullo et al. In addition, for *S. laurentia* [4,7], *S. minuta* [1,8], and *S. bivonae* [5], several subspecies have been recognized. Based on field surveys and herbarium material, the population growing in Kefalonia (Ionian Islands) shows some affinities with *S. minuta*, a species recorded from Crete, within which two subspecies were recognized by Greuter et al. [8]: the perennial (subsp. *minuta*) and the annual (subsp. *annua*). However, apart from the distinction between these two different life forms, the authors did not provide further diagnostic characters. Indeed, the analysis of numerous populations from several Cretan localities, including cultivated plants in the

Botanical Garden of Catania, failed to detect relevant morphological differences between the two subspecies, since all such differences fall within the variability of the species. Based on these observations, the annual habits of some individuals can be attributed to a juvenile stage of the plant, since the individuals flower from the first year. Therefore, the treatment proposed by Christodoulou et al. [9], who elevates the two subspecies to two distinct species is unacceptable, especially considering that no significant morphological differences were found to support their proposal. Another species closely related with the Kefalonia population is *S. antiphonitis*, occurring in Cyprus, with which it shares annual habits and small sizing, but several other features allow it to be distinguished very well from the latter. Previously, the *Solenopsis* population occurring on Kefalonia was attributed by Gutermann [10] and Flora Ionica Working Group [11] to *S. minuta* subsp. *annua*. However, Gutermann believed that this taxon should be treated as a distinct species for which he proposed the new name "*S. notabilis*", as indicated in some of his herbarium specimens, but the name remained unpublished. Based on a detailed morphological comparison of the Kefalonia population with the Cretan population of *S. minuta*, they are well differentiated from each other. Therefore, the plants occurring in Kefalonia are here described as a new species to science, namely *Solenopsis gutermannii*. In addition, an identification key for the currently accepted species of the genus *Solenopsis* is provided.

## 2. Materials and Methods

The morphological investigations of the new species *Solenopsis gutermannii* were carried out on wild plants from Kefalonia, which were collected in the type locality and cultivated in the Botanical Garden of Catania (Italy). Fresh material from *S. minuta* populations collected in several localities of Crete were examined, whereas for *S. antiphonitis*, herbarium material and the literature data were used. Qualitative and quantitative morphological features with a diagnostic value in the genus *Solenopsis* were measured and scored across more than ten cultivated plants (Table 1). In addition, herbarium specimens kept in B, CAT, CBH, FI, G-BOISS, G-DC, JE, L, P, PAL-GREUTER, PL, RO, U, W, WA, WU, some of which were consulted online, were also examined for taxonomic comparison (acronyms by Thiers [12]). The material was observed under a Zeiss Stemi SV 11 Apo stereomicroscope at 6–66× magnification (Microscope Marketplace, Sanford, NC, USA). Comparative diagnostic features of the investigated taxa are listed in Table 1. Electron micrographs (SEM) of seeds were obtained under a Zeiss EVO LS10 scanning electron microscope at an accelerating voltage of 10 kV (Microscope Marketplace, Sanford, NC, USA). In particular, 10 seeds were directly mounted on aluminum stubs with double adhesive tape and coated with gold prior to observation. The terminology describing the seed testa sculpturing mainly followed Barthlott [13,14] and Gontcharova et al. [15]. Pollen micro-morphology was examined using a scanning electron microscope (SEM), particularly the Zeiss EVO LS10. Dried pollen was mounted on stubs without any preparation, while terminology followed Walker and Doyle [16], Punt et al. [17,18], and Hesse et al. [19]. Pollen material was obtained from living plants cultivated in the Botanical Garden of Catania (Italy). Vouchers were deposited in the Herbarium of the University of Catania (CAT) and WU.

**Table 1.** Main diagnostic morphological features of Solenopsis gutermannii and associated species.

| Characters | *S. gutermannii* | *S. minuta* | *S. antiphonitis* |
|---|---|---|---|
| Life form | annual | annual to perennial | annual |
| Habit | acaulescent to briefly scapose | acaulescent | acaulescent |
| Leaf rosette diameter (cm) | 1.2–2 | (2–) 2.5–6 | 1.5–5 |
| Leaf length (mm) | 4–12 | 7–30 | 6–18 |
| Leaf margin glands | no | yes | yes |

**Table 1.** *Cont.*

| Characters | *S. gutermannii* | *S. minuta* | *S. antiphonitis* |
|---|---|---|---|
| Leaf blade size (mm) | 2–5.5 × 1.2–3 | 3–14 × 2–7 | 2–8 × 1.5–7 |
| Petiole lenght (mm) | 2–8 | 3–13 (20) | 4–11 |
| Bracteole size (mm) | 1.5–2.7 × 0.2–0.3 | (2–) 2.5–4.5 × 0.3–0.7 | 1.8–2.5 |
| Bracteole hairs | 1 apical and 2–4 lateral | 1 apical and 2–4 lateral | 1–3 apical and 1–4 lateral |
| Bracteole glands | 1–2 per side | 1–2 per side | (1) 2–4 per side |
| Floral pedicel (mm) | 15–45 | 20–50 | 14–40 (55) |
| Calyx lenght (mm) | 2.5–3.3 | 3.5–4.5 (–5) | 2–2.5 |
| Calyx lobes lenght (mm) | 1.8–2 | (2–) 2.5–3.5 | 1.3–1.7 |
| Corolla colour | bluish-lilac | bluish-lilac | lilac to white-lilac |
| Corolla lenght (mm) | 6–7 | 7–10 | 5–6.5 |
| Corolla tube lenght (mm) | 2–2.5 | 2.5–3.5 | 3–3.5 |
| Lobes upper lip size (mm) | 2.5–2.7 × 1.0–1.2 | 3–4.2 × 1.2–1.4 | 2.7–2.9 × 1.4–1.5 |
| Lobes upper lip papillae | no | yes | yes |
| Lower lip lenght (mm) | 3.7–4.2 | 5–6 | 3.4–3.7 |
| Lower lip lobes size (mm) | 1.8–2.3 × 1.8–2.2 | 2.5–3.5 × 2.2–3.2 | 2.3-3.2 × 2.3-2.6 |
| Lower lip papillae | up to lobe base | up to lobe middle | up to lobe apex |
| Lower lip papillae lenght (mm) | 0.02–0.2 | 0.05–0.4 | 0.13–0.25 (0.38) |
| Staminal filament lenght (mm) | 3–3.5 | 3–5 | 2.5–3 |
| Anther tubo lenght (mm) | 1.0–1.1 | 1.1–1.3 | 0.8–1 |
| Style lenght (mm) | 3–3.5 | 3.5–4.0 | 3.5–3.6 |
| Capsule lenght (mm) | 1.8–2.0 | 2.5 | 2–3 |
| Capsule surface | papillose | smooth | smooth |
| Seeds (mm) | 0.36–0.40 × 0.20–0.25 | 0.48–0.50 × 0.24–0.25 | (0.33) 0.36–0.38 × (0.2) 0.23–0.25 |

## 3. Results

In addition to the results obtained from investigations of *S. gutermannii*, data concerning the closely related *S. minuta* are provided for comparative purposes. These data concern the morphology, nomenclatural aspects, phenology, distribution, ecology, conservation status, and micromorphology of the seed testa and pollen grains, and are based on living and herbarium material.

