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Campanula quercetorum subsp. *densiflora*: A New Taxon of *Campanula* (Campanulaceae) from Eastern Anatolia (Türkiye)

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Abstract
Türkiye is a crucial country for the genus *Campanula* diversity in the Mediterranean Basin. Also, more than half of *Campanula* species in Türkiye are endemic. In this paper, *Campanula quercetorum* subsp. *densiflora* (Campanulaceae) is described as a new subspecies from Tunceli (Türkiye). According to its morphological features, it belongs to the *Campanula* subgen. *Campanula* sect. *Rupestres*. This section mainly consists of perennial polycarpic or perennial monocarpic and chasmophyte species. It is morphologically closely related to *C. quercetorum* subsp. *quercetorum*. It is easily distinguished from *C. quercetorum* subsp. *quercetorum* by its dense inflorescence, dense indumentum, densely hairy corolla surface, conspicuous purplish-blue corolla veins, and ascending to erect habitus. Diagnostic characteristics, a full description, and comprehensive photographs are given in this study.
Keywords: *Campanula*, sect. *Rupestres*, endemic, taxonomy, Türkiye

Campanula quercetorum subsp. *densiflora*: Doğu Anadolu'dan (Türkiye) Yeni Bir Campanula (Campanulaceae) Taksonu

Özet
Türkiye, Akdeniz Havzasındaki *Campanula* cinsi çeşitliliği için anahtar ülkelerinden biridir. Ayrıca Türkiye'deki *Campanula* türlerinin yarısından fazlası endemiktir. Bu çalışmada, *Campanula quercetorum* subsp. *densiflora* (Campanulaceae), Tunceli'den (Türkiye) yeni bir takson olarak tanımlanmaktadır. Morfolojik özelliklerine göre, *Campanula* altcins *Campanula* sect. *Rupestres*'e aittir. Bu seksiyon çoğunlukla çok yıllık polikarpik veya çok yıllık monokarpik ve kazmofit türlerinden oluşur. Morfolojik olarak *C. quercetorum* subsp. *quercatorum* ile yakından ilişkilidir. *C. quercatorum* subsp. *quercatorum* 'dan yoğun çiçek durumu, yoğun tüy durumu, korolla üzerinde yoğun tüylenmesi ve korolla damarların bariz morumsu-mavi olması ve yükseliciden dik duruşluya kadar olan habitusu ile kolaylıkla ayrıt edilmektedir. Teşhis özellikleri, tam betimi ve kapsamlı fotoğrafları bu çalışmada verilmiştir.
Anahtar kelimeler: *Campanula*, endemik, sect. *Rupestres*, taksonomi, Türkiye

INTRODUCTION

Campanulaceae Juss. (Asterales) is a cosmopolitan family containing 84 genera and approximately 2400 species (Lammers 2007). Campanulaceae is divided into five main subfamilies (namely, Campanuloideae Burnett, Lobelioideae Burnnet, Cyphioideae Walp. Nemacladoideae Lammers, Cyphocarpoideae Miers.) (Cosner et al. 1994; 2004; Lundberg & Bremer 2003; Tank & Donoghue 2010; Beaulieu et al. 2013; Crowl et al. 2016; Liveri et al. 2020).

