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Authors: Bogdanović, Sandro, Shuka, Donald, Rešetnik, Ivana, Cambria, Salvatore, and del Galdo, Gianpietro Giusso

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Morphological and molecular analyses support recognition of *Campanula brulloi* as a new species in *C. ser. Garganicae* (*Campanulaceae*) from Albania

Sandro Bogdanović¹, Donald Shuka², Ivana Rešetnik³, Salvatore Cambria⁴ & Gianpietro Giusso del Galdo⁴

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Abstract: As part of ongoing taxonomic investigations into *Campanula* ser. *Garganicae*, a new species from Albania is described and proposed here as *C. brulloi*. This isophyllous group, distributed across Mediterranean amphi-Adriatic and Ionian regions, is composed of chasmophytes that are often very localized or exhibit a dotted distribution. Phylogenetic analyses based on nuclear and plastid markers (ITS and *trnL-trnF*) indicate that *C. brulloi* is genetically distinct from other members of the series. Detailed descriptions of its vegetative and reproductive structures, seed testa micromorphology, ecology, distribution and an accompanying iconography are provided. While *C. brulloi* shows some morphological affinities with *C. debarensis*, a narrow endemic of North Macedonia, it differs significantly in several key diagnostic features, justifying its recognition as a separate species. An analytical key including all currently accepted species of *C. Ser. Garganicae* is provided.

Keywords: Albania, Balkan Peninsula, *Campanula brulloi*, *Campanula* ser. *Garganicae*, *Campanulaceae*, morphology, new species, phylogeny, taxonomy

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Introduction

The genus *Campanula* L. s.s. (*Campanulaceae*) is mainly distributed in the northern hemisphere and includes both annual and perennial taxa, particularly thriving in dry habitats such as grasslands, garrigue, meadows, woodlands, cliffs and rocks (Roquet & al. 2008). Currently, 449 species are recognized within the genus (Plants of the World Online [continuously updated]), the majority of which are distributed in the Mediterranean region, establishing this as one of the principal centres of diversity. According to the literature, *Campanula* taxa exhibit remarkable variability in habit, leaf and flower morphology, carpology, seed testa, palynology and karyology (Gadella 1966a, 1966b; Dunbar 1975; Dunbar & Wallentinus 1976; Geslot 1980; Contandriopoulos 1984; Kolakovsky 1986, 1994; Roquet & al. 2008; Akcin 2009; Xu & Hong 2021). For a hierarchical arrangement of the genus, we follow the recent phylogenetic studies carried out by several authors (Eddie & al. 2003; Park & al. 2006; Roquet

& al. 2008, 2009; Borsch & al. 2009; Haberle & al. 2009; Mansion & al. 2012; Lakušić & al. 2013; Crawl & al. 2014). Based on literature data (Park & al. 2006; Liber & al. 2008; Stefanović & al. 2008; Frajman & Schnee-weiss 2009; Lakušić & al. 2013; Janković & al. 2016), a group particularly rich in endemics is *C. ser. Garganicae* Trinajstić, first identified by Lovašen-Eberhardt & Trinajstić (1978). All the members of *C. ser. Garganicae* share a set of relevant morphological features, as emphasized by Damboldt (1965) and Lovašen-Eberhardt & Trinajstić (1978), such as monopodial growth form, isophyllous and long-petiolate leaves with cordate to ovate blade, elongated and more or less unilateral inflorescence, campanulate or rotate corolla, filaments hairy at the base, and pale brown, shiny seeds. The monophyletic origin of this series is supported by several phylogenetic studies (Park & al. 2006; Liber & al. 2008; Frajman & Schnee-weiss 2009). Taxa belonging to this group are distributed across the western Balkan and the amphi-Adriatic region, where they are predominantly represented by endemic

¹ University of Zagreb Faculty of Agriculture, Department of Agricultural Botany, Svetošimunska cesta 25, 10000 Zagreb, Croatia.

² University of Tirana, Department of Biology, FNS, 1000 Tirana, Albania.

³ University of Zagreb Faculty of Science, Department of Botany, Marulićev trg 9a, 10000 Zagreb, Croatia.

⁴ Università degli Studi di Catania, Dipartimento di Scienze Biologiche, Geologiche e Ambientali, via A. Longo 19, 95125 Catania, Italy.

Author for correspondence: Sandro Bogdanović, sbogdanovic@agr.hr

chasmophytes, often exhibiting a dotted distribution (Damboldt 1965, 1968; Bogdanović & al. 2014a, 2014b, 2015, 2019), and include: *C. acarnanica* Damboldt, *C. aureliana* Bogdanović & al., *C. cephalenica* Feer, *C. cremnophila* Bogdanović & al., *C. debarensis* Rech. f., *C. fenestrellata* Feer subsp. *fenestrellata*, *C. fenestrellata* subsp. *istriaca* (Feer) Federov, *C. garganica* Ten., *C. portenschlagiana* Roem. & Schult., *C. poscharskyana* Degen, *C. reatina* Lucchese, *C. skanderbegii* Bogdanović & al. and *C. teutana* Bogdanović & Brullo.

In the Albanian flora, *Campanula* is represented by 50 taxa according to the checklist of vascular plants of Albania (Barina & al. 2018). During recent taxonomic investigation of the Albanian bellflowers, only two groups were studied in detail: the *C. pyramidalis*–*versicolor* group by Lakušić & al. (2013) and Janković & al. (2016, 2019), and *C. ser. Garganicae* by Bogdanović & al. (2014a, 2015). In the frame of a taxonomic investigation on the last group, a population of a rare and morphologically distinctive *Campanula* species was examined. This species is restricted to well-circumscribed rocky habitats in Albania, localized along a narrow gorge near the town of Klos. Morphological and phylogenetic surveys of this chasmophyte revealed a close relationship with *C. debarensis*, a species originally recorded from North Macedonia by Rechinger (1939). However, the Albanian population differs significantly in several morphological characters and is further supported by molecular data. Therefore, it is described here as a species new to science, namely *C. brulloi*.

Material and methods

Plant material

The morphological investigations on *Campanula brulloi* were carried out on specimens collected during a field survey on the carbonate rocks near Ura e Vashës, located along a gorge of Mati river near Klos (Albania). For comparative purposes, material of *C. debarensis* was also examined, based on individuals collected from the Debar-Struge region, within the canyon of Crni Drim River (North Macedonia), which represents the locus classicus of this species. In order to avoid impacting the small populations, only 15 individuals of each species were sampled. Flowers and capsules were preserved in a 50 % glycerine-ethyl alcohol solution for further morphological assessment.

Leaf material from five individuals was collected and preserved in silica gel for molecular-phylogenetic analyses. To obtain denser sampling of *Campanula* ser. *Garganicae* for the phylogenetic analyses we used ITS and *trnL-trnF* sequences available in GenBank from previous studies (Park & al. 2006; Frajman & Schneeweiss 2009; Bogdanović & al. 2014a, 2024b, 2015, 2019; Rešetnik & al. 2020). These include 37 accessions of *C. ser. Garganicae*, 10 of other closely related *Campanula* species, and *Phyteuma globulariifolium* Sternb. & Hoppe as an

outgroup (for details see Table 2). Herbarium specimens of isophyllous species of *Campanula* were studied from B, BEO, BEOU, CAT, CNHM, GZU, H, HMMNH, K, LJU, M, MKNH, W, WU, ZA and ZAGR (abbreviations follow Index Herbariorum [continuously updated]).

Scanning electron microscopy (SEM)

Ten mature capsules were collected from the field, and dried seeds were removed and prepared for the micro-morphological seed testa analyses by using a scanning electron microscope (Zeiss EVO LS10) at the University of Catania (Italy). Terminology of seed coat sculpturing follows Barthlott (1981) and Gontcharova & al. (2009). Seeds of *Campanula brulloi*, collected in Albania, and those of *C. debarensis*, collected in North Macedonia, were processed according to the method of Huttunen & Laine (1983).

DNA extraction, amplification and sequencing

Extraction of total genomic DNA was performed from silica-gel-dried leaves using the GenElute Plant Genomic DNA Miniprep Kit (Sigma-Aldrich, St. Louis, Missouri, U.S.A.), following the manufacturer's instructions. Polymerase chain reactions (PCR) were performed as described in Bogdanović & al. (2015) using the 17SE and 26SE primers (Sun & al. 1994) for the nuclear ITS and c and f primers (Taberlet & al. 1991) for the plastid *trnL-trnF* region. PCR products were purified with Exosap-IT (ThermoFisher Scientific, Waltham, Massachusetts, U.S.A.) and sequenced by Macrogen (Amsterdam, The Netherlands) with the same primers as used for amplification. Contigs were assembled and edited, and sequences were aligned using Geneious Pro5.3.6 (Drummond & al. 2011). Base polymorphisms in the ITS sequences were coded using NC-IUPAC ambiguity codes. The newly generated sequences were deposited in GenBank (Table 2); for ITS and *trnL-trnF* alignments, see Supplemental content online.

