

Campanula alisan-kilincii (Campanulaceae), a new species from eastern Anatolia, Turkey

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Abstract: *Campanula alisan-kilincii* Yıldırım & Şenol (Campanulaceae) is described and illustrated as a new species from Malatya Province in eastern Anatolia, Turkey. The new species belongs to the section *Rupestres*, based on morphological features. It is morphologically similar to *Campanula quercetorum* and *C. strigillosa* but clearly differs from them based on the morphological differences presented in the species description. In addition, the conservation status, the distribution map, and notes on the biogeography and ecology of the new species are given.

Key words: *Campanula*, *Rupestres*, rupicolous species, ecology, conservation, taxonomy

1. Introduction

The genus *Campanula* L. includes approximately 420 species, which are widely distributed in temperate and subtropical zones of the northern hemisphere (Lammers, 2007). Its center of diversity is in the Mediterranean region extending to the East Caucasus. Endemic species are particularly concentrated in the eastern Mediterranean region, the Balkan Peninsula, the Caucasus, and Turkey (Borsch et al., 2009; Khansari et al., 2012).

In terms of life-span, *Campanula* consists of annual, biennial, and perennial species that show variations in habit from dwarf arctic and alpine species to large temperate grassland and woodland species (Khansari et al., 2012). Most of the *Campanula* species are edaphically and microclimatically specialized chasmophytes. For this reason, many endemic species of *Campanula* are distributed in very local areas (Damboldt, 1965; Kovanda, 1970; Park et al., 2006). *Campanula* is represented by 125 species in Turkey and about half of them are endemic (Damboldt, 1978; Davis et al., 1988; Güner, 2000; Akçiçek et al., 2005; Özhatay and Kültür, 2006; Kandemir, 2007; Özhatay et al., 2009; İlçim et al., 2011; Yıldırım, 2013). *Campanula* subgenus *Campanula* comprises 13 sections in Turkey. The section *Rupestres* (Boiss.) Charadze of subgenus *Campanula* is represented by 25 species in Turkey, 20 of which are endemic (Damboldt, 1978; Davis et al., 1988; Güner, 2000; Özhatay and Kültür, 2006; Özhatay et al., 2009).

In recent years, technological improvements in DNA techniques provided new insights to the taxonomically problematic genus *Campanula* (Eddie et al., 2003; Haberle et al., 2009; Roquet et al., 2009; Mansion et al., 2012). The most comprehensive phylogenetic study to date of *Campanula* was recently done by Mansion et al. (2012), who investigated the phylogenetic relation of *Campanula* species and allies. In the scope of this study, the petD regions of cpDNA of 310 *Campanula* species were sequenced and *Campanula* species were subdivided into 17 well-supported major clades.

Malatya is located in the eastern part of Turkey, one of the main endemism centers in the country. The province is also floristically one of the richest in Turkey (Yıldız et al., 2003). Many new plant species still continue to be discovered in Malatya (Yıldırım et al., 2010; Mutlu and Karakuş, 2012; Tan et al., 2012; Koç and Aksoy, 2013; Yıldırım and Erol, 2013).

In June 2010, while conducting a field trip in the Levent Canyon in Malatya, eastern Anatolia, unusual specimens of *Campanula* were collected by Alişan Kılınç and the authors. At first glance, they were morphologically similar to *Campanula quercetorum* Hub.-Mor. & Simon and *C. strigillosa* Boiss. However, after careful comparison with herbarium specimens (ANK, EGE, G, GAZI, and HUB) and relevant literature (Boissier, 1875; Fedorov, 1957; Rechinger and Schimann-Czeika, 1965; Damboldt, 1976, 1978; Fedorov and Kovanda, 1976; Davis et al.,

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1988; Güner, 2000; Özhatay and Kültür, 2006; Özhatay et al., 2009), we concluded that these specimens are new to science.

2. Materials and methods

Gross morphology of the new species was examined by stereo-binocular microscope. At least 20 mature seeds and 30 pollen grains were measured using light microscopy. For scanning electron microscopy (SEM), the selected seed and pollen grains were placed on aluminum stubs using double-sided adhesive tape, sputter coated with gold using an Emiteck K550, and then examined using the FEI

Quanta250 FEG and JEOL Neoscope JCM-5000 scanning electron microscope. Photographs of living material were taken with a Nikon D300 digital camera.