*Taxonomic Treatment*

**A) *Solenopsis gutermannii*** Brullo, Cambria, Costanzo& Giusso, ***sp. nov.*** Figures 1 and 2.

**Holotype:** GREECE. Ionian Islands, Kefalonia. Maspali, south of Mantzavinata, on wet clay outcrops, 25 m, 38°10′11″ N 20°24′47″ E, 5 May 2023, *S. Brullo*, *S. Cambria*, *E. Costanzo s.n.* (CAT). **Isotypes**: CAT, WU.

*Diagnosis*: *Solenopsis gutermannii* is similar to *S. minuta* in having usually rosulate leaves, bracteole indumentum, and corolla colour, but it differs in having a permanent annual habit, being acaulescent or briefly scapose, having a leaf rosette 1.2–2 cm in diameter, leaves no more than 12 mm long, with blade entire or weakly crenate without glands at the margin, usually smaller, with a smaller bracteole, smaller calyx (2.5–3.3 mm long), shorter calyx lobes, shorter corolla (6–7 mm long), smaller upper lips of the corolla (2.5–2.7 × 1.8–2.2 mm), not papillate, shorter lower lip of the corolla (3.7–4.2 mm long), papillate at the base, with papillae usually being shorter (0.02–0.2 mm), the staminal filaments and anther tube usually being shorter, the capsule being smaller and papillose, and the seeds smaller.

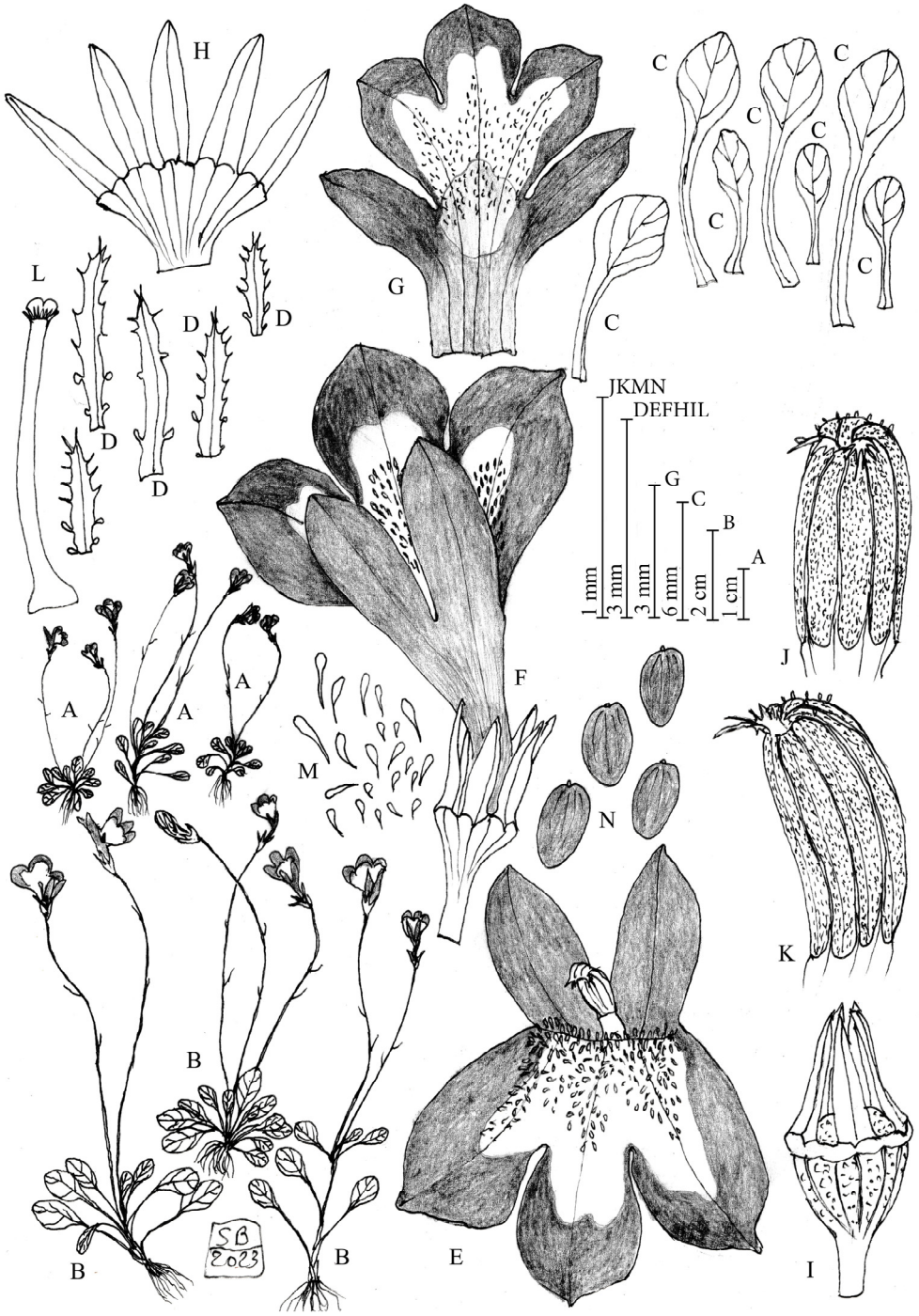



**Figure 1.** *Solenopsis gutermannii* from type locality. (**A**) Habit; (**B**) Habit magnification (×2); (**C**) Leaves; (**D**) Bracteoles; (**E**) Flower (frontal view); (**F**) Flower (lateral view); (**G**) Open corolla; (**H**) Open calyx; (**I**) Calyx with capsule; (**J**) Anthers (frontal view); (**K**) Anthers (lateral view); (**L**) Style and stigma; (**M**) Corolla papillae; (**N**) Seeds. Drawing: S. Brullo.

*Description:* Annual herb, acaulescent or briefly scapose, usually rosulate, 1.2–2 cm in diameter, provided with fibrose slender roots. Leaves 4–12 mm long, spathulate to oblanceolate, with blade entire to weakly crenate, glabrous, without glands, 2–5.5 × 1.2–3 mm, with petiole 2–8 mm long. Floral pedicels 15–45 mm, with 2 bracteoles, 1.5–2.7 mm long, 0.2–0.3 mm wide, with 4–8 hairs in the upper half, of which 1 apical and 2–4 per side, stipulated glands 1–2 per side in the lower half. Calyx 2.5–3.3 mm long, with linear-lanceolate lobes, 1.8–2 mm long, glabrous. Corolla 6–7 mm long, bilabiate, with tube pale lilac, 2–2.5 mm long, 0.6–0.7 mm in diameter; upper lip with two lobes lanceolate,

2.5–2.7 mm long, 1.0–1.2 mm wide, bluish-lilac, acute at apex, without glands; lower lip trilobed, 4.5–5.5 mm long, yellowish at the base, lobes widely ovate and apiculate, 1.8–2.3 × 1.8–2.2 mm, widely edged in bluish-lilac and irregularly white in the central part until the base, covered by dense papillae up to the base of the lobes, papillae 0.02–0.2 mm long. Stamen filaments free, 3–3.5 mm long, anthers violet, connate into a tube 1.0–1.1 mm long, wholly encapsulating the stigma; the two lower anthers are smaller, without papillae at base, each appendiculate at the top with a tuft of hairs, closing a narrow fissure; the three upper anthers are curved, hairy dorsally. Ovary fused with the calyx tube; style whitish, 3.0–3.5 mm long; stigma pale lilac, bifid, papillate, with a ring of hairs just under the base. Capsule papillose, 1.8–2 mm long. Seeds ellipsoid, brownish shining, 0.36–0.40 × 0.18–0.20 mm.

