

Centaurea uysalii (Cyanus/Asteraceae), a new species from Turkey

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Received: 10.01.2019 • Accepted/Published Online: 28.08.2019 • Final Version: 21.11.2019

Abstract: *Centaurea uysalii* Şirin & Çeçen, a new Asteraceae species from the province of Karaman, in Turkey, is described and illustrated herein. It is morphologically similar to *C. bourgaei* Boiss. (Subgen. *Cyanus*), but it mainly differs from its relative in terms of the involucre and achene lengths. The achene micromorphological features and karyomorphology of *C. uysalii* and *C. bourgaei* were examined in this study. The IUCN conservation status is the Critically Endangered [CR B2 a b (i, iii)] category.

Key words: Asteraceae, Centaureinae, endemic, taxonomy, Turkey

1. Introduction

Cyanus comprises 35 species worldwide (Hellwig, 2004; Bancheva and Stoyanov, 2009; Kaya and Bancheva, 2009; Boršić et al., 2011; Ranjbar and Negaresh, 2012; Olšovská et al., 2013; Ranjbar et al., 2013a, 2013b; Bancheva and Kaya, 2015; Stoyanov, 2016; Kaya and Özel, 2017; Kaya et al., 2018), 18 of which (Kaya et al., 2018) occur in Turkey.

The general characters of the subgenus *Cyanus* are as follows: annuals or perennials, roots sometimes dimorphic, stem and leaves usually hairy, stem generally erect-ascending, leaves rarely heteromorphic, usually entire, less often lyrate or pinnatifid, generally lanceolate or linear-lanceolate, involucre ovoid or ovoid-subglobose, radiant; appendages decurrent, ciliate, not ending in mucro or mucronulate, laceration absent, with blackish or brownish border, usually ovate-oblong or ovate-triangular; florets usually violet or blue, rarely whitish, yellowish, pink, or red; marginal florets with 5–6 lobes, sterile, without staminodes, central flowers hermaphrodite; achenes generally ovoid-oblong, insertion areole hairy, mostly with pappus, pappus scabrose or barbellate-scabrose (Wagenitz, 1975).

During our field study, some specimens belonging to subgenus *Cyanus* were collected and then identified according to Flora of Turkey (Wagenitz, 1975). Some clear morphological differences between the collected specimens and *C. bourgaei* enabled us to describe them as a new species.

2. Materials and methods

The new species material was compared to the herbarium collections of *Centaurea* in ANK, HUB, GAZI, ISTF, ISTE, and KNYA (acronyms follow Thiers, 2018).

The morphology of the specimens was examined under a binocular microscope, and the specimens were compared with closely related species: *C. bourgaei*, *C. pichleri*, and *C. reuteriana*. Moreover, the type specimens of the related species were viewed as digital photographs.

The achenes of 2 species were dehydrated in an alcohol series (70%, 80%, 96%, and 100%) for cleaning and coated with gold for viewing under a ZEISS EVO LS-10 model scanning electron microscope (SEM) on high-vacuum mode to observe their surfaces at magnifications of 30×, 1000×, and 2000×. The terminology of the achene characteristics was according to Stearn (1995) and Koul et al. (2000).

Mature achenes were selected and germinated for chromosomal analysis. Counting of the chromosomes was conducted during the somatic metaphase using the squash technique. Primer root meristems were used to obtain the metaphase plates. The samples were pretreated with 0.002 M 8-hydroxyquinoline for 8 h at 4 °C and then fixed with Carnoy's solution for 24 h at a low temperature. Prior to dyeing, the material was hydrolyzed with 5N HCl for 30 min at room temperature and stained with 1% acetone-orcin. The preparates were made permanent according to the method of Bowen (1956). At least 5 metaphases were examined and the best image was photographed at

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a magnification of 100× with an Olympus DP-72 digital camera attached to an Olympus BX53 microscope.

The chromosome nomenclature followed was that of Levan et al. (1964), where the metacentric chromosomes were symbolised by the letter m. The chromosome length change variation (CV_{cl}) and karyotype asymmetry index were calculated according to the method proposed by Paszko (2006) and the mean centromeric asymmetry (M_{CA}) was calculated according to the method of Peruzzi and Eroğlu (2013). The karyograms and idiograms of the taxa were conducted using a Kameram™ digital camera (Micro System Computer Aided Microscope Systems Co. Ltd. Maslak/İstanbul).