3. Results

3.1. Description

Campanula alisan-kilincii Yıldırım & Şenol sp. nov. (Figures 1–4).

Type: Turkey, B7 Malatya: Levent Canyon in Akçadağ district, near Çatak village, on calcareous rocks, 1400–1650 m, 30.06.2010, *H. Yıldırım* 1747 (holotype: EGE; isotypes: EGE, HUB, ISTF, Yıldırımli Herb.).

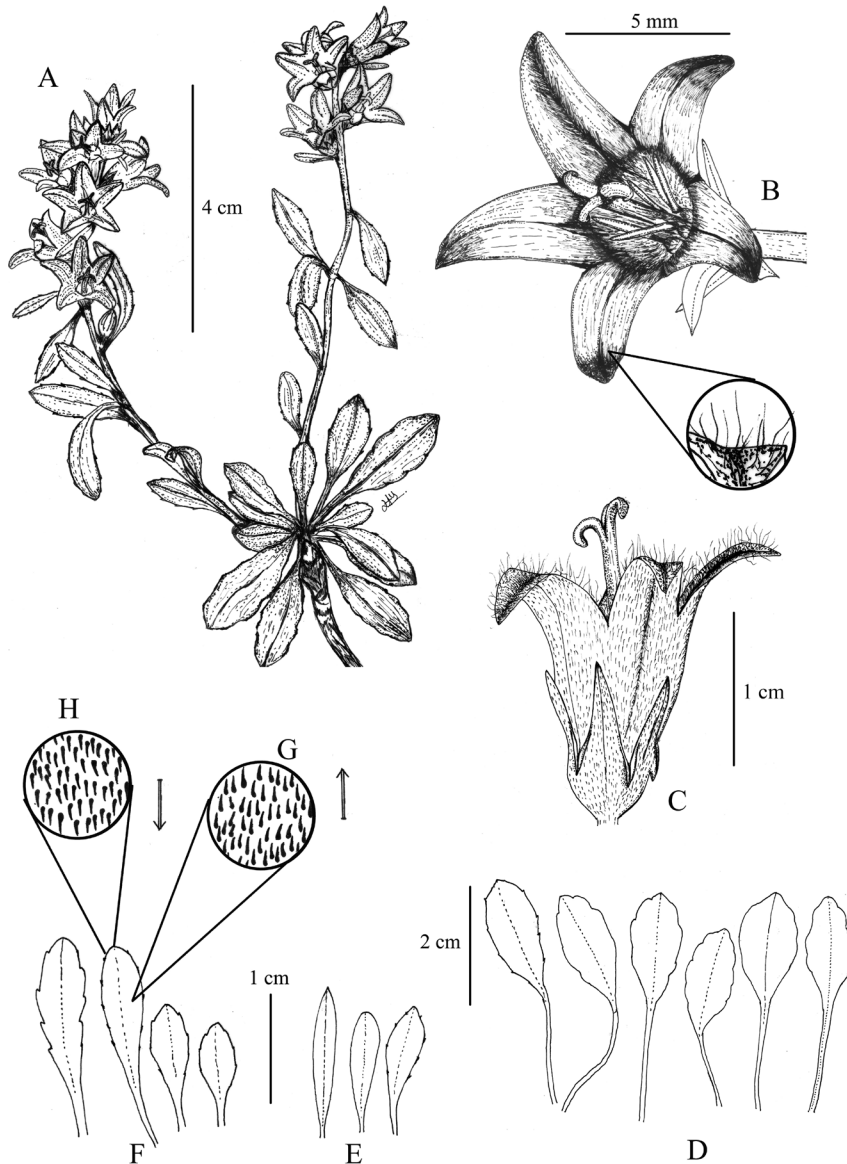


Figure 1. *Campanula alisan-kilincii*: A- habit, B and C- flowers, D- basal rosette leaves, E- upper cauline leaves, F- lower cauline leaves, G- indumentum of upper surface of leaves, H- indumentum of lower surface of leaves.