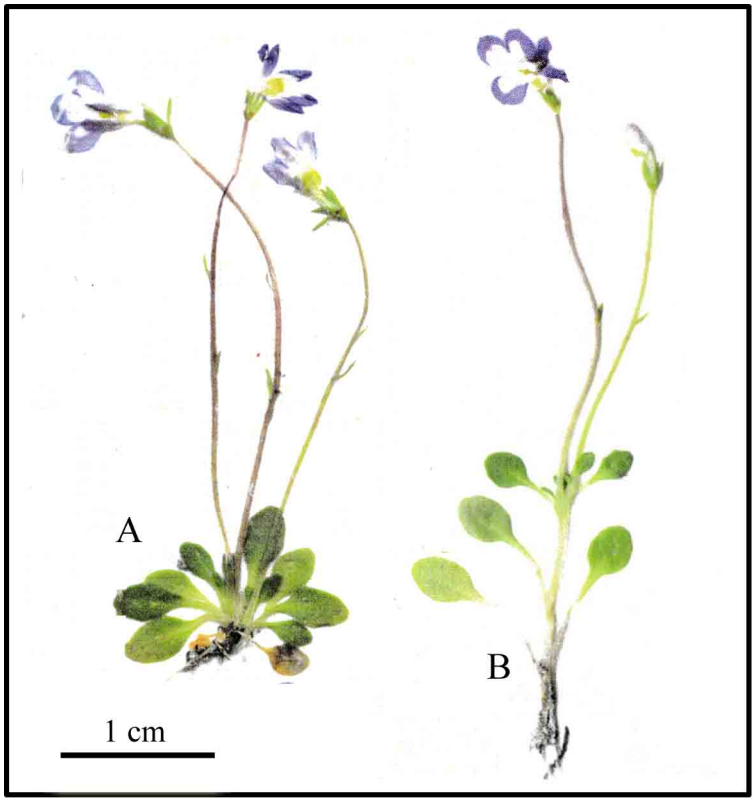



**Figure 2.** Habit of living plants of *Solenopsis gutermannii* from Kefalonia. (**A**) Stemless individual. (**B**) Caulescent individual.

*Etymology:* The species is dedicated to the late Walter Gutermann, Austrian botanist from Vienna (1935–2023), and expert on the flora of Austria and the Ionian Islands (Greece), who was the first to discover this species in Kefalonia.

*Phenology*: *Solenopsis gutermannii* flowers and fruits from late April until early June, based on field observations and cultivated plants in the Botanical Gardens of Catania.

*Distribution and ecology***:** *Solenopsis gutermannii* is an annual hygrophyte growing in wetlands, represented by large clayey depressions temporarily flooded by rainwater from winter until early spring. Based on current knowledge, it is found in a restricted area of Kefalonia island (Figure 3) in the Ionian archipelago (Greece), where it occurs in thick clay deposits localized in the southern part of Paliki Peninsula. These flat surfaces, that remain humid for much of the spring season (Figure 4), are colonized by an ephemeral vegetation characterized by some microphytes, such as *Lysimachia talaverae* L. Sàez & Aymerich, *Polypogon subspathaceus* Requien, *Centaurium tenuiflorum* (Hoffmanns. & Link) Fritsch, *Anthemis arvensis* L., *Trifolium resupinatum* L., *Daucus involucratus* Sm., *Blackstonia intermedia* (Ten.) Sennen ex Martinez, and exceptionally *Solenopsis laurentia*. These species grow

usually among muscinal carpets dominated by *Pleuridium acuminatum* Lindb., *Trichostomum crispulum* Bruch and *Fissidens gracilifolius* Brugg.-Nann. & Nyholm.

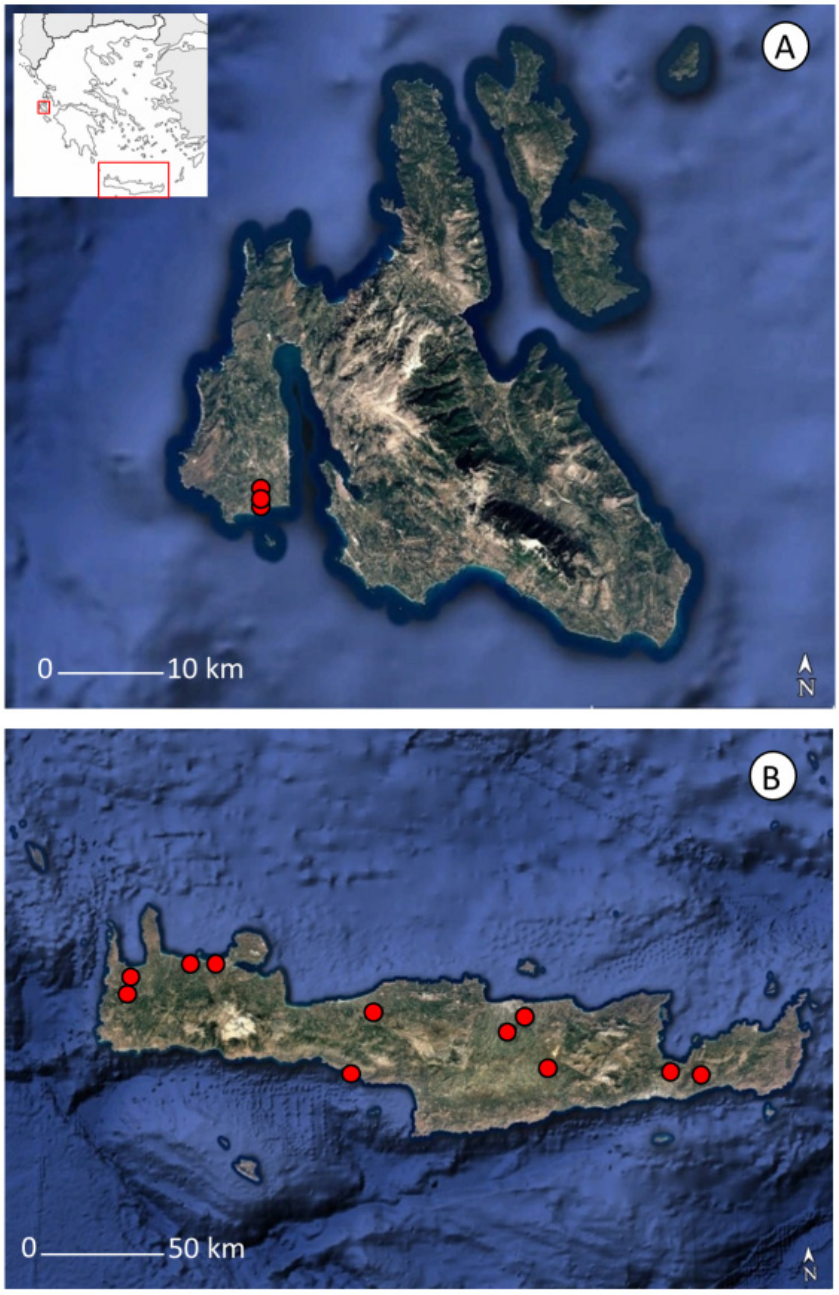



**Figure 3.** Distribution map of *Solenopsis gutermannii* from Kefalonia (**A**) and *S. minuta* from Crete (**B**) based on herbarium material (red dots).