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The genus *Campanula* L. belongs to the Campanulinae section of the subfamily Campanuloideae. *Campanula* contains about 450 species worldwide. The genus is distributed throughout the northern hemisphere, southern Asia, and central Africa (Eddie et al. 2003; Roquet et al. 2008; Cellinese et al. 2009; Haberle et al. 2009; Yoo et al. 2018; POWO 2023). *Campanula* is represented by approximately 140 taxa, more than 50% of which are endemic in Türkiye (Damboldt 1978; Davis et al. 1988; Güner 2000; Akçiçek et al. 2005; Kandemir 2007; İkinci 2012; Yıldırım 2013; 2018; Yıldırım & Şenol 2014; Mutlu & Karakuş 2015; Yıldırım et al. 2019; Yıldırım & Özdöl 2019; Özdöl et al. 2022a; 2022b; 2022c; 2022d; Fırat et al. 2022). Türkiye species of the genus *Campanula* are classified into six subgenera (namely, *Megalocalyx* Damboldt, *Rapunculus* (Fourr.) Kharadze, *Roucela* (Dumort.) Damboldt, *Brachycodonia* (Fed.) Damboldt, *Sicyodon* (Feer) Damboldt and *Campanula*). In "*Flora of Turkey and the East Aegean Islands*", the subgenus *Campanula* is classified into 13 sections (Dambolt 1976; 1978). The section *Rupestres* (Boiss.) Charadze., which also includes *Campanula quercetorum* Hub.-Mor. & C.Simon, consists mainly of perennial polycarpic or perennial monocarpic and chasmophyte species. This situation causes the limitation of the distribution areas of the taxa in question and indirectly increases the endemism rates.

Campanula quercetorum is an endemic species known only from Tunceli (Türkiye). During field studies in the province of Tunceli, an exciting population of *Campanula*, closely related to *C. quercetorum,* was discovered by us, between the center of Tunceli and Ovacık district in the Munzur Valley (Figure 1). As a result of our detailed studies, we decided that this specimen is a new taxon of *C. quercetorum*.

MATERIAL AND METHOD

The material was collected from the Munzur Valley/Ovacık district of Tunceli province in June 2015. Samples of the new subspecies were compared with other *Campanula* collected from different localities and deposited in various herbaria, such as AEF, ANK, E, EGE, G, HUB, K, NGBB, VANF, and W (Thiers 2023). In addition, relevant literature (Boissier 1875; Fedorov 1957; Rechinger & Schimann-Czeika 1965; Fedorov & Kovanda 1976; Damboldt 1976; 1978; Davis et al. 1988; Güner 2000; IPNI 2023) was revised. The gross morphology of the new subspecies was examined under a stereo-binocular microscope, and measurements of these specimens were performed with a millimetric ruler. A total of 25 specimens of the new subspecies were examined. During the field studies, photographs of the living material of the new subspecies and its related taxa were taken with a Nikon D300 digital camera.

RESULTS AND DISCUSSION

Campanula quercetorum Hub.-Mor. & C.Simon subsp. ***densiflora*** Yıldırım, **subsp. nov.** (Figures 2 and 3)

Type. Türkiye. **Tunceli**: Between Tunceli and Ovacık, Munzur Valley, rocks, 1120 m a.s.l., 21.06.2015, *H.Yıldırım 3242* (**holotype**: EGE!, **isotype**: EGE!, ANK!, HUB!, NGBB!).

Paratypes. Türkiye. **Tunceli**: Between Tunceli and Ovacık, 15. km, rocks, 1150–1200 m a.s.l., 10.06.2002, *H.Altınözlü 3801* (ANK!); Ovacık road, 20 km from Ovacık, 1127 m a.s.l., 20.07.2015, *H.Yıldırım 3464* (EGE!).

Diagnosis. *Campanula quercetorum* subsp. *densiflora* is distinguished from *C. quercetorum* subsp. *quercetorum* by its fully dense setulose-hispidulous hairy corollas (not only on veins), conspicuously purplish-blue veins on corolla (not inconspicuous or concolour), ascending or erect and rigid stem (not fragile, flexuose and decumbent), and dense inflorescence (not mostly lax and sparse).