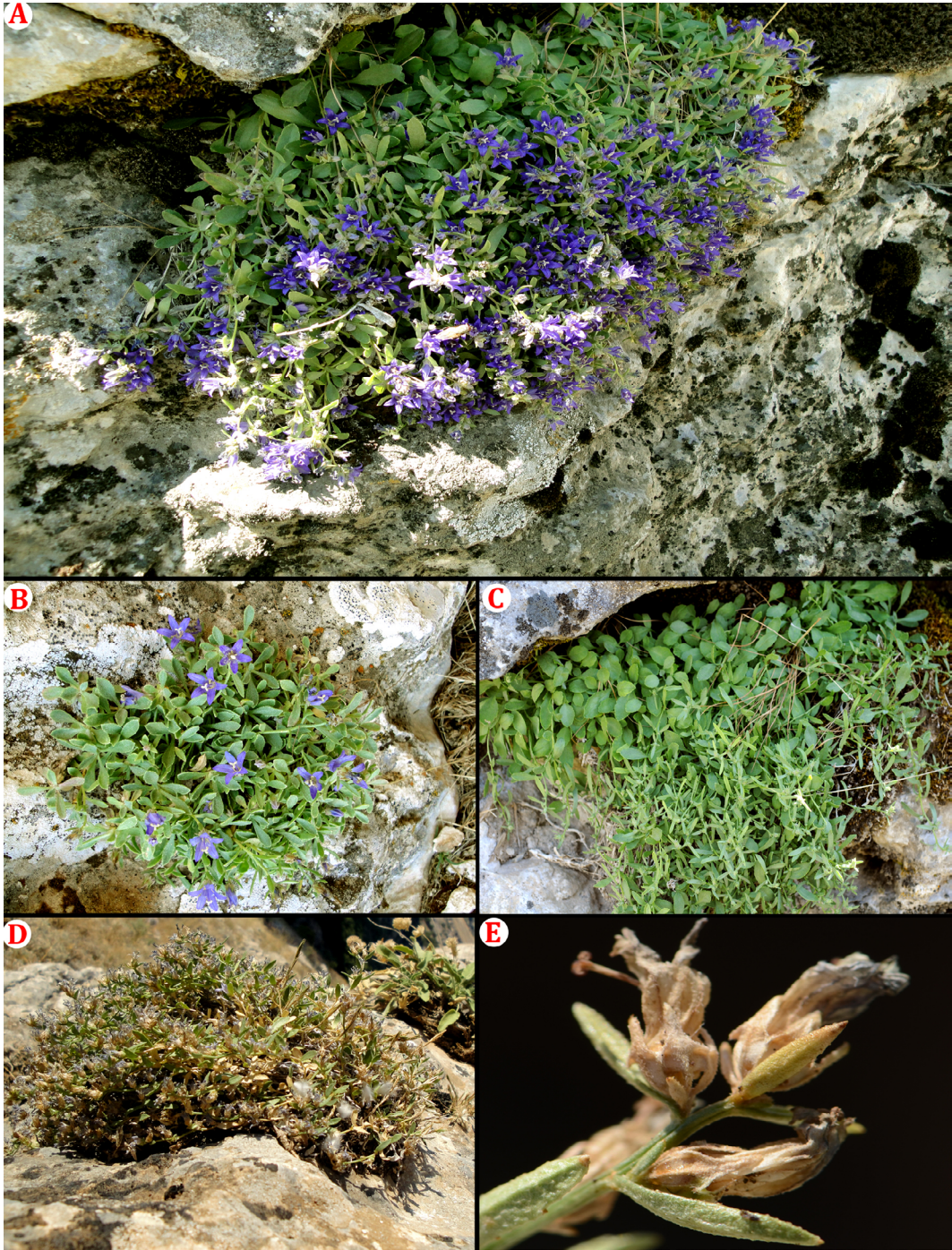


Figure 2. *Campanula alisan-kilincii*: A and B- habitat in flowering time, C- habitat before flowering time, D- habitat in fruiting time, E- capsules.

Diagnosis: *Campanula alisan-kilincii* is related to *Campanula quercetorum* and slightly resembles *C. strigillosa*. It differs from them by decumbent to ascending, simple stems (not ascending to erect, branched); oblanceolate to spatulate basal leaves (not elliptic or

linear-lanceolate); dense, 1–5 cm (not 5–20 cm); solitary, terminal, and axillary flowers (not many-flowered panicle or on short branches); divided to 1/2 corolla lobes (not 1/5 to 1/4 or 2/3); 2–3 mm calyx lobes (not 1–2 mm or 3–4 mm); hemispherical capsules (not turbinate).