*Conservation status*: *Solenopsis gutermannii* is localized in a peculiar landscape characterized by badlands with irregularly corrugated hills, furrowed by more or less deep watersheds, and shallow depressions that are periodically flooded. These habitats are used only moderately for goat grazing and are not exposed to any immediate threats. It should be noted, however, that near the coast, this interesting natural landscape has recently been altered by anthropic activities linked to tourism. Therefore, for long-term preservation of this species, it is recommended that public authorities implement suitable safeguard measures, including the designation of this area as a protected site (e.g., Natura 2000). Given that this species occurs primarily in three close locations, one with high abundance and two with rather sporadic populations, and that the total number of mature individuals

is fewer than 10,000, all distributed over a surface area < 20 km$^2$, this species should be considered as Vulnerable (VU D2) according to IUCN criteria [20].




**Figure 4.** Phenological features of *Solenopsis gutermannii.* (**A**) Natural habitat (Kefalonia). (**B**) Habit. (**C**) Flower (frontal view). (**D**) Flower (lateral view). Photos by S. Cambria.

***B) Solenopsis minuta*** (L.) C. Presl, Prodr. Monogr. Lobel. 32, 1836 (Figure 5).

***Neotype:*** GREECE. Crete, Rapuntium Creticum, minimum, Bellidi folio, flore maculato, Coroll. Inst. R. Herb. 9, *Tournefort 861*, Herbier de Vaillant (P00260368), designated by Meikle [21].

Syn.: *Lobelia minuta* L., Mantissa Plantarum Altera: 292, 1771; *Laurentia minuta* (L.) DC., Prodromus 7: 410, 1839; *Lobelia pumila* Salisb., Prodromus Stirpium Chap. Allerton: 129, 1796; *Rapuntium minutum* (L.) Chaz., Supplementum Dict. Jard. 2: 400. 1790; *Lobelia setacea* Sm. in Sibth. & Sm., Fl. Graec. Prodr. 1:145 (1806), non Thunb., Phytogr. Bl. [Hoffm.] 1: 21 (1803).

*Description*: Perennial or annual herb, acaulescent, rosulate, 2.5–6 cm in diameter, provided with fibrose slender roots. Leaves 7–30 mm long, spathulate to oblanceolate, with blade slightly crenate, glabrous, with a small gland in the incisions, 3–14 × 2–7 mm, with petiole 3–13 mm long. Floral pedicels 20–50 mm, with two bracteoles, 2.5–4.5 mm long, 0.3–0.7 mm wide, with 4–8 hairs in the upper half, of which 1 apical and 2–4 per side, stipulated glands 1–2 per side in the lower half. Calyx 3.5–4.5 (5) mm long, with linear-lanceolate lobes, 2.5–3.5 mm long, glabrous. Corolla 7–10 mm long, bilabiate, with tube pale lilac, 2–3.5 mm long, 0.7–0.8 mm in diameter; upper lip with 2 lobes lanceolate, 3–4.2 mm long, 1.2–1.4 mm wide, bluish-lilac, acute at apex, ventrally with scattered papillae; lower lip trilobed, 3.7–4.2 mm long, yellowish-green at the base with three small bluish spots at the edges, lobes widely ovate and apiculate at the apex, 2.5–3.5 × 2.2–3.2 mm, widely edged in bluish-lilac and irregularly white in the central part until the base, covered by dense papillae almost to the middle of the lobes, papillae 0.05–0.4 mm long. Stamen filaments free, 3–4 mm long, anthers violet, connate into a tube 1.2–1.3 mm long, wholly encapsulating the stigma; the two lower anthers are smaller, without papillae at basis, each appendiculate at the top with a tuft of hairs, closing a narrow fissure; the three upper anthers are curved,

hairy dorsally. Ovary fused with the calyx tube; style whitish, 3.5–4 mm long; stigma pale lilac, bifid, papillate, with a ring of hairs just under the base. Capsule smooth, 2.5 mm long. Seeds oblong, brownish shining, 0.36–0.45 × 0.21–0.24.

*Iconography:* t. 221 Sibthorp & Smith [22], as *Lobelia setacea*.

*Phenology: Solenopsis minuta* flowers and fruits from late April until August (rarely September), based on field observations and herbarium material.

*Distribution and ecology*: *Solenopsis minuta* is widespread in several localities of Crete (Greece), where it occurs from sea level up to approximately 1300 m (Figure 2). It grows usually in wetlands, represented by surfaces flooded during winter, which remain humid until the end of summertime. The habitats colonized by this species are more or less cool and shaded, since they are located in environments sheltered from direct sunlight, such as near rocky walls or underwood. This hygrophyte grows in sandy-loamy or clayey soils, where it tends to form small populations that are often almost monophytic and remain in flower for several months.

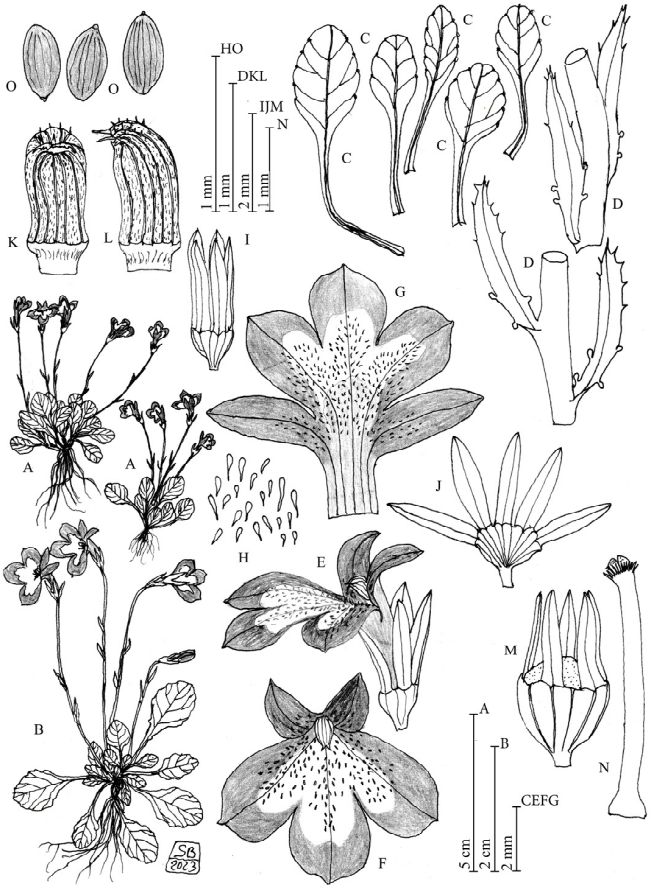



**Figure 5.** *Solenopsis minuta* from living plant sourced from Preveli Beach (Crete) collected by S. Cambria. (**A**) Habit; (**B**) Habit magnification (×2); (**C**) Leaves; (**D**) Bracteoles; (**E**) Flower (lateral view); (**F**) Flower (frontal view); (**G**) Open corolla; (**H**) Corolla papillae; (**I**) Calyx; (**J**) Open calyx; (**K**) Anthers (ventral view); (**L**) Anthers (lateral view); (**M**) Calyx with capsule; (**N**) Style and stigma; (**O**) Seeds. Drawing: S. Brullo.