Phylogenetic analyses

Two different data sets (ITS and *trnL-trnF*) were analysed using Bayesian inference (BI) and maximum parsimony (MP). The trees were rooted using *Phyteuma globulariifolium* as an outgroup. Bayesian analyses were performed using MrBayes v.3.2.2 (Ronquist & al. 2012) applying the SYM+G substitution model selected based on the Akaike information criterion implemented in MrModelTest v.2.3 (Nylander 2004). The settings for the Markov chain Monte Carlo (MCMC) process included two runs with four chains each, run simultaneously for 10 000 000 generations each, sampling trees every 1000th generation using default priors. Posterior probabilities (PP) were determined from the combined set of trees, discarding the first 2500 trees of each run as burn-in. Convergence of

the MCMC procedure was assessed by visual inspection of the traces and via effective sample size values calculated with the program Tracer v.1.4 (Rambaut & Drummond 2007). Maximum parsimony and MP bootstrap (BS) analyses were performed using PAUP v.4.0b10 (Swofford 2003). To find the most parsimonious trees, we conducted a heuristic search with 1000 replicates of random sequence addition, TBR swapping and MulTrees on. The data set was bootstrapped using full heuristics, 1000 replicates, TBR swapping, MulTrees option off and random addition sequence with 100 replicates.

Results

Molecular phylogeny

Bayesian and maximum parsimony reconstructions resulted in congruent topologies confirming the monophyly of the *Campanula* ser. *Garganicae* (Fig. 1, 2). The sequence data of both data sets confirmed the distinct position of the newly described *C. brulloi* (ITS: 1 PP/99 BS; *trnL-trnF*: 1 PP/98 BS; Fig. 1, 2). In particular, *C. brulloi* exhibited a low-supported sister relationship with *C. debarensis* according to the ITS data (0.53 PP in Bayesian inference and no BS in maximum parsimony, Fig. 1), whereas according to the plastid data it belongs to the southern amphi-Adriatic group (0.99 PP/61 BS; Fig. 2) including *C. acarnanica*, *C. cephalenica*, *C. cremnophila*, *C. debarensis*, *C. garganica*, *C. poscharskyana* and *C. teutana*. All species within *C.* ser. *Garganicae* received high support from both BI and MP (with the exception of *C. garganica* and *C. poscharskyana* in the plastid dataset), although the relationships within the group are not resolved.

Taxonomy

Campanula brulloi Bogdanović, D. Shuka, Rešetnik, Cambria & Giusso, **sp. nov.** – Fig. 3, 6A, 7.

Holotype: Albania, Mati River, S of Klos, Ura e Vashës canyon, in rocky crevices and on walls near the bridge, 41°28'02.65"N 20°06'16.23"E, 26 Jun 2019, S. Bogdanović, I. Rešetnik, I. Ljubičić & A. Terlević s.n. (ZAGR [80847]!; isotypes: B [B 10 1244800]!, CAT [076081]!, TIR!, ZA [82072]!, ZAGR [82071]!).

Diagnosis — *Campanula brulloi* differs from *C. debarensis* in having larger size, covered by an indumentum of scattered and shorter hairs; branches not adherent to substrate; petiole to 12 cm long; leaf blade green, lanceolate with base cordate, to 10 cm long; pedicel longer; calyx teeth longer, patent at flowering; corolla larger with longer tube; filaments shorter; anthers longer; style longer; capsule ovoid, longer, without pores.

Description — Plants perennial, hairy, with patent sub-rigid to rigid hairs. Rootstock woody, 3–7 mm in diam.,

shortly branched in upper part, covered by petiole remains. Stems numerous, prostrate-creeping, pendulous, herbaceous, simple, 30–40 cm long, leafy, ending in ± lax racemes. Leaves laxly covered with rigid hairs 0.05–0.15 mm long on surface and 0.2–0.3 mm long at margin; petiole 0.3–12 cm long; leaf blade green, lanceolate, 10–100 × 5–60 mm, base cordate, margin irregularly 1–3-serrate with numerous teeth of different sizes, venation pinnate and branched; basal leaves larger, ± in rosettes; cauline leaves similar to basal ones, gradually decreasing upward, distributed up to apex of stem. Flowers usually arranged in several lateral racemes at leaf axils; racemes 1.5–6 cm long; pedicel 10–25 mm long, hairy, with 0–2 bracteoles. Calyx teeth patent in bud and anthesis, reflexed in fruit, green, linear, 4–7 × 0.7–1 mm, 1-nerved, densely hairy with hairs 0.4–0.6 mm long, margin entire, apex acute. Corolla blue-lilac, white in throat, rotate, 10–12 × 14–15 mm, hairy along margin of lobes and outside on 5 main veins; tube 3–4 mm long; lobes divaricate, lanceolate, 7–8 × 2.2–2.6 mm, with 1 midrib, apex acute. Stamens 5; filaments 1.5–1.7 mm long, base widened into an ovate blade 0.9–1 × 0.9–1 mm, margin densely ciliate with cilia 0.1–0.2 mm long, distal part glabrous; anthers lilac, linear-lanceolate, c. 5.5 mm long, apex acuminate; pollen whitish. Style exerted from tube, white proximally, pale blue-lilac distally, c. 12 mm long, glabrous proximally, less than half of apical part lanuginous; stigmas 3, c. 1.5 mm long. Capsule ovoid, c. 4 mm long, 5-ribbed, densely hairy with hairs 0.4–0.6 mm long, with reflexed calyx teeth, dehiscing by tearing of wall. Seeds pale brown, shiny, ovoid to ellipsoid, c. 0.6 × 0.38–0.4 mm.

Phenology — Flowering from May to the first half of July; fruiting from the second half of June to the end of July.

Distribution and ecology — *Campanula brulloi* grows within a narrow gorge in the upper part of Mati River c. 4 km southeast of the town of Klos in Central Albania (Fig. 4). It is restricted to rocky limestone walls on the left bank of the water flow. The species has a highly localized distribution, occurring only within the gorge above Ura e Vashës. The species was recorded along a stretch of c. 1.2 km, from the uppermost population near the Blishta Hydroelectric Power Plant at 460 m a.s.l., down to the lowermost occurrence, c. 30 m beyond the bridge, at 350 m a.s.l. In terms of ecological requirements, *C. brulloi* grows exclusively in rock crevices, often covered with a moss carpet. This microhabitat is characterized with relatively high humidity, dense shrub and tree cover on rocky slopes with a northeastern exposure, which results in reduced sunlight and lower summer temperatures. It is also found in cracks of the stone walls of the Ura e Vashës. Chasmophytes more frequent in the stands colonized by *C. brulloi* are mainly *Asplenium ceterach* L., *A. trichomanes* L., *Asyneuma limonifolium* (L.) Janch.,

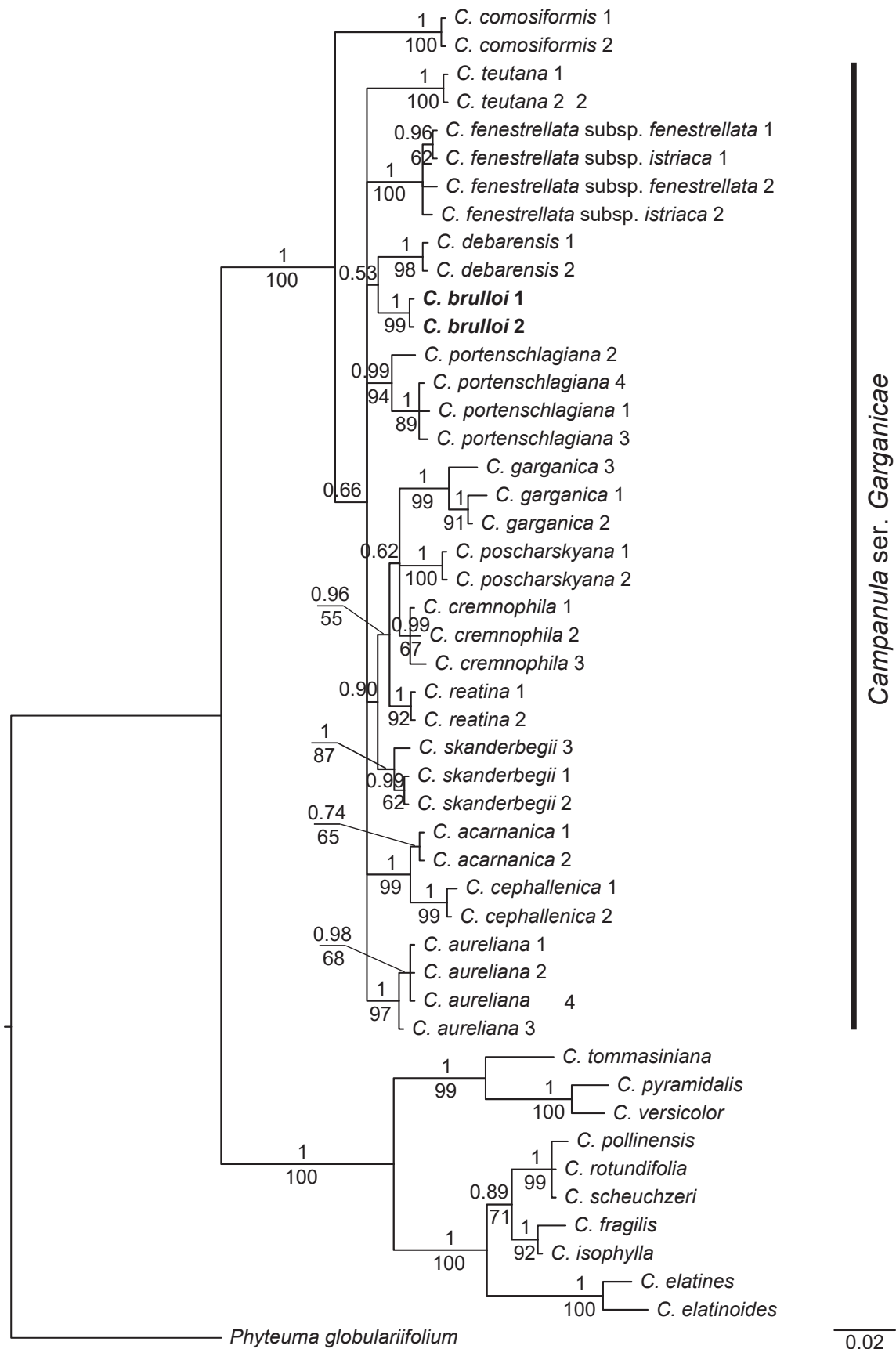


Fig. 1. Phylogenetic relationships among *Campanula* ser. *Garganicae* and closely related species inferred from ITS sequences. Bayesian consensus phylogram; numbers above branches are posterior probabilities > 0.50, those below branches are maximum parsimony bootstrap values > 50 %.