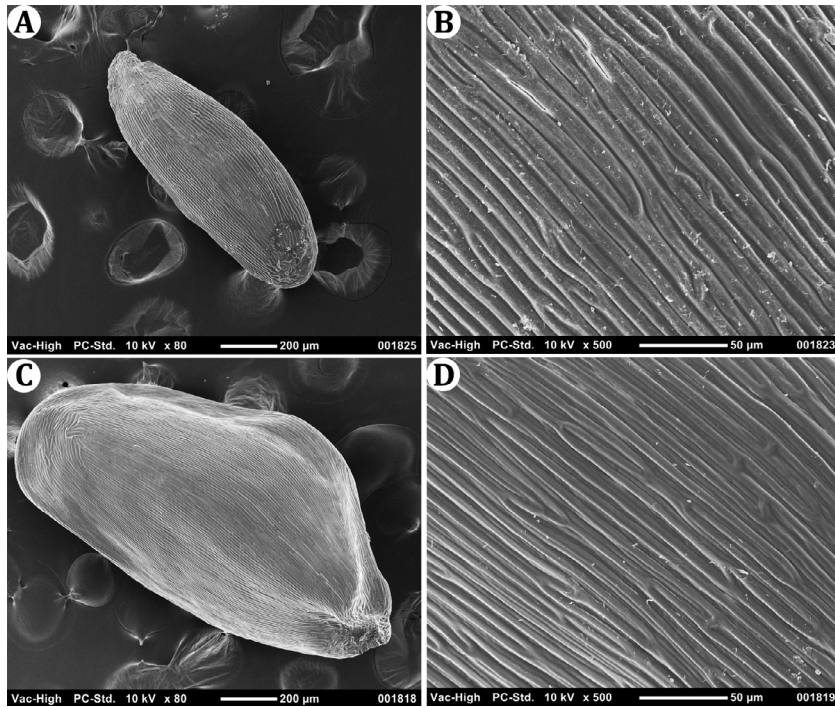


Figure 3. SEM photographs of seed and seed surface of: A and B- *Campanula alisan-kilincii*, C and D- *C. strigillosa*.

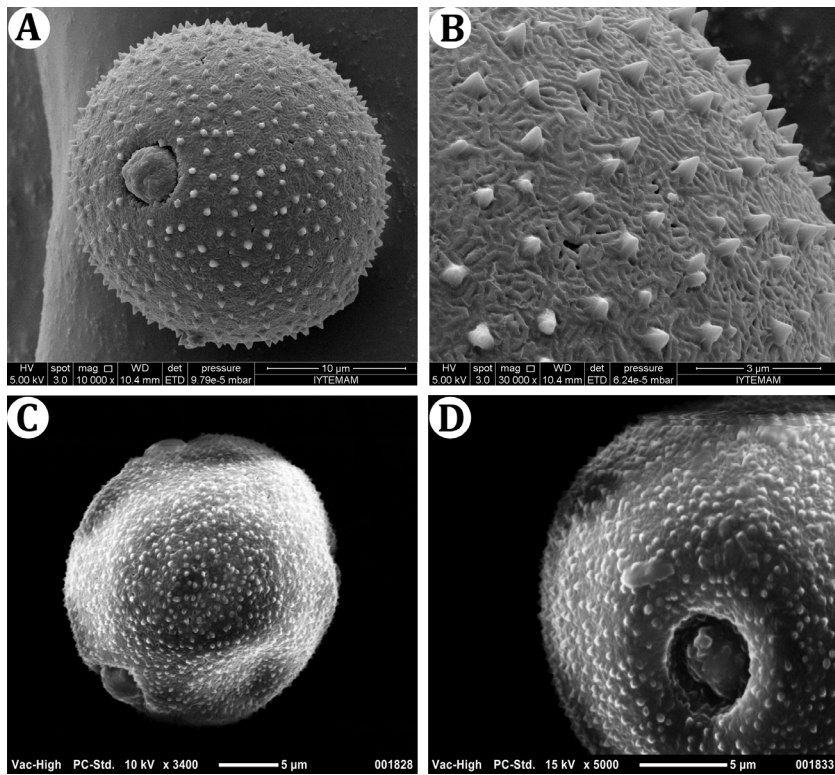


Figure 4. SEM photographs of pollen grain and pollen surface of: A and B- *Campanula alisan-kilincii*, C and D- *C. strigillosa*.