Description. Perennial, chasmophyte, retrorsely setulose-hispidulous. Stem 1 or many at base, 15–40 cm long, branched, erect or ascending, rigid. Rosette leaves 7–15 cm long (including petiole), with numerous small lobes on through the petiole 0.2–1 cm long, sometimes upper segments lyrate ca. 2.5 × 1 cm, both surface setulose-hispidulous hairy; lamina obovate-spathulate to oblong-elliptic, attenuate, irregularly and deeply dentate, dentate or entire, 2.5–6 × 1.5–4 cm; petiole 4.5–9 cm long, mostly winged to the base. Stem leaves elliptic-ovate to obovate-spathulate, 0.5–7 × 0.2–4 cm, irregularly dentate or regularly dentate, setulose-hispidulous hairy. Inflorescence raceme to paniculate, 25–80-flowered, mostly upturned; pedicel 1–9 mm long. Bract 4–12 × 0.8–1.2 mm, lanceolate, setulose-hispidulous. Calyx lobes linear-lanceolate, 5–6.5 × 1–2.2 mm, apex and margins retrorsely setulose-hispidulous, mid-vein conspicuous; appendage small, not more than 0.8 mm long. Corolla cylindric-campanulate, densely retrorsely setulose-hispidulous hairy, 12–17 × 4–6 mm, whitish-cream, very lightly whitish-blue or light pinkish-white, veins conspicuously purplish-blue, divided into 1/5–1/4; lobes triangular, 2.4–4 × 1.7–3.5 mm. Stamen 5–8 mm long; anther 4–5.5 × 0.7–1 mm; filament 1.8–2.6 mm long, triangular at base, 1–1.5 mm wide, margins ciliate. Style 8–13 mm long, including. Capsule 3–5 × 2.5–4 mm, semi-spheroidal, densely setulose-hispidulous hairy, conspicuously 9–10-keeled, opening by three basal pores. Seeds light brown, 0.5–0.7 × 0.2–0.3 mm.

Flowering time. June to August

Etymology and suggested Turkish name. The specific epithet indicates the dense inflorescence of the plant. The Turkish name of this species is given as “ovacıkçanı”, according to the guidelines of Menemen et al. (2016).

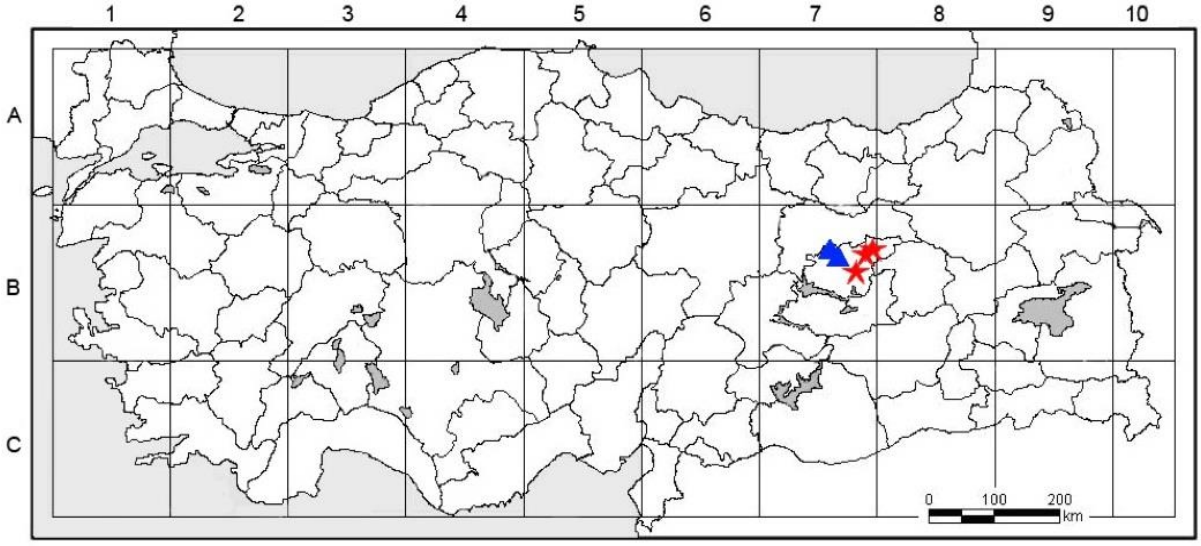

Figure 1. Distribution map of *Campanula quercetorum* subsp. *quercetorum* (★) and *C. quercetorum* subsp. *densiflora* (▲).