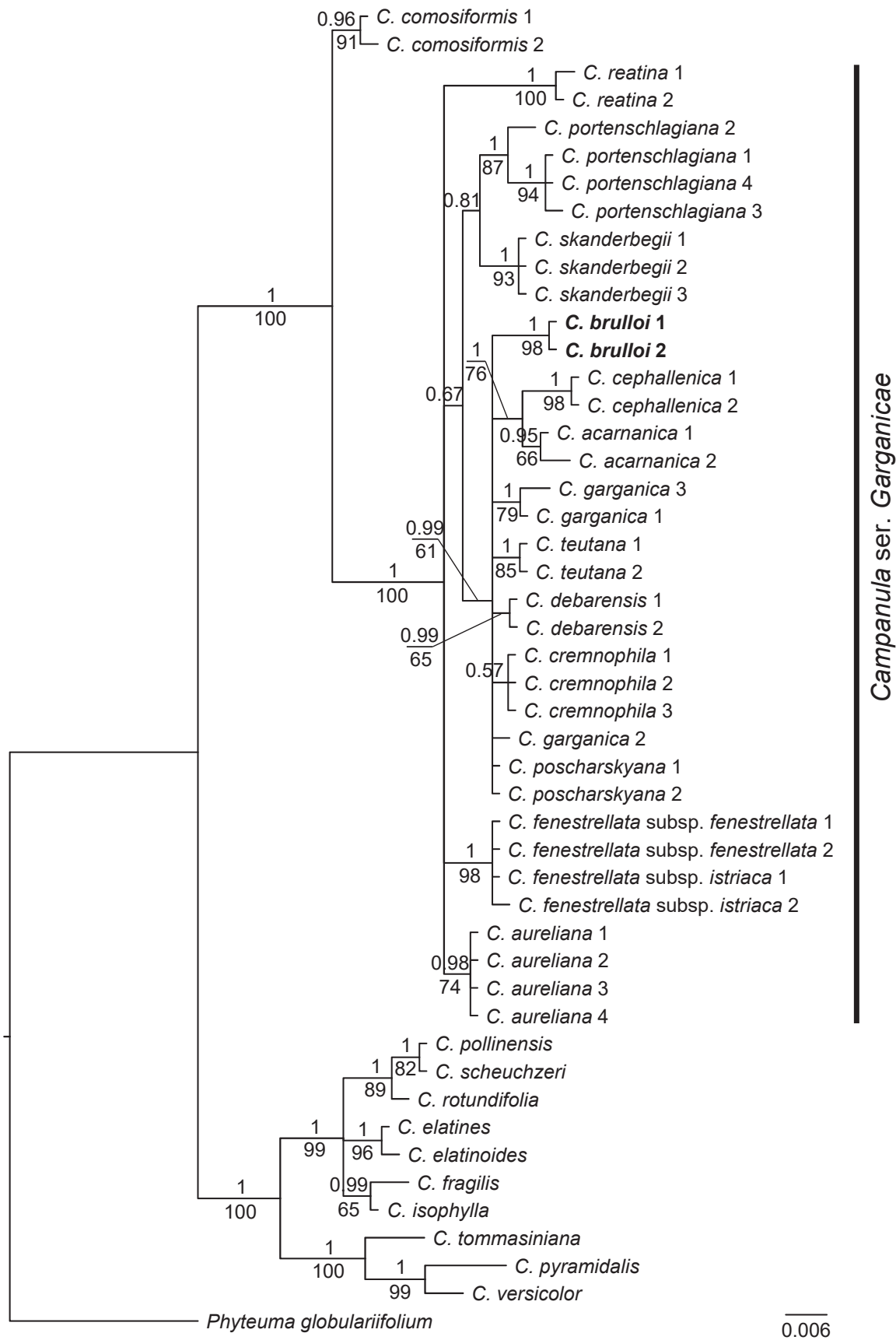


Fig. 2. Phylogenetic relationships among *Campanula* ser. *Garganicae* and closely related species inferred from plastid *trnL-trnF* sequences. Bayesian consensus phylogram; numbers above branches are posterior probabilities > 0.50, those below branches are maximum parsimony bootstrap values > 50 %.

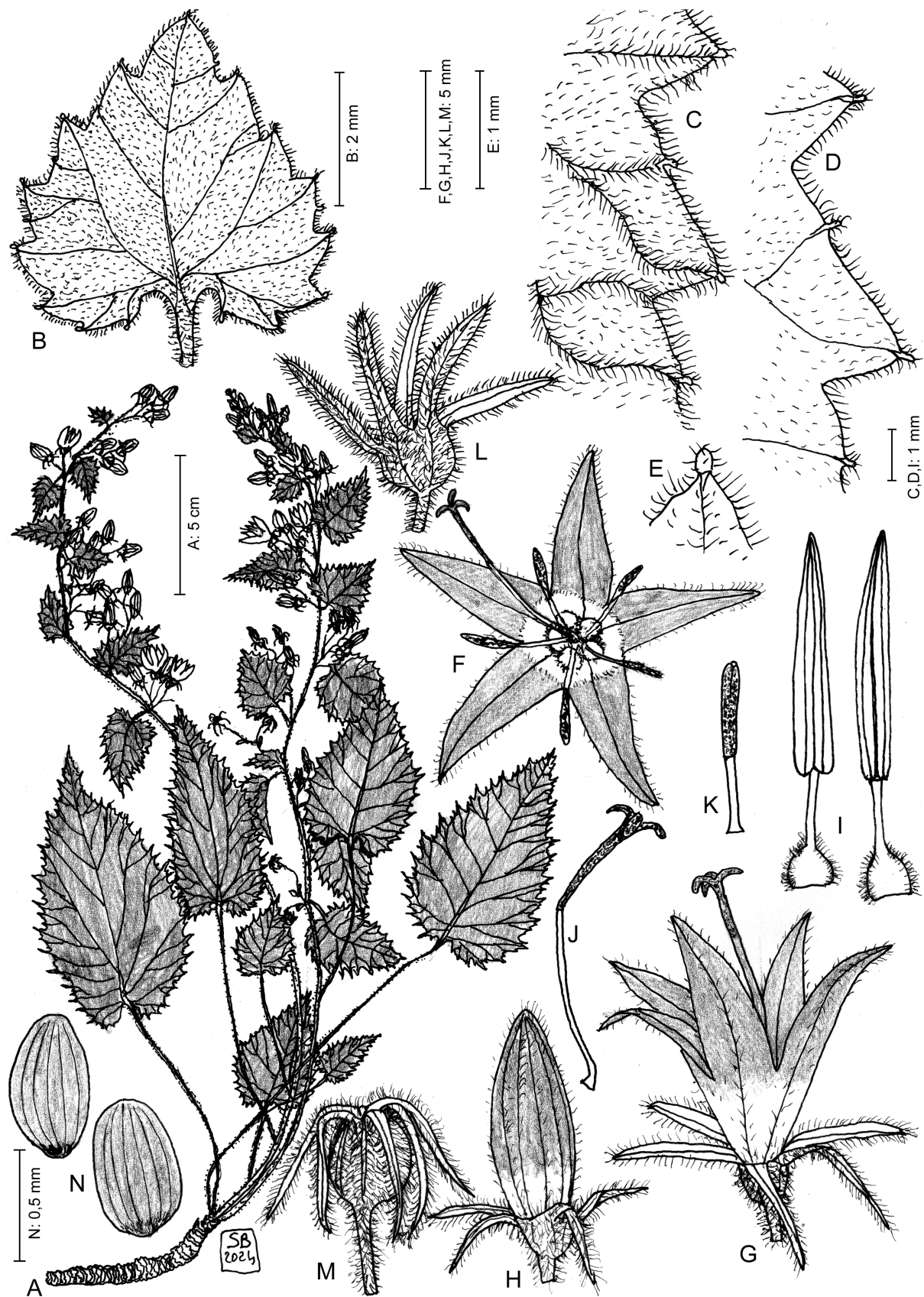


Fig. 3. *Campanula brulloi* – A: habit; B: cauline leaf; C: leaf detail of abaxial surface; D: leaf detail of adaxial surface; E: detail of leaf apex; F: flower, adaxial view; G: flower, lateral view; H: flower bud, lateral view; I: stamens; J: mature style and stigma; K: juvenile style and stigma; L: calyx at anthesis; M: capsule; N: seeds. – A–N from the holotype, S. Bogdanović & al. s.n. (ZAGR [80847]). – Drawn by S. Brullo.