Description: Densely or sparsely retrorse-strigose, dwarf suffruticose, caespitose perennial. Stems numerous, unbranched, decumbent to ascending, flexuous, fragile, 3–14 cm, 1–9 (12) terminally and axillary flowered, arising from the collar of a thick taproot with fertile and sterile leaf rosettes. Leaves entirely or slightly dentate, upper surface densely antrorse-strigose; lower surface sparsely retrorse-strigose; basal leaves oblanceolate to spatulate, slightly dentate, petiolate, $10\text{--}50 \times 2\text{--}13$ mm (including petiole); cauline leaves narrowly oblanceolate and slightly petiolate on lower leaves, oblanceolate to linear-lanceolate and sessile on upper leaves, $4\text{--}20 \times 1\text{--}3$ mm. Inflorescence 1–5 cm long, dense, distinctly leafy. Flowers subsessile, erect, terminal and axillary, upper surface densely retrorse-strigose, long-hairy inside. Calyx lobes triangular-lanceolate, $2\text{--}3 \times 0.9\text{--}1.1$ mm, erect, densely retrorse-strigose; appendages inconspicuous, 0.5–1 mm, not enlarged after anthesis. Corolla tube broadly infundibular to conical, densely retrorse-strigose, pale-blue to violet-blue, 10–12 mm long, divided to 1/2 tube; corolla lobes 5–6 mm long, lanceolate. Bracts linear, c. 1 mm. Style subexserted, 6–8 mm. Stigmas 3, 2 mm long. Stamen 3.5–6.0 mm long; filaments white, 1.5–2 mm long, with base rotundate to widely lanceolate, $3\text{--}1.5 \times 1.2\text{--}1.5$ mm, densely hairy on margin; anthers yellow, $3\text{--}4 \times 0.4\text{--}0.8$ mm; pollen yellow, triporate, rugulate. Capsule hemispherical, densely retrorse-strigose, erect, $3\text{--}4 \times 3\text{--}4$ mm, 3-locular, opening by 3 valves. Seeds narrowly ellipsoid to narrowly oblong, $0.7\text{--}0.9 \times 0.3\text{--}0.4$ mm, dark brown, shiny; testa striate. Pollen grain triporate, spheroidal, diameter 22.4 ± 1.32 μm , spinulate, spinule length 0.3–0.5 μm , Flowering occurs in June–July and fruiting in August–September.

3.2. Etymology

This new species is named in memory of Alişan Kılınç, uncle of the first author, who first collected the new species. Unfortunately, he died tragically in a road accident in October 2011.

3.3. Distribution, habitat, and ecology

Campanula alisan-kilincii is a local endemic restricted to Levent Canyon in Malatya, eastern Anatolia (Figure 5). It is an element belonging to the Irano-Turanian floristic region. The new species grows only on the calcareous rock cliffs in Levent Canyon, preferably those with west and northeastern aspect, between 1400 and 1650 m a.s.l. It is an obligate rupicolous plant.

Species growing in the near vicinity include *Asplenium haussknechtii* Godet & Reut., *Chaenorhinum semispeluncarum* Yıldırım, Kit Tan, Şenol & Pirhan*, *Galium scopulorum* Schön.-Tem.*, *Micromeria cristata* (Hampe) Briseb. subsp. *orientalis* P.H.Davis*, *Minuartia juniperina* (L.) Maire & Petitm, *Onosma molle* DC., *Parietaria judaica* L., *Parietaria lusitanica* L., *Pimpinella paucidentata* Matthews, *Potentilla recta* L., *Potentilla speciosa* Willd. var. *speciosa*, *Rosa canina* L., *Rosularia sempervivum* (M.Bieb.) Berger subsp. *libanotica* (Labill.) Eggli, *Scrophularia rimarum* Bornm., *Silene brevicaulis* Boiss.*, *Silene odontopetala* Fenzl, *Stachys cataonica* Bhattacharjee & Hub.-Mor.*, *Tanacetum argenteum* (Lam.) Willd. subsp. *canum* (C.Koch) Grierson var. *canum*, and *Urtica dioica* L. Taxa denoted here by an asterisk are endemic to Turkey.

3.4. Suggested conservational status

The population of *Campanula alisan-kilincii* was calculated as occupying an area of 0.09 km² and approximately 300 individuals were observed in total. No anthropogenic or grazing effects were observed on the population. Following the criteria laid out by the IUCN (2011), the plant is categorized as ‘Vulnerable’ (VU) D1 + 2, on account of its restricted distribution.