Pollen grains micromorphology: SEM investigations carried out on dried pollen grains of *Solenopsis gutermannii* revealed that they are, as well as all other previously studied species [3,4,23], 3-colporate with a perplorate shape. In particular, the pollen is ellipsoid, measuring 37.0–41.5 µm in length and 15.0–20.0 µm in width (Figure 6C), with sexine loosely reticulate, characterized by slightly convex and irregularly anastomosed branched lirae, usually not overlapping, with a thickness of 0.2–0.5 µm, delineating irregular lumina

0.6–1.5 µm in diameter. Pollen grains of *S. minuta* are ellipsoid-fusiform, shorter, measuring 33.5–37.0 µm in length and 17.2–17.8 µm in width (Figure 6F), characterized by markedly convex and irregularly anastomosed branched lirae, clearly overlappimg, with a thickness of 0.1–0.2 µm, delineating irregular lumina 0.1–0.3 µm in diameter.

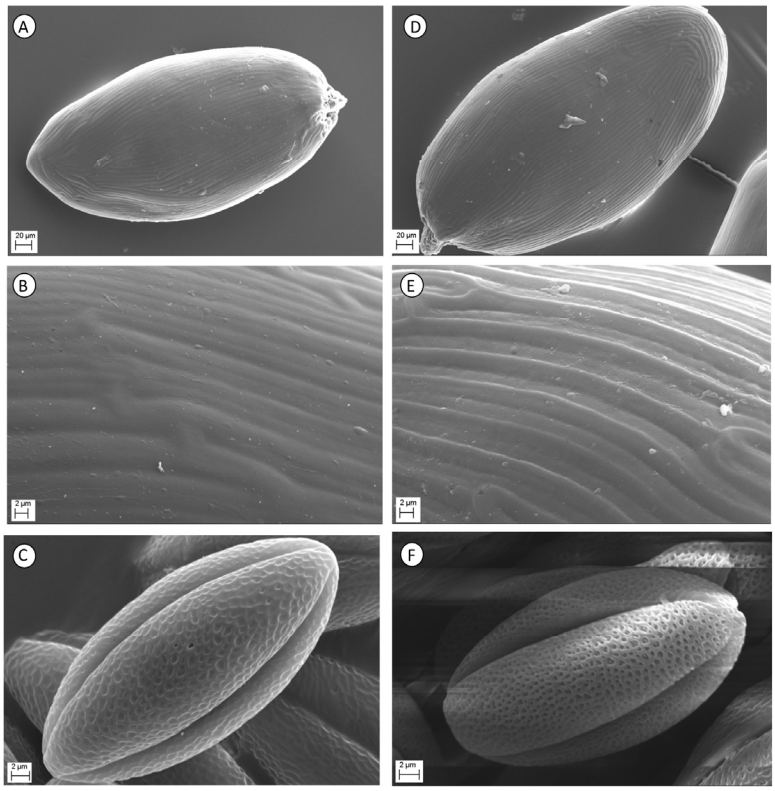



**Figure 6.** SEM micrographs of seed coat (**A**,**B**) and pollen grain (**C**) of *Solenopsis gutermannii* and seed coat (**D**,**E**) and pollen grain (**F**) of *S. minuta*. (**A**,**D**) Seed shape (×250). (**B**,**E**) Detailed seed testa (×1000). (**C**,**F**). Pollen grain equatorial view (×2800).

*Seed micromorphology*: According to the literature [1,24–27], the ornamentations of the seed coat surface in the Lobelioideae subfamily (Campanulaceae) have a remarkable diagnostic value and also phylogenetic significance. *Solenopsis* was investigated by [1–5,27], who emphasized that the seed coat sculptures are quite similar across all species. In particular, the seed testa is longitudinally furrowed by long and narrow cells, which are incised on the back by a superficial groove. The SEM investigation carried out on *S. gutermannii* highlighted that the seeds (Figure 6A) typically have an elliptical shape and are slightly apiculate at the extremities, with a size of 0.36–0.40 × 0.18–0.20 mm. Regarding the seed testa, the cells show flatter and broader periclinal walls, 16–24 µm wide, crossed by a thin central ridge, with shallow and often inconspicuous anticlinal walls, 1–1.5 µm wide (Figure 6B). In *S. minuta*, the seeds (Figure 6D) typically have an oblong shape and are rounded at the extremities, with a size of 0.36–0.45 × 0.21–0.24 mm. Regarding the seed testa, the cells show raised and narrower periclinal walls, 10–14 µm wide, without a central ridge, with flat and often inconspicuous anticlinal walls, 8–10 µm wide (Figure 6E).

**Specimens examined of *Solenopsis gutermannii* (Paratypes):** GREECE. Ionian Islands: Insel Kefallinía (Nom. Kefallinías). Palikí: Hügel Maspáli (Kote 101 m) S Mantzavináta, Therophytenrasen frühjahrsfeuchter Mulden (Tonmergel), 40–100 m, 27 April 1995, *W. Gutermann 29236* (WU-GUT!) sub »*S. notabilis* ined.«; Ionische Inseln, Insel Kefallinía (Nom. Kefallinías). Palikí: Hügel Maspáli S von Mantzavináta, Feuchte Senke, 40–100 m, 27 April 1995, *E. Hörandl*, *F. Hadaček*, *W. Gutermann*, *L. Mucina 6515* (W0279148!) sub *S. minuta* subsp. *annua*; Ionische Inseln, Insel Kefaloniá (Nom. Kefaloniás). Palikí: Ak. Xi,

Hügelland [»Stráfi«] nordwestlich ober dem Kap (2–2½ km SSW Mantzavináta), Therophytenflur feuchter Mulden, über Tonmergel, 0–20 m, 18 April 1997 *W. Gutermann* et al. *31500* (WU-GUT!) sub »*S. notabilis* ined.«; Kefalonia: offene vegetation über mergel, Kap Xi bei Strati und ostl.anschlicßende Flachküste, Kephallinia, 18 April 1997, *M. Staudinger K8/12* (W0279146) sub *S. minuta*; Insel Kefalonià (Nom. Kefaloniàs), Paliki, Hügel Maspàli SSE Mantzavinata: Sudflanke. Phrygana, Therophytenfluren über kalk und Tonmergeln, 30–60 m, 1 May 2011, *W. Gutermann* et al. *40150* (WU082849, WU082850, CBH00277) sub *S. minuta* subsp. *annua* (*S. notabilis*).