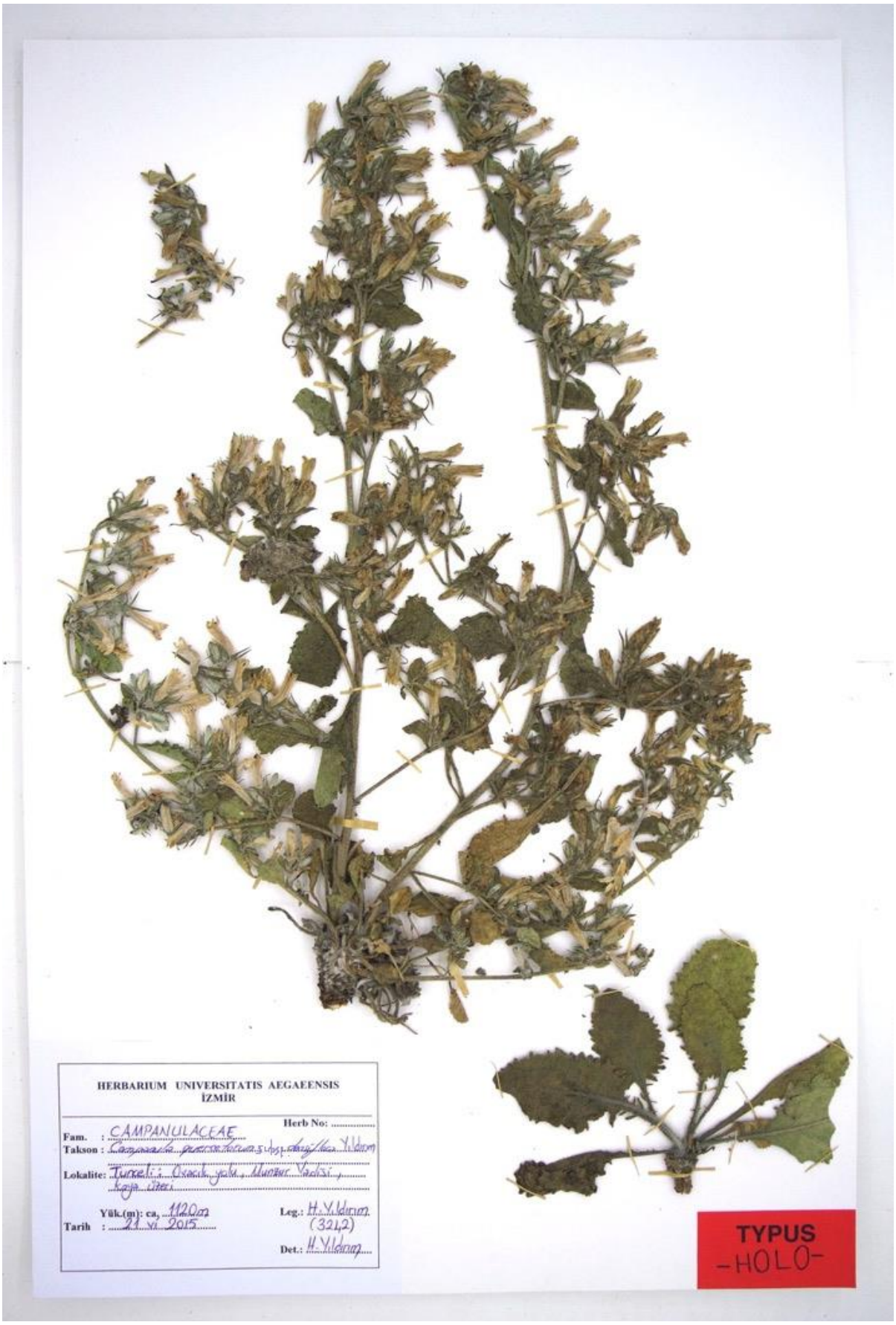

Figure 2. Holotype of *Campanula quercetorum* subsp. *densiflora*.

Figure 3. *Campanula quercetorum* subsp. *densiflora*. A-B: Habitus, C: Flowers.