4. Discussion

Campanula alisan-kilincii belongs to *Campanula* subgen. *Campanula* sect. *Rupestris*, characterized by perennial suffruticose-caespitose habit; numerous, fragile, few-

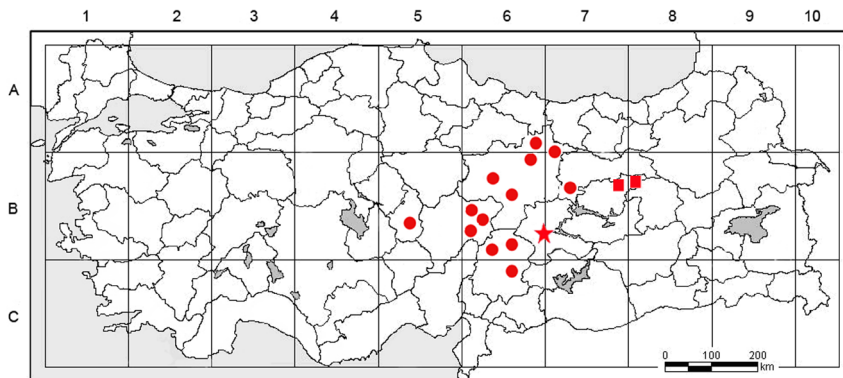


Figure 5. Distribution of: *Campanula alisan-kilincii* (*), *C. quercetorum* (■), *C. strigillosa* (●).

flowered, often low stems, mostly in dense rosettes basal leaves; distinctly developed or inconspicuous calyx appendages, opening by 3 basal valves capsules, rarely dehiscing irregularly between ribs (Damboldt, 1978). Nearly all species in *C. sect. Rupestres* in Turkey are obligate rupicolous plants. For this reason, the ratio of endemism is very high (80%) and distribution of species is very restricted.

Akcin (2009) indicated that micromorphological features of *Campanula* seed surfaces are useful for distinguishing some *Campanula* species. Taking Akcin's

(2009) study into consideration, seeds of *Campanula alisan-kilincii* are placed in seed surface "Type 2", which is characterized by elongate striate testa cells, fusiform or fibriform, with relatively thick radial walls and often an indistinct lumen (Figure 3).

Campanula alisan-kilincii is known only from a very restricted area in Malatya. Although it resembles *C. quercetorum* and *C. strigillosa* Boiss. (Figure 6), it can easily be distinguished from both species by several noticeable morphological characters (see Table 1). The most important features of *C. alisan-kilincii* are: oblanceolate



Figure 6. *Campanula strigillosa*: A- habitat, B- flowers, C- holotype specimen (G). Pictures A and B were obtained from Serdar Aslan and this specimen was collected from Sivas Province: between Kangal and Gürün, east of Mancılık Village, steppe, 1640 m, 10.07.2007, Z.Aytaç 9073, S.Asan & M.E.Uzunhisarcıklı.

Table 1. Morphological differences among *Campanula alisan-kilincii*, *C. quercetorum*, and *C. strigillosa*.

Characters	<i>Campanula alisan-kilincii</i>	<i>Campanula quercetorum</i>	<i>Campanula strigillosa</i>
Stem	decumbent to ascending; greenish; generally unbranched; with distinct fertile and sterile leaf rosettes; weakly to densely strigose; 3–14 cm	ascending to erect ± branched, densely patent or retrorse-setulose with distinct fertile and sterile leaf rosettes; densely patent or retrorse-setulose; 10–25 cm	ascending to erect, grayish; branched in upper part or unbranched; leaf rosettes absent or inconspicuous; densely strigose; 20–35 cm
Leaves indumentum	upper surface antrorse strigose; lower surface retrorse strigose	upper and lower surface patent or retrorse-setulose	upper and lower surface retrorse strigose
Basal leaves	oblanceolate to spatulate, slightly dentate; 10–50 × 2–13 mm with petiole	elliptic to spatulate, simply and coarsely dentate, 22–35 × 7–12 mm with petiole	linear-lanceolate, entire; sessile, 10–25 × 2–3 mm
Cauline leaves	lower cauline leaves narrowly oblanceolate, slightly petiolate; upper oblanceolate to linear-lanceolate, sessile	elliptic to spatulate, simply and coarsely dentate, mostly sessile	lower and upper cauline leaves linear-lanceolate to linear, sessile
Flowering stem	dense, 1–5 cm, distinctly leafy	elongate, lax, 5–20 cm, leafy or leaves reduced on middle and upper part	lax, 5–15 cm, leaves very reduced on middle and upper part
Flowers	solitary, terminal, and axillary	many-flowered panicle	solitary and terminal on short branches, 1–3 sessile in axillary clusters (mostly at base)
Corolla	infundibular to conical, divided to 1/2	narrowly cylindrical-campanulate; divided to 1/5–1/4	infundibular to conical, divided to 2/3
Calyx lobes	2–3 mm	3–4 mm	1–2 mm
Capsule	hemispherical	hemispherical	turbinate