**Specimens examined of *Solenopsis minuta*:** GREECE. Crete: Creta, s.d., *J. Sibthorp s.n.* (W0279145), as *Lobelia laurentia*; Turtuli in Creta, s.d., *F.W. Sieber s.n.* (P00260367, BR0000028176176), as *Lobelia laurentia* (*L. setacea*); Ile de Crete, 1817, *F.W. Sieber s.n.* (BR0000028176282); Tortuli, 1826, *F.W. Sieber s.n.* (G-DC00329489); Crete, s.d., *F.W. Sieber s.n.* (G-BOISS00731732); Region des plaines basses (0–150 m), prairies autour de Khaina (La Canée), 12 May 1845, *V. Raulin 344* (P00260357, P00260358); Champs, prairies de Khaina, Malaya, May 1845, *V. Raulin 344* (G-BOISS00781681); Ad scaturigines prope Skilons distr. Peshiadaha, 26 Juin 1899, *A. Baldacci 184* (P00260346, P00260347, P00260348); Candia, s.d., *G.A. Olivier 436* (P00260343); Distr. Hagios Vasilis. An Strassenböschungen bei Spili, 15 June 1904, *J. Dörfler 669* (P00260349); Ad fontis et in umidis, April 1846, *T. de Heldreich s.n.* (P00260350); In locis semper inundatis ad scaturigines et fontes ins. Cretae, vulgaris crescit, April–May 1846, *T. de Heldreich 1365* (G-BOISS00761705); Ad scaturigines vulgaris, May 1846, *T. de Heldreich s.n.* (P00260352, P00260353, P00260354, G00781703); Prope pagum Archanes in eparchia Temenes ad radices Dichtaei montis, alt. 1200′–1400′, 30 August 1987, *T. de Heldreich 1365* (BR0000028176244); In eparchia Temenes in valle Kartero to Pharaggi pr. Skaloni, 3 August 1970, *T. de Heldreich 1765* (G-BOISS00781704); Kimassos, lieux arides, 19 May 1884, *E. Reverchon 100* (P00360366), as *Laurentia cretica* Juss.; In humidis ad Kasteli et Lusakies, 21.22 July 1893, *A. Baldacci 31* (P00260345); Marais de Platania, lieux secs et arides, 4 June 1883, *E. Reverchon 100* (P00260360, P00260362, P00260363, P00260364, BR0000028176244), as *Laurentia cretica* Juss.; Marais de Platania, lieux secs et arides, 4 June 1883, *E. Reverchon s.n.* (FI, BR0000028176244), as *Laurentia cretica* Juss.; Chania, Faraggi Prevelis Chelidorion North of Preveli Beach, degradaded garigue, pelouse with small spimy shrubs on a moist and a bit muddy place, 1 May 2015, *E.L.A.N. Simons 1708* (WAG1963774); Eparchia Rethimni: Sphakoriako-Tal, S-Teil der Prasiano-Schludit 35°19′ N 24°33′ E, Schattungen Schluchtgrund, 90 m, 16 June 1982, *Risse 62* (PAL-Gr34669); District Hagios Vassilis, Spili, 15 June 1904, *I. Dörfler 669* (PAL-Gr5791); Province Iraklion, Panagia, W slope at Dikti Mts, 500 m, 26 May 1983, *K. Larsen 38467* (PAL-Gr); Ep. Ierapetra-Sitia: ad molas aquaria Psichro, inter Aj. Joànias et Schinokäpsala, 450 m. In rupestribus irriguis secum viam frequens, 28 September 1966, *W. Greuter 7819* (PAL-Gr); Ep. Ierapetra/Sitia: b. Aòri am Sattel zw. den Bergen Skliròs u. Afendi Kavusi 1000 m ü.m. Lahmboder, Borde einer Quelle u. des Quellbächleins mit Samolus, 18 June 1961, *W. Greuter s3600* (PAL-Gr): Krete: Eparchie Rethimni: Tal des Sfakoriako S der Prasino Schlucht. 24 May 1982, *J. J. Greuter, W. Greuter, U. Matthäs & H. Risse 19301* (B100365591); Crete, Kissamos, Deliana Gorge, 240 m a.s.l., 28 April 2022, *S. Cambria s.n.* (CAT); Crete, Kissamos, Deliana Gorge, 240 m a.s.l., 28 May 2022, cultivated, *S. Cambria s.n.* (CAT); Crete, Chania, Preveli beach, among the palm trees, 10 m a.s.l., 23 April 2022, *S. Cambria s.n.* (CAT); Crete, Kissamos, Messavlia Gorge, 400 m a.s.l., 28 April 2022, *S. Cambria s.n.* (CAT).

**Specimens examined of *Solenopsis antiphonitis*:** CYPRUS. Division 7, Kalograia, Argaki tous Maronites, ca. 2 km W of Agias Paraskevi, humid ground in stream bed, alt. c. 250 m, 3 May 2007, *R. Hand & J. Hadjikyriakou 5340* (B100387077); Argaki tous Maronites, E of Kalograia, above Agia Marina, moist rocky places in stream bed, 200–255 m, 28 June 2005, *J. Hadjikyriakou 6677* (B100206634, B100206635, JE00007270).

## 4. Conclusions

Based on this investigation, *Solenopsis gutermannii* is an annual species usually characterized by leaves in basal rosettes with flowers carried by pedicels that depart from the base, having divaricate and bicolored corolla. However, it sometimes exhibits a shortly caulescent habit with leaves inserted along the scape. These characteristics were previously known only in *S. minuta* from Crete and *S. antiphonitis* from Cyprus (Figure 7). Compared to *S. minuta*, *S. gutermannii* usually shows a more reduced size with smaller basal rosettes and smaller flowers, as well as sometimes a shortly caulescent habit. It is also differentiated by leaves up to 12 mm long (vs. up to 30 mm) without glands at the margin, usually with a smaller blade, petioles with bracteoles 1.5–2.7 mm long (vs. 2.5–4.5 mm), calyx 2.5–3.3 mm long (vs. 3.5–5 mm) with lobes 1.8–2 mm long (vs. 2–3.5 mm), corolla 6–7 mm long (vs. 7–10 mm) with tube 2–2.5 mm long (vs. 2.5–3.5 mm), lobes of the upper lip 2.5–2.7 mm long (vs. 3–4.2 mm) without papillae (vs. present papillae), lower lip 3.7–4.2 mm long (vs. 5–6 mm) with lobes 1.8–2.3 × 1.8–2.2 mm (vs. 2.5–3.5 × 2.2–3.2 mm), covered with papillae up to the lobes base (vs. up the lobes middle) up to 0.2 mm long (vs. up to 0.4 mm), style 3–3.5 mm long (vs. 3.5–4 mm), capsule 1.8–2 mm long (vs. 2.5 mm) and papillose (vs. smooth), and seeds 0.36–0.40 mm long (vs. 0.48–0.50 mm).