3. Results

Centaurea uysalii Şirin & Çeçen **sp. nova** (Figure 1).

Type: [Turkey C4 Karaman] Çakırdağı, between Kavurgalık Hill and Pelitli Stream, rocky area, 1270–1390 m, 37°23'11"N, 33°29'26"E, 01 May 2018, E. Şirin 733 and Ö. Çeçen (holotype KNYA, isotype ANK).

3.1. Diagnosis

Centaurea uysalii resembles *C. bourgaei* Boiss. by its lyrate rosette leaves and fusiform roots (Figures 1–3). It clearly differs by the length of the stem, 12–20 cm (not 3–10 cm); involucre length, 12–13 mm (not 15–17 mm); achene length 3.6–3.9 mm (not 4.5–5 mm) and achene width 1.6–1.9 mm (not 2.5–2.9 mm) (Table).

3.2. Description

Perennial herbs, 12–20 cm, root fusiform and stolon present. Stem erect–ascending or rarely decumbent, densely grey tomentose, terete, usually branched upper part, 1–3 mm diameter at base. Leaves heteromorphic, decurrent, densely grey tomentose; basal and median stem leaves similar, entire or lyrate, lanceolate; upper stem leaves sessile, entire, lanceolate with prominent veins; median stem leaves 2.5–4 × 0.2–0.9 cm; basal leaves fresh at flowering time, 3.5–7.5 × 0.4–1.2 cm, rosette leaves generally pinnatipartite with 1–5 pairs of lateral segments, 5–13 × 0.9–3.2 cm (Figure 2). Capitula solitary at the end of branches. Involucre ovoid-subglobose, 12–13 × 9–11 mm. Bracts usually with 3–4 series. Appendages cartilaginous, glabrous, or tomentose, strongly decurrent, with 9–10 silvery 0.5–2 mm cilia; outer appendages ovate-oblong, 5–7 × 2–3 mm; median appendages ovate-oblong, 7–10 × 2.5–3 mm; inner appendages linear-lanceolate, 12–13 × 1–2.5 mm. Outer phyllaries ovate-triangular, 3.5–4 × 2–2.5 mm; median phyllaries ovate-oblong and obtuse, 8–9 × 2–3 mm; inner phyllaries linear-lanceolate, 9.5–10 × 1–2 mm. Florets blackish-violet or yellowish-white, marginal sterile and radiant, 20–21 mm, without staminodes, with 5 linear-filiform, acute lobes 9–10 mm; central florets hermaphrodite, 13–14 mm, with 5 lobes 5–6 mm; anther tubes violet (Figure 3). Achene 3.6–3.9



Figure 1. Original habitat views of *C. uysalii* Şirin & Çeçen (a) and *C. bourgaei* Boiss. (b).

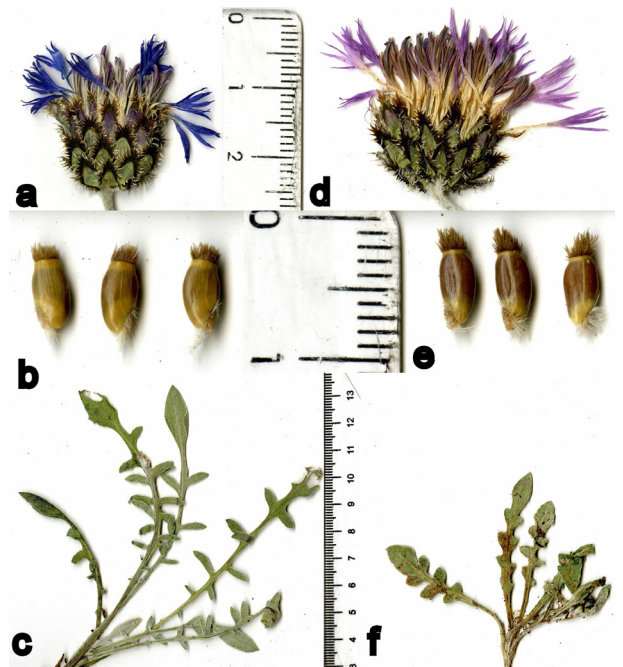


Figure 2. Different parts of *C. uysalii* Şirin & Çeçen (a–c) and *C. bourgaei* Boiss. (d–f). (a–d): capitula, (b–e): achene, (c–f): rosette leaves.