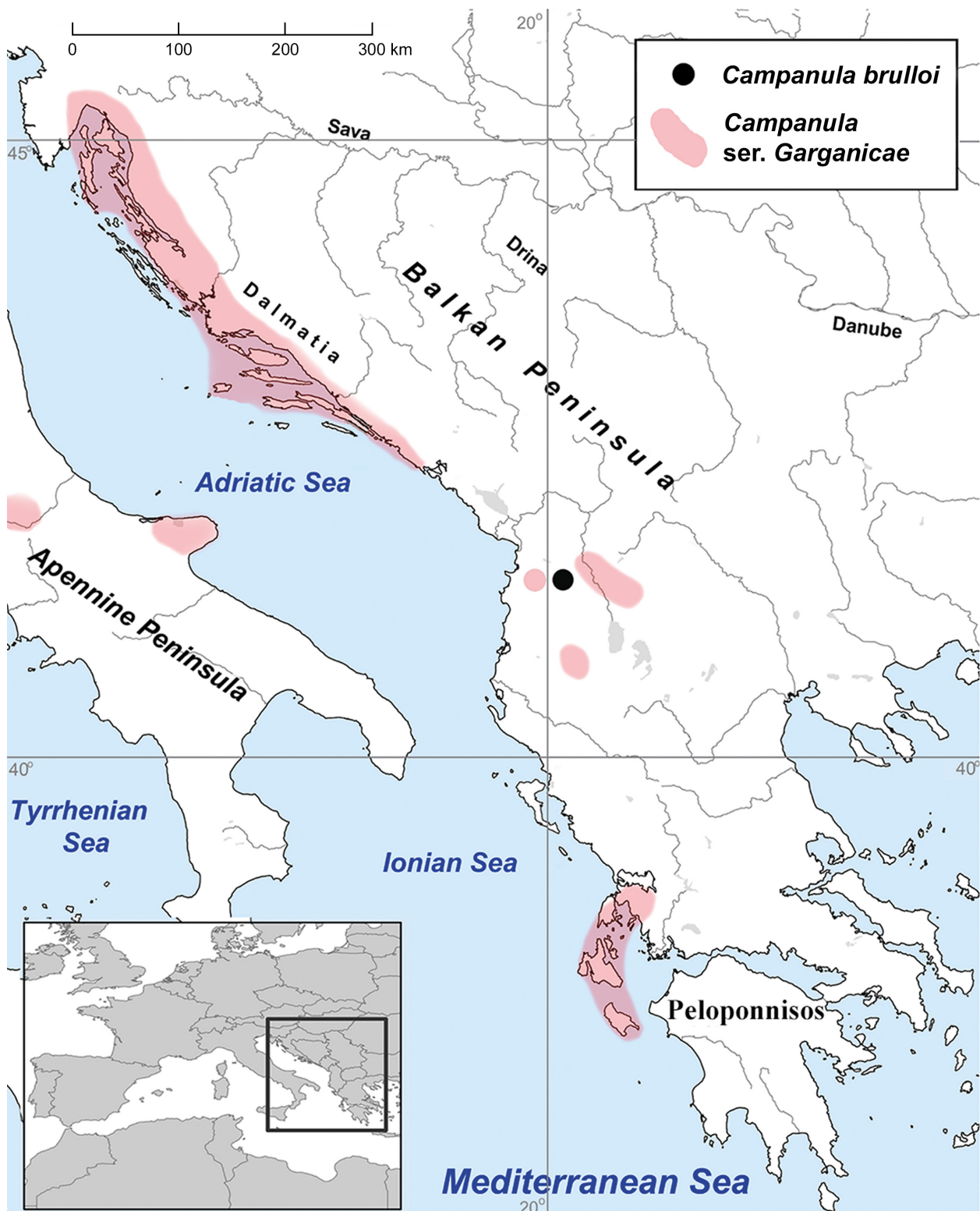


Fig. 4. Distribution map of *Campanula brulloi* in Albania with distribution area of other species belonging to *C. ser. Garganicae*.

Campanula austroadriatica D. Lakušić & Kovačić, *C. ramosissima* Sm., *Erysimum linariifolium* Tausch, *Hylo-telephium maximum* (L.) Holub, *Iberis umbellata* L., *Micromeria juliana* (L.) Benth. ex Rchb., *Moltkia petraea* (Tratt.) Griseb., *Plocama calabrica* (L. f.) M. Backlund & Thulin, *Ramonda serbica* Pančić, *Satureja montana*

L., *Saxifraga paniculata* Mill., *S. rotundifolia* L. and *Thlipthisa rupestris* (Vis.) P. Caputo & Del Guacchio.

Conservation status — *Campanula brulloi* is a stenoendemic species of central Albania with its distribution range in the canyon of Ura e Vashës. Its Extent of Occur-

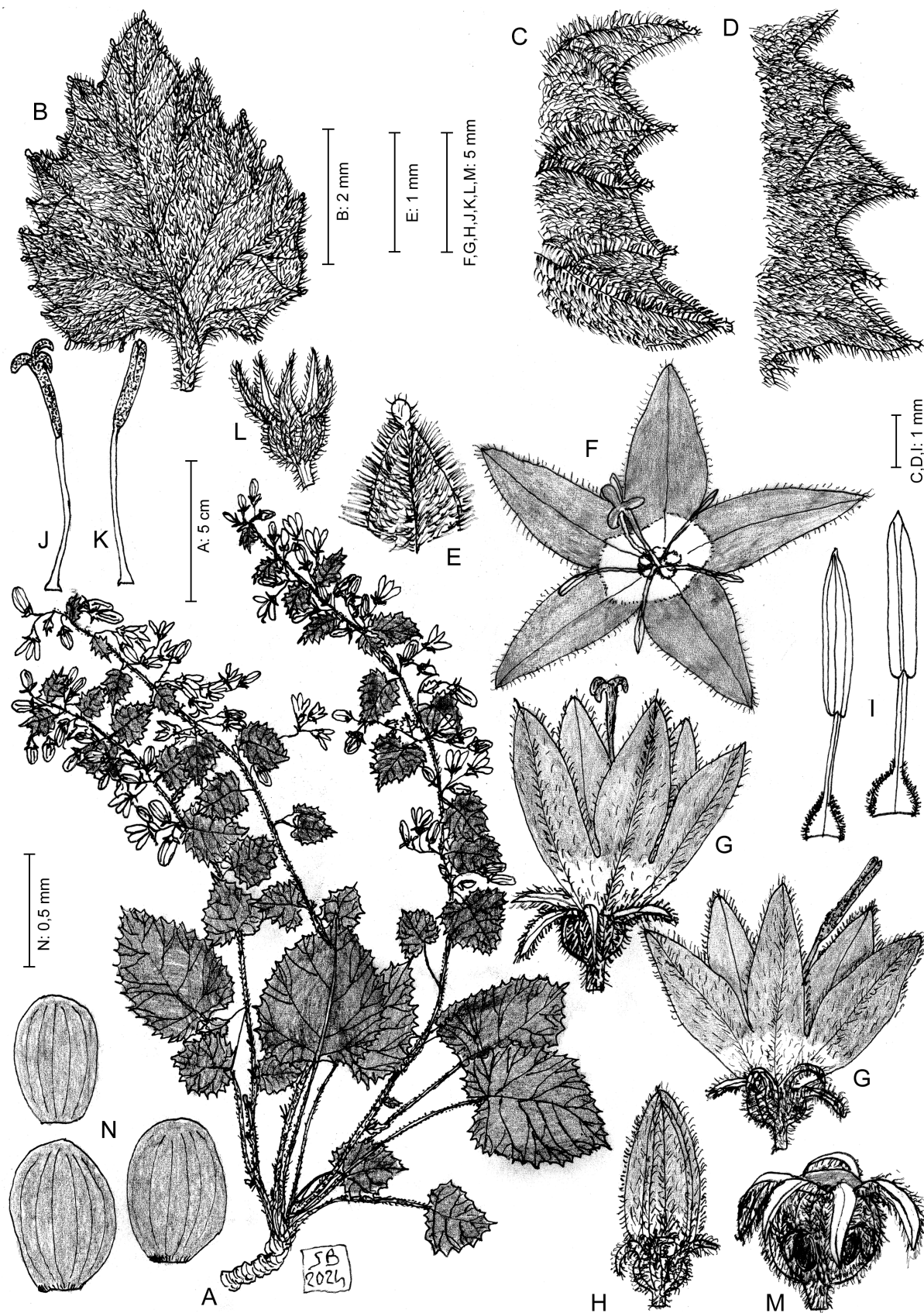


Fig. 5. *Campanula debarensis* – A: habit; B: cauline leaf; C: leaf detail of abaxial surface; D: leaf detail of adaxial surface; E: detail of leaf apex; F: flower, adaxial face; G: flowers, lateral view; H: flower bud, lateral view; I: stamens; J: mature style and stigma; K: juvenile style and stigma; L: calyx at anthesis; M: capsule; N: seeds. – A–N from S. Bogdanović & M. Jug-Dujaković s.n. (CAT). – Drawn by S. Brullo.

rence (EOO) and Area of Occupancy (AOO) are 4 km². Monitoring of the species population during June 2024, resulted in counting of fewer than 500 mature individuals, with more than ⅔ of them found 50 m above and below the stone bridge. Currently, this population appears stable, but impending changes threaten its natural balance. The construction of hydroelectric power plants above the upper limit of its distribution, seen here as a plausible future threat, an increase in visitor numbers and building a restaurant under the stone bridge could disrupt the natural balance of water flow, temperature and landscape. Furthermore, the predicted increase of temperatures between 1.2°C and 4.4°C by 2100, according to Shumka & al. (2025), will impact the floristic composition of the canyon and negatively affect the population of *C. brulloi*. The species is therefore assessed as Vulnerable (VU): D1+D2 according to IUCN criteria (IUCN 2024). Within the Ura e Vashës canyon, additional restricted endemics include three terrestrial molluscs and *Aesculus hippocastanum* L., a globally threatened species. Therefore, we recommend the integration of the canyon into Albania's existing network of protected areas.