Taxonomical notes

Campanula quercetorum is closely related to *C. hedgei* P.H.Davis. It is distinguished from *C. hedgei* by having prominent rosette leaves, long and generally paniculate inflorescences, and whitish-cream flowers. Basal leaves are very similar to *C. yildirimlii* Kit Tan & Sorger, *C. demirsoyi* Kandemir, and *C. dersimensis* Fırat & Yıldırım (Damboldt 1978; Davis et al. 1988; Kandemir 2007; Fırat et al. 2022). It can be mixed with these species when it is juvenile. But it can be easily distinguished from all of them by its capsule opening with three basal pores, corolla color and indumentum, calyx indumentum, calyx appendages, inflorescence type, and stem indumentum (Table 1). Damboldt (1978) stated that the flowers as of *C. quercetorum* are purplish-blue. However, this appears to be incorrect. Sometimes the flowers are slightly bluish when wilted, but the mature flowers are always whitish and sometimes a thin striped purplish-blue color on the veins, rarely quite a light pinkish-white. *Campanula quercetorum* subsp. *densiflora* is closely related to *C. quercetorum* subsp. *quercetorum* (Figure 4). It is easily distinguished from *C. quercetorum* subsp. *quercetorum* by its denser flowers and densely hairy flowering stems (not lesser flowers and slightly hairy); wholly densely hairy corolla (not hairy only on vein), and vein coloration on the corolla is generally conspicuous (not inconspicuous). Although the specimens of *C. quercetorum* subsp. *quercetorum* are habitus decumbent and stems are quite fragile and flexuous, the *C. quercetorum* subsp. *densiflora* has stiffer, coarser, and erect stems. In general, individuals of *C. quercetorum* subsp. *densiflora* show more branches. Though some of the characters slightly overlap, these specimens are considered a new subspecies of *C. quercetorum* (Table 1).

Identification key for subspecies of *Campanula quercetorum*

1a. Corolla setulose-hispidulous only on veins; coloration on veins of corolla concolour; stems decumbent, flexuous, and fragile; inflorescence mostly lax and sparse ….. **subsp. *quercetorum***

1b. Corolla wholly densely setulose-hispidulous; veins conspicuous purplish-blue; stem ascending to erect and rigid; inflorescence dense……..……**subsp. *densiflora***

Table 1. Morphological differences between *Campanula quercetorum* subsp. *densiflora*, *C. quercetorum* subsp. *quercetorum*, *C. dersimensis* and *C. yildirimlii*.

Characters	***C. quercetorum* subsp. *densiflora***	***C. quercetorum* subsp. *quercetorum***	***C. dersimensis***	***C. yildirimlii***
Plant colour	green	green	dark green	glaucous
Stem	erect or ascending, 15–40 cm long, branched, retrorsely setulose-hispidulous	prostrate to ascending, 10–40 cm long, distinctly branched, retrorsely hirsute to pubescent	erect, 15–85 cm long, unbranched or shortly branched in upper half, retrorsely hirtulous to pubescent, rarely subglabrous above	erect, 25–92 cm long, unbranched or very shortly branched, glabrous
Leaves	both surface setulose-hispidulous hairy	both surfaces densely retrorsely hirsute to pubescent, margin hispidulous and hirtulous	both surfaces densely retrorsely hirsute and pubescent, margin usually retrorsely hispidulous and hirtulous	both surfaces glabrous, margin retrorsely hispidulous