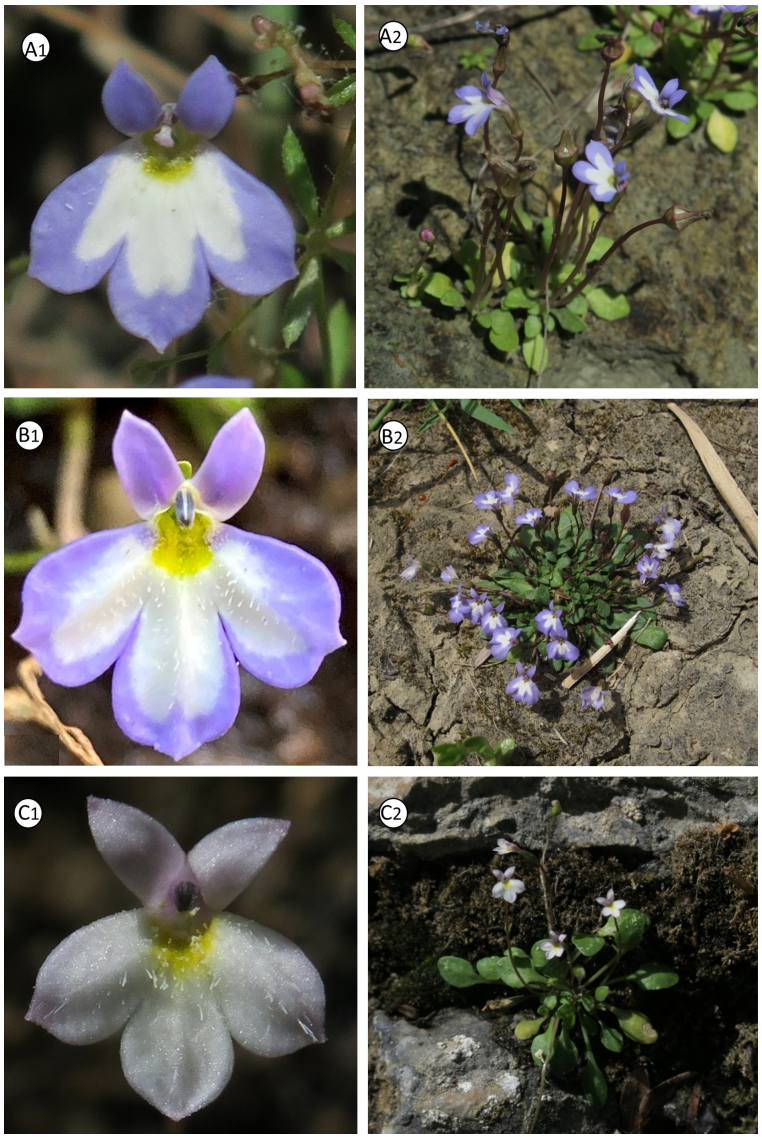



**Figure 7.** Comparative phenological features of *Solenopsis gutermannii* (**A**), *S. minuta* (**B**), and *S. antiphonitis* (**C**). **1.** Flower. **2.** Habit. (Photos by S. Cambria).

*S. antiphonitis* represents another species showing some taxonomic affinities with *S. gutermannii*, since it is also annual, with leaves in basal rosettes, reduced bracteoles, corolla having the same shape, and seeds of quite similar size, but they are well distinguished by numerous other morphological features. The characters that allow differentiation of *S. antiphonitis* from *S. gutermannii* are the leaves that tend to reach a larger size, with blades up to 8 mm long (vs. max. 5.5 mm), with glands on the margin (vs. no glands), bracteoles with one apical hair (vs. 1–3) and with 1–2 pairs of glands (vs. 2–4), calyx 2–2.5 mm long (vs. 2.5–3.3 mm) with lobes 1.3–1.7 mm long (vs. 1.8–2 mm), corolla lilac to white-lilac (vs. bluish-lilac) and 5–6.5 mm long (vs. 6–7 mm) with tube 3–3.5 mm long (vs. 2–2.5 mm), upper lip with lobes 2.7–2.9 × 1.4–1.5 mm long (vs. 2.5–2.7 × 1–1.2 mm) with papillae (vs. no papillae), lower lip 3.4–3.7 mm long (vs. 3.7–4.2 mm) with lobes 2.3–3.2 × 2.3–2.6 mm (vs. 1.8–2.3 × 1.8–2.2 mm), papillae up to lobe apex (vs. up to lobe base), up to 0.38 mm long (vs. 0.2 mm), and a smooth capsule that is 2–3 mm long (vs. papillose and 1.8–2 mm long). Regarding their ecological requirements, *S. gutermannii* and *S. minuta* are localized on flat surfaces constituted by clay soils that are periodically flooded, but remain damp for more or less long periods. However, *S. gutermannii* has a more ephemeral life cycle, since the soils dry out faster and it usually grows together with numerous highly specialized hygrophilous microphytes, while *S. minuta* is found in soils that remain humid even in the summer period and usually is part of almost monophytic plant communities. Conversely, *S. antiphonitis* grows on small inclined rocky surfaces, subject to dripping and covered by a quite large moss layer.

## 5. Identification Key for *Solenopsis* Genus

On the basis of current knowledge on the genus *Solenopsis* [1–6], an analytical key is elaborated to accommodate all taxa recognized or quoted in the recent literature [28]. Regarding *S. laurentia* subspecies, refer to Brullo et al. [4], and for those of *S. bivonae*, refer to Brullo et al. [5].

1. Plant erect to subacaulescent, with leaves and flower pedicels all or partially inserted on the stem.....2

1′. Plant stemless (rarely subcaulescent); leaves all rosulate and flower pedicels inserted at the base.....4

2. Corolla with lobes always patent, lower lip widely white in the central part and lilac to bluish at the margins.....*S. bicolor*

2′. Corolla with lobes connivent or slightly divaricate, uniformly coloured.....3

3. Flower pedicels provided with one bracteole; calyx 2–2.5 mm long; corolla white, 3–3.5 mm long.....*S. mothiana*

3′. Flower pedicels usually provided with two bracteoles; calyx 2.5–5 mm long; corolla blue-lilac, 3.5–6 mm long.....*S. laurentia*

4. Plant always annual.....5

4′. Plant perennial (sometimes annual).....6

5. Leaf blade without glands at the margin; calyx 2.5–3.3 mm long; corolla bluish-lilac, with tube 2–2.5 mm long and lower lip with papillae at the base; capsule 1.8–2 mm long.....*S. gutermannii*

5′. Leaf blade with glands at the margin; calyx 2–2.5 mm long; corolla lilac to white-lilac with tube 3–3.5 mm long and lower lip with papillae up to lobe apex; capsule 2–3 mm long.....*S. antiphonitis*

6. Corolla lips uniformly dark blue-lilac (rarely white near the throat).....7

6′. Corolla lips bluish-lilac, white in central part of lower lip.....8

7. Bracteoles with 4–10 hairs on each side; corolla 13–16 mm long, with upper lip acute, 2.5–3.3 mm long; papillae covering only the throat of the lower lip; seeds 0.50–0.52 mm long and 0.30–0.32 mm wide.....*S. bacchettae*

7′. Bracteoles with 0–4 hairs on each side; corolla 6.3–6.5 mm long, with upper lip obtuse, 5–7 mm long; papillae covering the lower lip up to the lobe base; seeds 0.40–0.44 mm long and 0.24 mm wide.....*S. corriasii*

8. Leaves hairy.....9

8′. Leaves glabrous or rarely subglabrous.....11

9. Leaves irregularly lobate, with petiole 15–20 mm long; calyx 3.5–4.5 mm long; corolla 7–9 mm long; anther tube dorsally hairy; capsule 1–2 mm long.....*S. balearica*

9′. Leaves entire or slightly crenate, with petiole 2–15 mm long; calyx 2.4–3 mm long; corolla 4–4.5 mm long; anther tube dorsally glabrous; capsule 2–2.5 mm long.....10

10. Bracteoles with 3–6 lateral hairs; calyx 2.5–3 mm long; corolla with upper lip 1.4–1.5 mm long and lower lip ovate and obtuse; papillae 2–4 in the basal part of lower lip, 0.18–0.3 mm long; anther tube without basal papillae.....*S. corsica*

10′. Bracteoles with 7–12 lateral hairs; calyx 2.4–2.5 mm long; corolla with upper lip 1.8–2 mm long and lower lip widely ovate and mucronate; papillae densely covering the throat and the basal part of the lower lip, 0.08–0.15 mm long; anther tube with two tufts of basal papillae.....*S. limbarae*

11 Leaves max. 30 mm long, with blade max 14 mm long and 7 mm wide; flower pedicel max. 50 mm long; corolla with upper lip 2.5–2.7 mm long.....*S. minuta*

11′ Leaves up to 100 mm long, with blade up to 40 mm long and 15 mm wide; flower pedicel up to 120 mm long; corolla with upper lip 3–6 mm long.....12