to spatulate and petiolate basal leaves; flowering stems dense, 1–5 cm, and distinctly leafy; indumentum of upper surfaces of all leaves antrorse-strigose, lower surfaces retrorse-strigose; infundibular to conical, divided to 1/2 corolla; habit decumbent to ascending obligate rupicolous plant; seeds narrowly ellipsoid to narrowly oblong, margin unwinged, 0.7–0.9 × 0.3–0.4 mm, testa stria distinct (Figure 3). Details of differences between *C. alisan-kilincii* and related species *C. quercetorum* and *C. strigillosa* are listed in Table 1.

Campanula sect. *Rupestris* is very unsatisfactory in its current structure. It is a very artificial group and includes species whose relationships are largely unknown. In *Flora of Turkey*, Damboldt (1978) included *C. strigillosa*, which was formerly assigned to *Podanthum* Boiss. by Boissier and to *Asyneuma* Griseb. & Schenk by Bornmueller. Molecular analysis confirms that *C. sect. Rupestris* is not well supported (Mansion et al., 2012). According to Mansion et al. (2012), *C. strigillosa* is closely related

to *C. scoparia* (Boiss. & Hausskn.) Damboldt, which is within *Campanula* sect. *Saxicole* (Boiss.) Charadze and is characterized by 3 basal or ± median pores and without calyx appendages.

Although *Campanula strigillosa* has small calyx appendages, it may be rapunculoid, because it has an slightly upward-curving style, which is more characteristic of rapunculoids and is probably an overlooked diagnostic character in *Campanula*. However, *C. alisan-kilincii* and *C. quercetorum* have straight styles, basal openings to the capsule, and obvious calyx appendages. It would certainly appear that these 2 species are not rapunculoid and that they are correctly placed in the *Campanula* s. str. clade (Eddie et al., 2003).

Campanula alisan-kilincii may have affinities with *C. damascena* Labill., which is distributed in Lebanon, Israel, and Syria. Nevertheless, *C. damascena* is easily distinguished from *C. alisan-kilincii* with well-branched flowering stem, densely hispid indumentum, whitish-blue

flowers, and broadly elliptical to lanceolate cauline leaves.

The pollen types of *Campanula alisan-kilincii* and *C. strigillosa* are triporate, spheroidal, and of nearly the same diameter in the 2 species. Spinule length of *C. alisan-kilincii* ($0.38 \pm 0.08 \mu\text{m}$) is greater than that of *C. strigillosa* ($0.27 \pm 0.05 \mu\text{m}$), whereas the number of spinules is much greater for *C. strigillosa* than for *C. alisan-kilincii*. The counted spinules of pollen located in $5 \mu\text{m}^2$ was 10–15 in *C. alisan-kilincii* and 40–55 in *C. strigillosa* (Figure 4). The seeds of *C. alisan-kilincii* are narrowly ellipsoid to narrowly oblong, the margin is unwinged, and the testa is distinctly striate. However, *C. strigillosa* seeds are broadly ellipsoid to oblong, slightly winged, and testa shallowly striate (Figure 3). Details of seed and pollen features of *C. alisan-kilincii* and *C. strigillosa* are given in Table 2.

4.1. Additional specimens examined (paratypes)

Turkey-Malatya: Levent Canyon, on calcareous rocks, 1400–1650 m, 18.05.2011, *H.Yıldırım* 1875 (EGE); *ibid.*, 26.06.2011, *H.Yıldırım* 2136 (EGE); *ibid.*, 10.09.2011, *H.Yıldırım* 2220 (EGE).

4.2. Additional specimens examined (similar taxa)

Campanula quercetorum: Turkey, B7 Tunceli: Tunceli - Pülümür, Quercetum beim Karakol am Harcik suyu 1100 m, 28.06.1951, *A.Huber-Morath* (E 00275096-isotypus); Tunceli-Ovacık yolu, 15. km yol kenarı, kayalık alanlar, 1150–1200 m, 10.06.2002, *H.Altınözlü* 3801 (HUB).