Etymology — This species is dedicated in honour of Prof. Salvatore Brullo, active botanist at Catania University and specialist in the taxonomy of many genera of the Mediterranean flora. The authors express their deep gratitude for his fundamental teachings and invaluable guidance in botanical studies.

Campanula debarensis Rech. f. in Repert. Spec. Nov. Regni Veg. 47: 175. 1939. – Lectotype (designated by Damboldt (1965: 346): [North Macedonia], Drin-Schlucht 30 km nördlich von Struga vor Dibra mit *Ramonda serbica*, 300 m, senkrechte, schattige Felswände, aber trocken, 2 Jul 1938, F. Lemperg 729 (W [W0325225]!; isolectotypes: GZU [GZU000273483]!, K [K000814326]!, M [M0189935]!). – Fig. 5, 6B, 8.

Description — Plants perennial, densely pubescent, with patent subrigid to rigid hairs. Rootstock woody, 3–4 mm in diam., shortly branched in upper part, covered by petiole remains. Stems numerous, prostrate-creeping, adherent to substrate, herbaceous, simple, 8–30 cm long, leafy, ending in ± lax racemes. Leaves densely covered with rigid hairs 0.1–0.5 mm long on surface and 0.3–0.5 mm long at margin; petiole 0.2–5(–8) cm long; leaf blade pale green, cordate to ovate-cordate, 30–50(–80) × 3–30(–40) mm, base cordate, margin irregularly 1- or 2-serrate with numerous teeth of different sizes, venation pinnate and branched; basal leaves larger, ± in rosettes; cauline leaves similar to basal ones, gradually decreasing upward, distributed up to apex of stem. Flowers usually arranged in several lateral racemes at leaf axils; racemes 1–2.5(–4) cm long; pedicel 5–8 mm long, hairy, with 0–2 bracteoles. Calyx teeth patent-reflexed in bud and anthesis, reflexed in fruit, green, linear, 2.5–3 × 0.3–

0.5 mm, 1-nerved, densely hairy with hairs 0.1–0.2 mm long, margin entire, apex acute. Corolla blue-lilac, white in throat, rotate, 9–10 × 10–14 mm, hairy along margin of lobes, sparsely hairy outside on main veins and lobes; tube c. 2.5 mm long; lobes divaricate, lanceolate, 6–7 × 2.5–3 mm, with 1 midrib, apex acute. Stamens 5; filaments 2.2–2.3 mm long, base widened into an ovate blade 0.7–0.8 × 0.8–0.9 mm, margin densely ciliate with cilia c. 0.1 mm long, distal part glabrous; anthers lilac, linear, c. 3.5 mm long, apex acute; pollen whitish. Style exerted from tube, white proximally, pale blue-lilac distally, 9–10 mm long, glabrous proximally, less than half of apical part lanuginous; stigmas 3, c. 0.8 mm long. Capsule globose, 2.5–3 mm long, 5-ribbed, densely hairy with hairs 0.2–0.4 mm long, with reflexed calyx teeth, dehiscing by lateral pores. Seeds pale brown, shiny, ovoid, 0.5–0.6 × 0.4–0.5 mm.

Phenology — Flowering from late May to early July; fruiting from June to late July.

Distribution and ecology — According to the literature (Rechinger 1939; Ehm 1956), *Campanula debarensis* is a chasmophyte growing on calcareous rocky and very shady places at an elevation of 300–600 m, exceptionally to 1600 m. Based on field surveys and herbarium research, the species appears to be restricted to localities in western North Macedonia, near Lukovo, Mavrovo, Debar, Struga and Jablanica. It is found together with the following species: *Allium amethystinum* Tausch, *A. scorodoprasum* L., *A. sphaerocephalon* L., *Asplenium ceterach* L., *Aurinia saxatilis* (L.) Desv., *Campanula versicolor* Andrews, *Carpinus orientalis* Mill., *Cuscuta approximata* Bab., *Digitalis laevigata* Waldst. & Kit., *Euphorbia myrsinites* L., *E. stricta* L., *Geranium lucidum* L., *Hedera helix* L., *Hypericum spruneri* Boiss., *Micromeria juliana* (L.) Benth. ex Rchb., *Orobancha hederæ* Duby, *Ostrya carpinifolia* Scop., *Pterocephalus plumosus* (L.) F. Dietr., *Ramonda serbica* Pančić, *Salvia officinalis* L., *Satureja montana* L., *Scabiosa ochroleuca* L. and *Stachys sylvatica* L.

Additional specimens examined — NORTH MACEDONIA: Klisura na Crni Drim, na varovičen kamenjar kraj s. Lukovo, 21 Jul 1974, K. Micevski s.n. (MKNH [031830]!, ZAGR [33467]!); Yugoslavia, Mavrovo, SW of Gostivar, 1600 m, vertical rock walls, occasionally in scree below, 26 Jun 1965, B. Mathew & A. J. Tomunson 4636 (K!); Yugoslavia, Mavrovo, SW of Gostivar, 1600 m, vertical rock walls, occasionally in scree below, 26 Jun 1965, B. Mathew & A. J. Tomunson 4639 (K!); Yugoslavia, Macedonia, Crni Drim, inter Debar et Struga, c. 600 m, in rupium fissuris, solo calcareo, 6 Jul 1963, E. Mayer 50646 (H [1428560]!, H [1428561]!, LJU!); Makedonija, Lukovo, kanjon Crnog Drima, 16 Oct 1988, V. Stevanović s.n. (BEOU!); Makedonija, Lukovo, krečnjak, May 2007, V. Stevanović & G. Tomović 24079 (BEOU!); Debar, pokraj

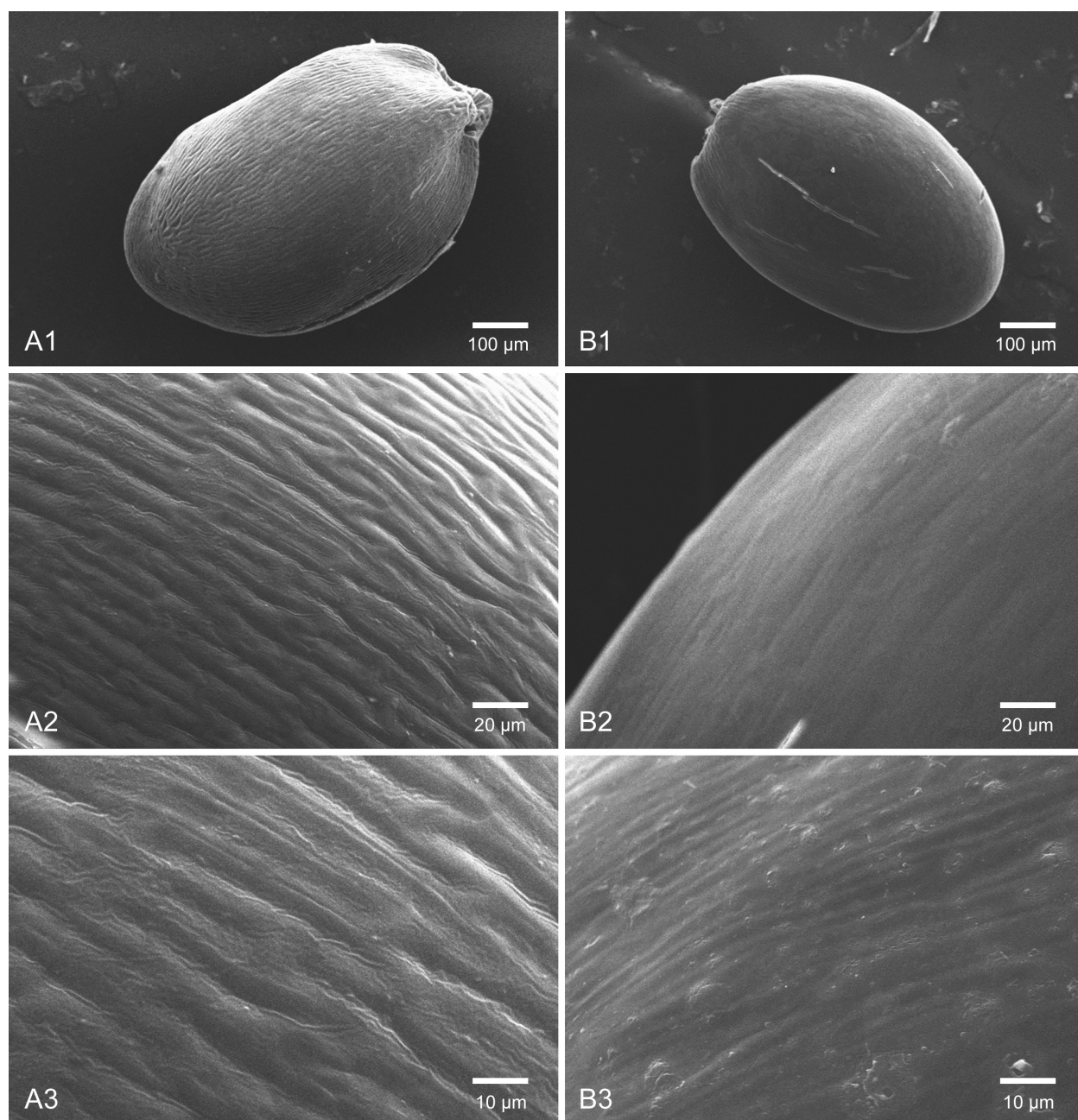


Fig. 6. SEM micrographs of seed coat of *Campanula brulloi* (A) and *C. debarensis* (B). – 1: seed full view; 2, 3: testa detail (two different magnifications). – A from the holotype, S. Bogdanović & al. s.n. (ZAGR [80847]); B from S. Bogdanović & M. Jug-Dujaković s.n. (CAT).