12 Corolla lips pale blue to pale violet; corolla throat uniformly greenish-yellow; lower lip of corolla with lobes oblong, anther tube 1–1.5 mm long; style 3.5–4 mm long.....*S. meikleana*

12′ Corolla lips bluish-lilac; corolla throat yellowish to greenish bordered of brown; lower lip of corolla with lobes ovate; anther tube 1.4–1.9 mm long; style 4–7 mm long.....*S. bivonae*

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## References

1. Crespo, M.B.; Serra, L.; Juan, A. *Solenopsis* (Lobeliaceae): A genus endemic in the Mediterranean Region. *Plant Syst. Evol.* **1998**, *210*, 211–229. [CrossRef]
2. Brullo, C.; Brullo, S.; Giusso Del Galdo, G. *Solenopsis mothiana* (Campanulaceae), a new species from Sicily. *Phytotaxa* **2013**, *145*, 15–26. [CrossRef]
3. Brullo, S.; Brullo, C.; Tavilla, G.; Siracusa, G.; Cambria, S. *Solenopsis bacchettae* (Campanulaceae, Lobelioideae), a new species from Sardinia. *Nordic J. Bot.* **2022**, *2023*, e03773. [CrossRef]
4. Brullo, S.; Brullo, C.; Cambria, S.; Minissale, P.; Sciandrello, S.; Siracusa, G.; Tavilla, G.; Tomaselli, V.; Giusso del Galdo, G. Taxonomical remarks on *Solenopsis laurentia* (Campanulaceae) in Italy. *Phytotaxa* **2023**, *584*, 59–88. [CrossRef]
5. Brullo, S.; Brullo, C.; Cambria, S.; Tomaselli, V.; Crisafulli, A.; Siracusa, G.; Minissale, P.; Giusso del Galdo, G.G. Taxonomic and ecological remarks on *Solenopsis bivonae* species complex (Campanulaceae). *PhytoKeys* **2023**, *229*, 77–111. [CrossRef] [PubMed]

6. Brullo, S.; Calvia, G.; Cambria, S.; Siracusa, G.; Giusso del Galdo, G.; Bacchetta, G. Taxonomical remarks on *Solenopsis corsica* (Campanulaceae) species complex, with the description of two new species from Sardinia. *Phytotaxa* **2024**, *677*, 233–250. [CrossRef]
7. Tomaselli, V.; Beccarisi, L.; Brullo, S.; Cambria, S.; Forte, L.; Minissale, P.; Veronico, G. Phytosociological research on temporary ponds in Apulia (southern Italy). *Medit. Bot.* **2020**, *41*, 15–41. [CrossRef]
8. Greuter, W.; Matthäs, U.; Risse, H. Additions to the flora of Crete, 1973–1983, I. *Willdenowia* **1984**, *14*, 27–36.
9. Christodoulou, C.S.; Hand, R.; Iosif, K. *Solenopsis annua* comb. nov., a new taxon for Cyprus. *Cypricola* **2020**, *17*, 1–8.
10. Gutermann, W. *Catalogus Abbreviatus Plantarum Vascularium ex Ionii Insulis Cognitarum. [Editio Reformata (Bryophytos Includens) Ad Usum Scientiae Amabilis Studiosorum Itineris 1997 Mediterranei Participium]*; Inst. Bot. Univ. Wien, 1997; pp. 1–76. Available online: https://floraionica.univie.ac.at/index.php?site=5&opt=single&lit=767 (accessed on 24 February 2025).
11. Flora Ionica Working Group (2016 Onwards): Flora Ionica—An Inventory of Ferns and Flowering Plants of the Ionian Islands (Greece). Available online: https://floraionica.univie.ac.at (accessed on 19 December 2024).
12. Thiers, B. *Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff*; New York Botanical Garden's Virtual Herbarium. Available online: http://sweetgum.nybg.org/ih (accessed on 19 December 2024).
13. Barthlott, W. Epidermal and seed surface characters of plants: Systematic applicability and some evolutionary aspects. *Nord. J. Bot.* **1981**, *1*, 345–355. [CrossRef]
14. Barthlott, W. Microstructural features of seed surface. In *Current Concepts in Plant Taxonomy*; Heywood, V.H., Moore, D.A., Eds.; Academic Press: London, UK, 1984; pp. 95–105.
15. Gontcharova, S.B.; Gontcharov, A.A.; Yakubov, V.V.; Kondo, K. Seed surface morphology in some representatives of the genus *Rhodiola* sect. *Rhodiola* (*Crassulaceae*) in the Russian Far East. *Flora* **2009**, *204*, 17–24. [CrossRef]
16. Walker, J.W.; Doyle, J.A. The bases of angiosperm phylogeny: Palynology. *Ann. Mo. Bot. Gard.* **1975**, *62*, 664–723. [CrossRef]
17. Punt, W.; Blackmore, S.; Nilsson, S.; Le Thomas, A. *Glossary of Pollen and Spore Terminology*; Lpp Foundation: Utrecht, Germany, 1994; pp. 1–71.
18. Punt, W.; Hoen, P.P.; Blackmore, S.; Nilsson, S.; Le Thomas, A. Glossary of pollen and spore terminology. *Rev. Palaeobot. Palynol.* **2007**, *143*, 1–81. [CrossRef]
19. Hesse, M.; Halbritter, H.; Zetter, R.; Weber, M.; Buchner, R.; Frosch-Radivo, A.; Ulrich, S. *Pollen Terminology. An Illustrated Handbook*; Springer: Wien, Austria, 2009; pp. 1–264.
20. IUCN Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. Prepared by the Standards and Petitions Subcommittee, Cambridge U.K. Available online: http://iucnredlist.org/documents/RedListGuidelines.pdf (accessed on 19 December 2024).
21. Meikle, R.D. Some notes on *Laurentia* Adanson (Campanulaceae). *Kew Bull.* **1979**, *34*, 373–375. [CrossRef]
22. Sibthorp, J.; Smith, J.E. *Flora Graeca: Sive Plantarum Rariorum Historia Quas in Provinciis Aut Insulis Graeciae*; Richardi et Arthurii Taylor: London, UK, 1819; Volume 3, pp. 1–93.
23. Dunbar, A. On the pollen of Campanulaceae and related families with special reference to the surface ultrastructure. II. Campaulaceae Subfam. Cyphoideae and Subfam. Lobelioideae; Goodeniaceae, Sphenocleaceae. *Bot. Not.* **1975**, *128*, 102–118.
24. Murata, J. Systematic implications of seed coat morphology in *Lobelia* (Campanulaceae—Lobelioideae). *J. Fac. Sci. Univ. Tokyo Sect. 3 Bot.* **1992**, *15*, 155–172.
25. Murata, J. A revision of infrageneric classification of *Lobelia* (Campanulaceae—Lobelioideae) with special reference to seed coat morphology. *J. Fac. Sci. Univ. Tokyo Sect. 3 Bot.* **1995**, *15*, 349–371.
26. Haridasan, V.K.; Mukherjee, P.K. Seed surface features in Indian Lobeliaceae. *Phytomorphology* **1993**, *43*, 287–294.
27. Serra, L.; Crespo, M.B. An outline revision of the subtribe Siphocampylinae (Lobeliaceae). *Lagascalia* **1997**, *19*, 881–888.
28. POWO Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Available online: http://www.plantsoftheworldonline.org/ (accessed on 19 December 2024).


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