Inflorescence	raceme to paniculate flowers solitary or in clusters, dense; pedicel 1–9 mm	raceme to paniculate; flowers solitary, mostly lax and sparse; pedicel 1–9 mm long	spicate to branched spicate; flowers solitary or in clusters of 2 or 3, sessile or pedicel to 2 mm long	spicate; flowers solitary or in clusters of 2–7, sessile or pedicel to 2 mm long
Bracts	4–12 m long, lanceolate, setulose-hispidulous	4–12 mm long, both surfaces and margin hispidulous	4–20 mm long, both surfaces densely pubescent to puberulent, margin retrorsely hispidulous	2–4 mm long, glabrous
Calyx lobes	linear-lanceolate, 5–6.5 mm long, apex and margins retrorsely setulose-hispidulous	linear-lanceolate, 4.7–6.7 mm long, retrorsely hispidulous at apex	linear-lanceolate, 3–6 mm long, retrorsely hispidulous toward apex	triangular, 2.5–6 mm long, glabrous
Calyx appendages	to 0.8 mm long	to 0.8 mm long	to 1 mm long	absent
Corolla	whitish-cream, very lightly whitish-blue or light pinkish-white with conspicuously purplish-blue veins, 12–17 mm long, splitting to 1/5–1/4, wholly retrorsely densely setulose-hispidulous hairy	whitish blue, cream, or light greenish yellow to whitish pink with concolour veins, 10–17 mm long, splitting to 1/5–1/4, setulose-hispidulous only on veins	light greenish yellow to yellowish white with concolour veins, 9–17 mm long, splitting to 1/5–1/4, glabrous outside, midrib and apex of lobes sometimes sparsely hirtulous	whitish to pinkish purple with concolour veins, 8–15 mm long, splitting to 1/4–1/3, glabrous outside
Filaments	1.8–2.6 mm long, triangular at base, ciliate at the margin of the base	1.7–2.7 mm long, triangular at base, ciliate at the margin of the base	2–3 mm long, triangular at base, shortly hairy at the margin of the base	2–3 mm long, triangular at base, papillate-puberulent at the margin of the base
Anthers	4–5.5 mm long	4–5.5 mm long	3–6 mm long	5–7 mm long
Style	8–13 mm long	6–13 mm long	5–11 mm long	8–13 mm long
Capsule	semi-spheroidal, 3–5× 2.5–4 mm densely setulose-hispidulous hairy, conspicuously 9–10 keeled, opening by three basal pores	semi globose when mature, 2.5–4.8 x 2–3.5 mm, densely hirsute, 9- or 10-ribbed, capsule opening with three basal pores	broadly ovoid-cylindric when mature, 2–6 x 1.5–5 mm, glabrous, (9 or) 10-ribbed, membranous structure between veins breaking down and capsule opening with (9 or)10 valves	globose when mature, 2–4 x 2–4 mm, glabrous, 10 ribbed, membranous structure between veins breaking down and capsule opening with 5–10 valves

Figure 4. *Campanula quercetorum* subsp. *quercetorum*. A: Isotype (E!), B-C: Habitus, D: Flowers.

Habitat, distribution and floristic regions

Campanula quercetorum subsp. *densiflora* is a local endemic taxon, restricted to Tunceli Province, eastern Anatolia (Figure 1). It is an element belonging to the Irano-Turanian phytogeographical region. The new taxa are distributed between 1150 and 1200 m. a.s.l. The area of occupancy (AOO) of *Campanula quercetorum* subsp. *densiflora* was calculated as 0.051 km^2, and about 350–400 individuals were estimated to occur. Overgrazing by sheep and goat herds was observed. There are also road works nearby *C. quercetorum* subsp. *densiflora* population. According to the criteria of the IUCN (2016), *C. que*rcetorum subsp. *densiflor*a is evaluated as "Critically Endangered" (CR) B2ab (ii,iii,v) in this paper.

Additional specimens examined

***Campanula quercetorum* subsp. *quercetorum*.** TÜRKİYE. **Tunceli**: Kutuderesi, Pülümür road, rocks, 21.07.2014, *H.Yıldırım 3103* (EGE!); Between Pülümür and Tunceli, 8. tunnel entry, rocks, 1200 m a.s.l., 20.07.2015, *H.Yıldırım 3461* (EGE!); Pülümür, Tunceli to Pülümür NE on Tunceli, open slopes, 1500 m a.s.l., 26.08.1986, *Archibald 8139* (148/88-48, E!); Tunceli-Pülümür, quercetum beim Karakol am Harçik suyu, 1100 m a.s.l., 28.06.1951, *Hub.Mor. 11072* (G!); Pülümür, kalkschlucht Tunceli-Pülümür, 46 km nördlich Tunceli, 1100 m a.s.l., 07.06.1959, *Hub.Mor. 15705* (G!).