patot za Struga, vo blizina na hidrocentralata “Globočica”, na karpi, 23 Jul 1999, Z. Nikolov s.n. (HMMNH!, WU [0028150]!); Makedonija, Jablonica, von Modrić zur Talstation am Crni Drim, 650–800 m, Gebüsch, Felstriften, Felsen, Kalk, Silikat, 10 Jul 1976, E. Krendl & F. Krendl s.n. (W!); Debar, prope pg. [pagum] Lukovo, 14 Sep 1933, R. Šoška s.n. (BEO!); Kanjon Crnog Drima, kod Struge, 4 May 1972, I. Trinajstić s.n. (CNHM!); Kanjon Crnog Drima, 15 Jul 1977, I. Trinajstić s.n. (CNHM!); Makedonija, Jablanica, kanjon Crnog Drima, 4 May 1972, I. Trinajstić s.n. (CNHM!); Makedonija, selo Lukovo, sjeverno od skretanja za Selca i Lukovo, 500 m, okomite stijene uz cestu, 13 Jul 2012, S. Bogdanović &

M. Jug-Dujaković s.n. (CAT!, ZAGR [32620]!, ZAGR [32621]!).

Seed morphology and microsculpturing of *Campanula brulloi* and *C. debarensis*

Based on the literature (Geslot 1980; Murata 1992, 1995; Toniuc 1999; Buss & al. 2001; Kovačić 2004; Akcin 2009; Alçitepe 2010; Alçitepe & Yildiz 2010), two main seed-coat patterns can be distinguished in *Campanula*: reticulate or striate microsculptures. Previously analysed species within *C. ser. Garganicae*, such as *C. aureliana* (Bogdanović & al. 2015), *C. cremnophila* (Bogdanović

& al. 2019), *C. fenestrellata* s.l. (Kovačić 2004), *C. skanderbegii* (Bogdanović & al. 2014a) and *C. teutana* (Bogdanović & al. 2014b), consistently exhibit seed testa with striate ornamentation. However, they differ in the shape and size of the cells forming the striae. In particular, *C. brulloi* is characterized by its seeds being pale brown, shiny, lenticular, ovoid to ellipsoid and measuring c. $0.6 \times 0.38\text{--}0.4$ mm. Its seed testa is distinctly striate, with elongated, highly anastomosed, fibriform cells measuring $30\text{--}67 \times 6.5\text{--}8.3$ μm . The periclinal walls are quite raised and slightly channelled on the back, while the anticlinal walls, conversely, display a fairly incised linear lumen (Fig. 6A). For comparison, the seeds of the closely related *C. debarensis* are ovoid and measure $0.5\text{--}0.6 \times 0.4\text{--}0.5$ mm. Their seed testa is weakly striate, characterized by thinner cells, not noticeably anastomosed, measuring $33\text{--}46.6 \times 5\text{--}6$ μm . Furthermore, the periclinal walls are narrower, slightly raised, and markedly channelled on the back, while the anticlinal walls are shallow and with a few evident lumina (Fig. 6B).

Key to species of *Campanula* ser. *Garganicae*

Modified from Bogdanović & al. (2014a).

1. Corolla campanulate, tube $\frac{1}{2}\text{--}\frac{3}{4}$ corolla length ... **2**
 - Corolla rotate, $\pm$ flattened or infundibular, tube $\frac{1}{6}\text{--}\frac{1}{2}$ corolla length **4**
2. Corolla $9\text{--}11 \times 12\text{--}14$ mm, outside totally hairy; calyx teeth deflexed in fruit, basal blade of filament semicircular, $0.6\text{--}0.8$ mm long *C. skanderbegii*
 - Corolla $14\text{--}25 \times 20\text{--}24$ mm, outside glabrous or hairy along midrib; calyx teeth erect to patent in fruit; basal blade of filament ovate to elliptic, $1.2\text{--}1.7$ mm long **3**
3. Pedicel $5\text{--}12$ mm long; calyx teeth $5\text{--}7$ mm long; corolla tube c. $\frac{1}{2}$ corolla length; filaments $2\text{--}2.5$ mm long; anthers white tinged with pale blue, pollen whitish *C. teutana*
 - Pedicel $12\text{--}25$ mm long; calyx teeth $3\text{--}4$ mm long; corolla tube $\frac{2}{3}\text{--}\frac{3}{4}$ corolla length; filaments $0.8\text{--}1$ mm long; anthers and pollen yellowish *C. portenschlagiana*
4. Corolla infundibular, $30\text{--}40$ mm in diam.; calyx teeth c. 7×3 mm, c. $2 \times$ as long as capsule *C. poscharskyana*
 - Corolla rotate to infundibular, $7\text{--}20$ mm in diam.; calyx teeth to 6×2 mm, subequal to or shorter than capsule **5**
5. Calyx teeth $1.5\text{--}2(\text{--}2.5)$ mm long **6**
 - Calyx teeth $2.5\text{--}6$ mm long **7**
6. Plants glabrous; leaf blade reniform; corolla $10\text{--}15$ mm long *C. reatina*
 - Plants densely hairy; leaf blade cordate; corolla $8\text{--}10$ mm long *C. aureliana*
7. Pollen yellow; leaf blade margin 1-serrate, rarely 2-serrate to dentate **8**
 - Pollen whitish to blue; leaf blade margin markedly 2-serrate to dentate **10**

8. Calyx teeth usually erect or rarely patent; corolla tube $\frac{1}{3}\text{--}\frac{1}{2}$ corolla length; style hairy c. $\frac{2}{3}$ its length *C. acarnanica*
 - Calyx teeth never erect, always patent to deflexed; corolla tube $\frac{1}{4}\text{--}\frac{1}{3}$ corolla length; style hairy $\frac{1}{3}\text{--}\frac{1}{2}$ its length **9**
9. Filaments with long and acute hairs at base; anthers c. 3 mm long; calyx teeth to 1 mm wide; capsule globose, c. 3×2.5 mm, opening by basal pores *C. cephalenica*
 - Filaments with short and rounded hairs at base; anthers c. 4 mm long; calyx teeth to 2 mm wide; capsule flattened, c. 3×4 mm, without pores *C. garganica*
10. Corolla tube $3\text{--}5$ mm long; filaments $0.5\text{--}1.7$ mm long; capsule without pores **11**
 - Corolla tube $2\text{--}3$ mm long; filaments $2.2\text{--}3.5$ mm long; capsule with pores **12**
11. Leaf blade reniform, margin shortly dentate; calyx teeth $2.5\text{--}3$ mm long; corolla $8\text{--}9$ mm long, lobes $3.5\text{--}5$ mm long; filaments c. 0.5 mm long; anthers $3\text{--}3.2$ mm long; capsule c. 2.5 mm long; seeds $0.45\text{--}0.5$ mm long *C. cremnophila*
 - Leaf blade lanceolate with base cordate, margin $1\text{--}3$ -serrate; calyx teeth $4\text{--}7$ mm long; corolla $10\text{--}12$ mm long, lobes $7\text{--}8$ mm long; filaments $1.5\text{--}1.7$ mm long; anthers c. 5.5 mm long; capsule c. 4 mm long; seeds c. 0.6 mm long *C. brulloi*
12. Inflorescence lax; corolla blue-lilac, glabrous proximally, lobes $2.5\text{--}3$ mm wide at base; calyx teeth reflexed, $0.3\text{--}0.5$ mm wide, as long as capsule *C. debarensis*
 - Inflorescence compact; corolla pale blue, ciliate proximally, lobes $3\text{--}4$ mm wide at base; calyx teeth usually erect, c. 1.5 mm wide, slightly longer than capsule **13**
13. Plants usually glabrous; corolla to 15 mm in diam.; basal leaf blade to 4×3 cm, margin 1- or 2-serrate; capsule c. 2.5×3.5 mm *C. fenestrellata* subsp. *fenestrellata*
 - Plants densely tomentose-velvety; corolla to 20 mm in diam.; basal leaf blade to 7×4 cm, margin 1-serrate; capsule c. 4×4.5 mm *C. fenestrellata* subsp. *istriaca*

Discussion

The newly described *Campanula brulloi* is a morphologically and phylogenetically well-differentiated species within *C. ser. Garganicae*, contributing to a remarkable diversity of highly localized endemic species in this isophyllous Mediterranean clade.

Morphologically (see Table 1), *Campanula brulloi* shows closer similarities with *C. debarensis* in having 2-serrate leaves, short racemes, infundibular, medium-sized corolla ($9\text{--}12$ mm long) and whitish pollen. However, distinct traits in their vegetative and reproductive struc-



Fig. 7. *Campanula brulloi* – A: habitat; B: habit; C: leaf, adaxial view; D: flower bud and flower, lateral view; E: flower, adaxial view; F: capsule, lateral view. – A–F: Albania, Ura e Vashës near Klos, 26 June 2019, photographs by S. Bogdanović.

tures clearly differentiate the two species. Specifically, *C. brulloi* is differentiated from *C. debarensis* in its larger size with stem 30–40 cm long (vs 8–30 cm), leaf blade lanceolate (vs cordate to ovate-cordate), pedicel 10–25 mm long (vs 5–8 mm), calyx teeth 4–7 mm long (vs 2.5–3 mm), calyx covered by hairs 0.4–0.6 mm long (vs 0.1–0.2 mm), corolla 10–12 mm long (vs 9–10 mm), corolla tube 3–4 mm long (vs c. 2.5 mm), filaments 1.5–1.7 mm long (vs 2.2–2.3 mm), anthers c. 5.5 mm long (vs c. 3.5 mm) and capsule ovoid, c. 4 mm long (vs globose, 2.5–3 mm).