Campanula strigillosa: Turkey, in Cappadocia orientali, 1854, *Tchihatcheff* (G 150492-holotype). Erzincan: Kemaliye, Salihli köyü üstü, taşlı yamaçlar, serpantin, 1460 m, 13.07.2006, *M.Vural* 9224 (GAZI). Kahramanmaraş: Berit dağı, Korkmaz köyü güneyi, 2300–2500 m, 07.08.1988, *Z.Aytaç* 2526 (GAZI); Göksun, Fındıklı Köyü, Kandil Dağı, Kayalık yamaç, orman içi ve

açıklıkları, 1700–1900 m, 27.07.1981, *B.Yıldız* 3076 (HUB) Binboğa Dağı, yalak, ca. 1500 m, *P.H.Davis* & *R.Çetik* (ANK) Göksun, Göksun - Değirmendere arası, Koruyaz dağı, Arpalık tepe, taşlı yamaçlar, 1800 m, 07.07.1993, *M.Ekici* 1620 (GAZI). Kayseri: Sarız, Yalak, Tekke kayası, step, 2250 m, 04.08.1991, *Z.Aytaç* 4315 et al. (GAZI !); Akkışla, Ganişeyh üzeri, Hınzır Dağı, Taşlık Dere, 1800 m, 19.08.1979, *B.Yıldız* 1981(HUB); Pınarbaşı, Kavak Köyü arkası, Hınzır Dağı, 1850–2000 m, kalker kayası üzeri, 26.8.1994, *A.Dönmez* 4231 (HUB); Sarız, Binboğa dağı, Yalak, kaya çatlakları, 1500–1700 m, 04.08.1991, *Z.Aytaç* 4340 et al. (GAZI); Sarız, Keklik kaya, Işık Dağı (Binboğa), taşlık yerler, 2400–2400 m, 12.09.1991, *Z.Aytaç* 4449 et al. (GAZI !); Sarız, Yalak (Yeşilkent) kuzeydoğusu, Binboğa Dağı, hareketli kayalıklar, 2000 m, 04.08.1988, *Z.Aytaç* 2480 (GAZI); Sarız, Binboğa Dağı, Yalak (Yeşilkent) doğusu, hareketli kayalıklar, 1650–2100 m, 04.08.1988, *Z.Aytaç* 2493 (GAZI). Sivas: Suşehri, Kelkit vadisi, 600–700 m, 27.06.1985, *B.Yıldız* 5832 et al. (GAZI); Suşehri, Kelkit vadisi, 700–800 m, 10.07.1986, *B.Yıldız* 8221 (GAZI); Şarkışla, Elçidere, Kale-Alamanlar Köyleri arası, kalker kayalıklar ve az derin topraklı yamaçlar, ca. 1400–1500 m, 19.07.1979, *T.Ekim* & *A.Düzenli* (ANK).

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Table 2. Pollen/seed measurements and features of *Campanula alisan-kilincii* and *C. strigillosa*.

Pollen						
	Polar axis (μm)	Equatorial axis (μm)	Ground sculpture	Spinule length (μm)	Spinule density (in $5 \mu\text{m}^2$)	Pore number
<i>C. alisan-kilincii</i>	(20–)22.40 $\pm$ 1.32(–26)	(21–)23.06 $\pm$ 0.96(–25)	Rugulate	(0.3–)0.38 $\pm$ 0.08(–0.5)	10–15	3
<i>C. strigillosa</i>	(22–)23.31 $\pm$ 1.02(–26)	(23–)24.90 $\pm$ 0.88(–27)	Rugulate	(0.2–)0.27 $\pm$ 0.05(–0.4)	40–55	3
Seed						
	Shape	Length (mm)	Wide (mm)	Stria	Margin	
<i>C. alisan-kilincii</i>	Narrowly ellipsoid to narrowly oblong	(0.7–)0.78 $\pm$ 0.46(–0.9)	(0.3–)0.35 $\pm$ 0.36(–0.4)	Distinct	Unwinged	
<i>C. strigillosa</i>	Broadly ellipsoid to oblong	(1.2–)1.29 $\pm$ 0.58(–1.4)	(0.7–)0.73 $\pm$ 0.28(–0.8)	Shallow	Slightly winged	

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