***Campanula dersimensis*.** TÜRKİYE. **Tunceli**: On way from Tunceli to Nazimiye, Kutu Stream, around Zülfikar Fountain, 1040 m a.s.l., limestone rock crevices, 01.08.2012, *M.Fırat 28888* (EGE!, 43200); ibid., 1104 m a.s.l., rocky areas, 05.08.2014, *M.Fırat 31538* (herb. M.Fırat!); ibid., 28.07.2012, *M.Fırat 28876* (herb. M.Fırat!); On way from Tunceli to Ovacık, Munzur Valley, 1087 m, rocky areas, 27.07.2012, *M.Fırat 28868* (herb. M.Fırat!); Tunceli-Ovacik road, Ovacık Canyon, approximately 20 km from Ovacık District, 1127 m a.s.l., 21.07.2015, *H.Yıldırım 3464a* (EGE!).

***Campanula yildirimlii*.** TÜRKİYE. **Erzincan**: Kemaliye, Sandıkbağı surroundings, 900 m a.s.l., rocky places, 17.11.1980, *Ş.Yıldırımlı 4174* (paratypes, ANK!, B!); Kemaliye, Salihli village, 1484 m a.s.l., serpentine area, 15.07.2014, *H.Yıldırım 3060* (EGE!); **Malatya**: Arguvan, Göldağı slopes, Yukarı Soğuksu, Perideresi Valley, 1484 m a.s.l., 15.06.2014 (sterile), *H.Yıldırım 2887* (EGE!); Arguvan, Divriği road, 3. km, 1609 m a.s.l., limestone cliffs, 21.07.2015, *H.Yıldırım 3469* (EGE!); Arapgir, Kayaarası Canyon, 1195 m a.s.l., cliffs, 08.09.2015, *H.Yıldırım 3690* (EGE!); Arapgir, 2–3 km after Divriği road junction, near fountain, 1451 m a.s.l., 08.09.2015, *H.Yıldırım 3691* (EGE!).

***Campanula hedgei*.** TÜRKİYE. **Erzincan**: Munzur Mountains, Çağlayan Village, Çağlayan (Girlevik) Waterfall side, calcareous rocks, 1372 m a.s.l., 22.07.2014, *H.Yıldırım 3109* (EGE!); Keşiş Dağ above Cimin, igneous rock crevices, 2700–2900 m a.s.l., 27.07.1957, *P.H.Davis 31634* (ANK!; K!); **Tunceli**: Above Ovacık, Munzur Mountains, below Karaçukur place, Sor Yaylası, calcareous rocks, 2259 m a.s.l., 20.07.2014, *H.Yıldırım 3100* (EGE!); Ovacık, Mercan place, 1450 m a.s.l., 22.06.2008, *M.Vural 15845* (AEF!); ibid., *M.Vural 15848* (AEF!); Laç Stream, rocks, 965 m a.s.l., 15.06.2002, *H.Duman 22033* (AEF!); Munzur Dağ above Ovacık, dry limestone cliff, 2100 m a.s.l., 19.07.1957, *P.H.Davis 31315 & I.Hedge* (E! [E00275093]; G! [G154487]; K! [2139/60-3, 2139/60-4, 2139/60-5]); Munzur gebirge NW Ovacık (Bekirdashe dağ), felsfluren, 1500–2900 m a.s.l., 17.08.1982, *F.Sorger 82-127-6* (W! [01469]); Ovacık, Munzur Mountains, above Aksudere, rocks, 1706 m a.s.l., 21.06.2015, *H.Yıldırım 3246* (EGE!); **Van**: Özalp, district center surroundings, 2300 m a.s.l., 09.08.1988, *F.Özgökçe 5480* (VANF!).

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AUTHOR CONTRIBUTION STATEMENT

In this study; the study idea and design, data collection, analysis and interpretation of the results, and drafting of the article were made by the authors.

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