For some features, such as the corolla tube length, short filaments and capsule without pores, *Campanula brulloi* shares similarities with *C. cremnophila*, but the two species differ clearly by numerous other diagnostic characters. Specifically, *C. cremnophila* has leaf blade reniform with margin dentate (vs lanceolate with margin 1–3-serrate), calyx teeth 2.5–3 mm long (vs 4–7 mm), corolla 8–9 mm long (vs 10–12 mm), corolla lobes 3.5–5 mm long (vs 7–8 mm), filaments c. 0.5 mm long (vs 1.5–1.7 mm), anthers 3–3.2 mm long (vs c. 5.5 mm), style c. 5 mm long (vs c. 12 mm), capsule c. 2.5 mm long (vs c. 4 mm) and seeds 0.45–0.5 mm long (vs c. 0.6 mm).

Furthermore, distinct differences were observed in the seed testa ornamentations of *Campanula brulloi* compared to *C. debarensis*. Specifically, *C. brulloi* shows longer and wider cells with more prominent and slightly channelled periclinal walls, and anticlinal walls with a more incised linear lumen. Regarding *C. cremnophila*, the seed testa cells are characterized by more prominent and raised periclinal walls, while the anticlinal walls show a deeply incised linear lumen compared to *C. brulloi*.

Campanula aureliana is another species showing some affinities with *C. brulloi* and occurring also in Albania, although its distribution is limited to a small area near Tomori village and mountain (Bogdanović & al. 2015). Morphologically, it differs from *C. brulloi* in having a small size with stems prostrate-ascending, 10–30 cm long and densely hairy (vs pendulous, 30–40 cm, laxly hairy), leaf blade cordate, 7–30 mm long (vs lanceolate, 10–100 mm), surface with hairs 0.4–1 mm long (vs 0.05–0.15 mm), margin irregularly dentate with hairs 0.4–1 mm long (vs 1–3-serrate, with hairs 0.2–0.3 mm), calyx teeth patent, 1.5–2.5 mm long (vs patent to re-



Fig. 8. *Campanula debarensis* – A, B, D: habit; C: flower, adaxial view; E: capsules. – A–E: North Macedonia, Selca and Lukovo, 13 July 2012, photographs by S. Bogdanović.

flexed, 4–7 mm), corolla 8–10 mm long (vs 10–12 mm long), corolla tube 1.5–2 mm long (vs 3–4 mm), anthers 3–3.2 mm long (vs c. 5.5 mm), style 7.5–9 mm long (vs c. 12 mm), capsule subglobose, 2.6–3 mm long (vs ovoid, c. 4 mm) and seeds subglobose-ovoid, c. 0.5 mm long (vs ovoid to ellipsoid, c. 0.6 mm).

Campanula brulloi is restricted to calcareous vertical rocky slopes along a semi-shaded canyon that is characterized by lower temperatures and higher humidity. It grows in cracks and crevices with other species forming typical chasmophytic vegetation. Generally, this type of habitat is known as a refugial one and harbours many endemic plant species such as *Campanula aureliana*, *C. austroadriatica*, *C. comosiformis* (Hayek & Janch.) Frajman & Schneew., *C. skanderbegii*, *C. versicolor* subsp. *korabensis* (F. K. Mey.) I. Janković & D. Lakušić, *Crepis macedonica* Kitan., *Erysimum linariifolium*, *Heliosperma nikolicii* (A. Seliger & Wraber) Niketić & Stevan., *H. oliverae* Niketić & Stevanović and *Ramonda serbica*, as well as endemic animal species such as *Cochlostoma hoyeri lillae* (Fehér, 2004), *Liburnica dochii* (Sturany,

1907), *Montenegrina timeae* (Erőss & Szekeres, 2006) and *M. helvola magna* (Fehér & Szekeres, 2006). Northern and central parts of Albania with their canyons and chasmophytic refugial habitats are known as one of the biodiversity hotspot centres within the Mediterranean area (Stevanović & al. 2009; Rakaj & Barina 2015). We assume that *Campanula brulloi* represents a case of endemic speciation within the refugial canyon, where prolonged reproductive isolation and the unique edapho-climatic regime that characterized the area in the past promoted its divergence from ancestral lineages.

In line with previous phylogenetic studies of *Campanula* ser. *Garganicae* (Park & al. 2006; Frajman & Schneeweiss 2009; Bogdanović & al. 2014a, 2014b, 2015, 2019; Rešetnik & al. 2020), the DNA sequence data remain inconclusive regarding fine-scale species relationships within the group. The morphological similarity between the newly described *C. brulloi* and *C. debarensis* is partially reflected in the nuclear dataset, although their sister relationship lacks statistical support (Fig. 1). In contrast, plastid data place both species within the well-supported

Table 1. Diagnostic characters of *Campanula brulloi* and allied species.

Character	<i>C. aureliana</i>	<i>C. brulloi</i>	<i>C. cremnophila</i>	<i>C. debarensis</i>
Stem habit	prostrate-ascending	pendulous	prostrate-creeping	prostrate-creeping, adherent to substrate
Stem length (cm)	10–30	30–40	5–15	8–30
Petiole length (cm)	2–7	0.3–12	1–5	0.2–5(–8)
Leaf blade colour	dark green	green	greyish green	pale green
Leaf blade shape	cordate	lanceolate	reniform	cordate to ovate-cordate
Leaf blade size (mm)	7–30 × 6–25	10–100 × 5–60	30–50(–80) × 3–30(–40)	30–50(–80) × 3–30(–40)
Leaf blade margin	irregularly dentate	irregularly 1–3-serrate	dentate	irregularly 1- or 2-serrate
Leaf blade indumentum	densely hairy	laxly hairy	densely hairy	densely pubescent
Leaf blade surface hair length (mm)	0.4–1	0.05–0.15	0.1–0.6	0.1–0.5
Leaf blade margin hair length (mm)	0.4–1	0.2–0.3	0.1–0.6	0.3–0.5
Raceme length (cm)	1.5–3.5	1.5–6	1–7	1–2.5(–4)
Pedicel length (mm)	5–20	10–25	3–15	5–8
Calyx teeth direction in flower	patent	patent	patent-reflexed	patent-reflexed
Calyx teeth direction in fruit	patent	reflexed	reflexed	reflexed
Calyx teeth size (mm)	1.5–2.5 × 0.8–1	4–7 × 0.7–1	2.5–3 × c. 1	2.5–3 × 0.3–0.5
Calyx hair length (mm)	0.4–1	0.4–0.6	0.1–0.3	0.1–0.2
Corolla size (mm)	8–10 × 14–16	10–12 × 14–15	8–9 × 8–13	9–10 × 10–14
Corolla tube length (mm)	1.5–2	3–4	3.5–5	c. 2.5
Corolla lobe size (mm)	6.5–8 × 2.5–3	7–8 × 2.2–2.6	3.5–5 × 2.2–2.6	6–7 × 2.5–3
Filament length (mm)	1.5–2	1.5–1.7	c. 0.5	2.2–2.3
Filament basal blade size (mm)	c. 1 × 1	0.9–1 × 0.9–1	0.6–0.8 × 0.5–0.6	0.7–0.8 × 0.8–0.9
Anther length (mm)	3–3.2	c. 5.5	3–3.2	c. 3.5
Style length (mm)	7.5–9	c. 12	c. 5	9–10
Stigma length (mm)	c. 1.5	c. 1.5	c. 1.5	c. 0.8
Capsule shape	subglobose	ovoid	subconic	globose
Capsule length (mm)	2.6–3	c. 4	c. 2.5	2.5–3
Capsule hair length (mm)	0.2–0.3	0.4–0.6	0.3–1	0.2–0.4
Capsule dehiscence	wall tearing	wall tearing	wall tearing	lateral pores
Seed shape	subglobose-ovoid	ovoid to ellipsoid	ovoid to ellipsoid	ovoid
Seed size (mm)	c. 0.5 × 0.54	c. 0.6 × 0.38–0.4	0.45–0.5 × c. 0.3	0.5–0.6 × 0.4–0.5

clade of southern amphi-Adriatic taxa (Fig. 2), reinforcing the hypothesis of multiple independent trans-Adriatic dispersal or vicariant events shaping the biogeographic history of this lineage (Park & al. 2006; Frajman & Schnee-weiss 2009; Bogdanović & al. 2014a, 2014b, 2015, 2019; Surina & al. 2014). Overall, the phylogenetic patterns observed within *C. ser. Garganicae* highlight the complexity of diversification processes in karstic and chasmophytic habitats, where physical isolation, ecological specializa-

tion and historical climatic stability have likely facilitated allopatric speciation. The consistently inferred well-supported and phylogenetically independent positions of all species within *C. ser. Garganicae*, combined with their highly localized and often relict distributions, underscore the ecological and evolutionary significance of Mediterranean microrefugia as reservoirs of unique floristic elements and genetic diversity. Such findings emphasize the urgent need for conservation strategies targeting these

fragile and biodiversity-rich habitats, especially in light of ongoing environmental change.

Author contributions

D.S. initiated the study; S.B., S.C. and I.R. wrote the first draft and the final version; G.G.G. collaborated to produce the second draft; S.B. and S.C. performed the morphological analysis; I.R. performed the molecular analysis; all co-authors collaborated and approved the final version.

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Supplemental content online

See <https://doi.org/10.3372/wi.56.14>

Online resource S1. Alignment of the nuclear ribosomal ITS dataset used for phylogenetic analyses. The NEXUS file contains all fasta files included in the study and used for phylogenetic reconstruction.

Online resource S2. Alignment of the plastid *trnL-trnF* dataset used for phylogenetic analyses. The NEXUS file contains all fasta files included in the study and used for phylogenetic reconstruction.

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Table 2. Checklist of *Campanulaceae* taxa analysed in this study, with collection localities, voucher information and GenBank accession numbers. New sequences produced in this study are marked with asterisk (*).

Taxon	Collection locality	Voucher specimen	GenBank accession numbers	
			ITS	<i>trnL-trnF</i>
<i>Campanula acarnanica</i> Damboldt 1	Greece, Acarnania, Akarnanika Ori	<i>Karamplanis 1692</i> (ATHU)	KF957752	KF957763
<i>C. acarnanica</i> 2	Greece, Acarnania, Kandila, Pighadia	<i>Bogdanović & Rešetnik s.n.</i> (ZAGR)	MK981222	MN013847
<i>C. aureliana</i> Bogdanović & al. 1	Albania, Tomori mountain, western part of village Kapinovë	<i>Bogdanović & Jug-Dujaković s.n.</i> (ZAGR)	KM215787	KM215789
<i>C. aureliana</i> 2	Albania, Tomori mountain, Tomori village	<i>Bogdanović & al. s.n.</i> (ZAGR)	KM215788	KM215790
<i>C. aureliana</i> 3	Albania, Lybeske, 1000 m	<i>Shuka C070</i> (ZAGR)	PV760331*	PV767871*
<i>C. aureliana</i> 4	Albania, Lybeske, 1000 m	<i>Shuka C071</i> (ZAGR)	PV760332*	PV767872*
<i>C. brulloi</i> Bogdanović & al. 1	Albania, Ura e Vashës	<i>Bogdanović & al. s.n.</i> (ZAGR [80847])	PV742338*	PV752211*
<i>C. brulloi</i> 2	Albania, Ura e Vashës	<i>Shuka 2019</i> (ZAGR)	PV742339*	PV752212*
<i>C. cephalenica</i> Feer 1	Greece, Ionian Islands, Kefallinia	<i>Gutermann 28945</i> (WU)	DQ304597	F1426576
<i>C. cephalenica</i> 2	Greece, Cephalonia, Mt Ainos	<i>Brullo & Giacalone s.n.</i> (CAT)	KF957753	KF957764
<i>C. comosiformis</i> (Hayek & Janch.) Frajman & Schneew. 1	Albania, Gjalica, Mustafe	<i>Bogdanović & Jug-Dujaković s.n.</i> (ZAGR)	KF957754	KF957765
<i>C. comosiformis</i> 2	Albania, Šija gorge E of Bicaj	<i>Frajman 11089</i> (WU)	F1426592	F1426572
<i>C. crennophila</i> Bogdanović & al. 1	Croatia, Pelješac peninsula, Marčuleti Bay, Rt Vrba	<i>Jeričević & al. s.n.</i> (ZAGR)	MK934576	MK940906
<i>C. crennophila</i> 2	Croatia, Pelješac peninsula, Marčuleti Bay, Rt Vrba	<i>Jeričević & al. s.n.</i> (ZAGR)	MK934574	MK940907
<i>C. crennophila</i> 3	Croatia, Pelješac peninsula, Marčuleti Bay, Rt Vrba	<i>Jeričević & al. s.n.</i> (ZAGR)	MK934575	MK940908
<i>C. debarensis</i> Rech. f. 1	North Macedonia, Crni Drin	<i>Kovačić 1097</i> (ZA)	DQ304595	F1426575
<i>C. debarensis</i> 2	North Macedonia, Crni Drin	<i>Micevski s.n.</i> (MKNH [031830])	KF957738	KF957745
<i>C. elatines</i> L.	Italy, Alpi Cozie	<i>Schönschwetter & Tribisch 6349</i> (WU)	DQ304624	F1426577
<i>C. elatinoides</i> Moretti	Italy, Southern Alps, Lago d'Iseo	<i>Gutermann 1879</i> (WU)	DQ304625	F1426578
<i>C. fenestrellata</i> Feer subsp. <i>fenestrellata</i> 1	Croatia, Velebit, Velika Paklenica	<i>Kovačić 920</i> (ZA)	DQ304592	F1426579
<i>C. fenestrellata</i> subsp. <i>fenestrellata</i> 2	Croatia, NP Krka, Roški slap	<i>Šegota & Hršak s.n.</i> (ZAGR)	KF957755	KF957766
<i>C. fenestrellata</i> subsp. <i>istriaca</i> (Feer) Damboldt 1	Croatia, Krk, Uvala Oprna	<i>Schönschwetter & Tribisch 6272</i> (WU)	DQ304594	F1426584
<i>C. fenestrellata</i> subsp. <i>istriaca</i> 2	Croatia, Istra, Plomin	<i>Bogdanović & Ljubičić s.n.</i> (ZAGR)	KF957756	KF957767

<i>C. fragilis</i> Cirillo	Italy, Calabria, city of Scalea	<i>Gutermann 36164</i> (WU)	DQ304626	FI426580
<i>C. garganica</i> Ten. 1	Croatia, cultivated in Botanical Garden of Zagreb (material from Italy); Italy, Gargano	<i>Kovačić 1012</i> (ZA); <i>Aldobrandi 12-VII-96 & al.</i> (MA [625685])	DQ304596	EF088725
<i>C. garganica</i> 2	Italy, Gargano, Vieste	<i>Brullo & Signorello s.n.</i> (CAT [037.2377])	KF957739	KF957746
<i>C. garganica</i> 3	Italy, Gargano, St. Angelo, S. Maria di Pulsano	<i>Bogdanović s.n.</i> (ZAGR)	MK981223	MN013848
<i>C. isophylla</i> Moretti	Croatia, cultivated in Botanical Garden of Zagreb (material from Italy)	<i>Kovačić 1013</i> (ZA)	DQ304630	FI426583
<i>C. pollinensis</i> Podlech	Italy, Monte Pollino	<i>Brullo & al. s.n.</i> (CAT [037.066/30])	KF957740	KF957747
<i>C. portenschlagiana</i> Roem. & Schult. 1	Croatia, Biokovo	<i>Kovačić 692</i> (ZA)	DQ304600	FI426587
<i>C. portenschlagiana</i> 2	Croatia, otok Brač, Vidova gora	<i>Ruščić s.n.</i> (ZAGR [2629 I])	KF957741	KF957748
<i>C. portenschlagiana</i> 3	Bosnia and Herzegovina, Ljubuški	<i>Šiljeg s.n.</i> (ZAGR)	KF957757	KF957768
<i>C. portenschlagiana</i> 4	Croatia, island of Hvar, Pitve	<i>Rimac s.n.</i> (ZAGR)	KF957758	KF957769
<i>C. poscharskyana</i> Degen 1	Croatia, Dubrovnik region	<i>Kovačić 690</i> (ZA)	DQ304601	FI426588
<i>C. poscharskyana</i> 2	Croatia, Radovčići	<i>Kovačić s.n.</i> (ZAGR)	KF957759	KF957770
<i>C. pyramidalis</i> L.	Croatia, Vratnik pass; Croatia, Rijeka	<i>Schönschwetter & Tribsch 6243</i> (WU); <i>Vitek 99440</i> (MA [641379])	DQ304606	EF088754
<i>C. reatina</i> Lucchese 1	Italy, Turano Valley	<i>Kovačić 768</i> (ZA)	DQ304599	FI426589
<i>C. reatina</i> 2	Italy, Valle del Salto, Ponte Figureto	<i>Kirin s.n.</i> (ZAGR)	KF957760	KF957771
<i>C. rotundifolia</i> L.	Croatia, Platak–Rijeka region; Andorra	<i>Kovačić 784</i> (ZA); <i>Saez 6134</i> (BCB)	DQ304615	EF088759
<i>C. scheuchzeri</i> Vill.	Croatia, North Velebit	<i>Kovačić 807</i> (ZA)	DQ304614	KF957749
<i>C. skanderbegii</i> Bogdanović & al. 1	Albania, Kruje	<i>Lakušić & al. s.n.</i> (ZAGR)	KF957761	KF957772
<i>C. skanderbegii</i> 2	Albania, Kruje	<i>Lakušić & al. s.n.</i> (ZAGR)	KF957762	KF957773
<i>C. skanderbegii</i> 3	Albania, Shakalia e Tujanit	<i>Shuka C068</i> (ZAGR)	PV760344*	PV767873*
<i>C. teutana</i> Bogdanović & Brullo 1	Croatia, Island of Vis, Oključina, calcareous cliffs near Kraljičina špilja	<i>Bogdanović s.n.</i> (ZAGR [32628])	KF957742	KF957750
<i>C. teutana</i> 2	Croatia, otok Vis, Oključina	<i>Bogdanović s.n.</i> (ZAGR)	KF957743	KF957751
<i>C. tommasiniana</i> Koch	Croatia, Učka	<i>Kovačić 775</i> (ZA)	DQ304611	FI426590
<i>C. versicolor</i> Andrews	Greece, Ionian Islands, Kefallinia	<i>Gutermann 30067</i> (WU)	DQ304607	FI426591
<i>Phyteuma globulariifolium</i> Sternb. & Hoppe	Austria, Niedere Tauern	<i>Schönschwetter & Tribsch 4551</i> (WU)	DQ304583	FI426582