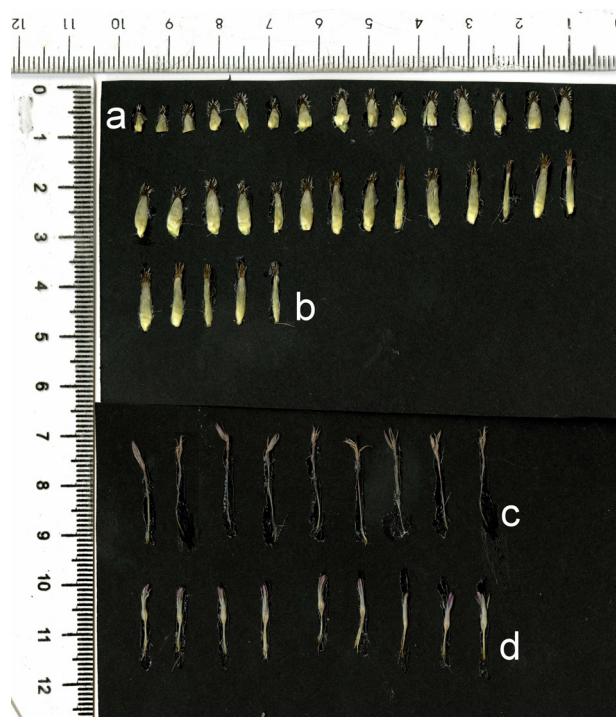


Figure 3. The phyllaries and florets of *C. uysalii* Şirin & Çeçen. (a): from outer to inner phyllary, (c): marginal florets, (d): central florets.

× 1.6–1.9 mm, ovoid-oblong, pericarp brown or creamy-brown, sericeous, rounded at base, areole lateral-basal and densely hairy, hairs exceed the elaisome. Pappus barbellate-scabrid, brown or creamy-brown, double; outer pappus 1.2–1.4 mm long, inner pappus 0.6–0.7 mm long.

3.3. Distribution and suggested conservation status and ecology

Centaurea uysalii is a locally endemic species and is only known from the type locality (Figure 4). It is a Mediterranean element. The species is rare in the field. Due to grazing, populations are threatened by extinction in the area if protection measures are not enforced. Therefore, the recommended conservation category of *Centaurea uysalii* is “Critically Endangered (CR)”, because the estimated entire range is less than 10 km² (criteria B2 a b (i, iii) of IUCN 2013).

Centaurea uysalii grows in Çakırdağı in the province of Karaman, at altitudes of 1270–1390 m in rocky areas. The vegetation in this area is formed by herbaceous plants including *Quercus trojana* Webb subsp. *trojana*, *Achillea lycaonica* Boiss. & Heldr., *Aethionema karamanicum* Ertuğrul & Beyazoğlu, *Ferula lycia* Boiss., *Prangos meliocarpoides* Boiss. var. *meliocarpoides*, *Helichrysum noeantum* Boiss., *Allium cappadocicum* Boiss., *Iris schachtii* Markgraf, *Dianthus stramineus* Boiss. & Heldr., *Bupleurum*

sulphureum Boiss. & Bal., *Lactuca tuberosa* Jacq., *Verbascum orientale* (L.) All. subsp. *branchsepalum* (Fisch. & Trautv.) Karavel & Aytaç, *Astragalus oxytropifolius* Boiss., *Corydalis erdelii* Zucc., *Securigera varia* (L.) Lassen, *Silene supina* M. Bieb subsp. *pruinosa* (Boiss.) Chawdh., *Linum austriacum* L. subsp. *austriacum*, *Trigonella filipes* Boiss., *Silene stenobotrys* Boiss. & Hausskn., *Carlina oligocephala* Boiss. & Kotschy subsp. *oligocephala*, *Cerastium dichotomum* var. *dichotomum* Boiss., *Gladiolus atrovioleaceus* Boiss., *Galium verticillatum* Danthoine ex Lam., *Ornithogalum comosum* L. and *Centaurea urvillei* DC. subsp. *urvillei*.

3.4. Karyology

The chromosome number of the new species was $2n = 20$ (Figure 5a). The shortest chromosome length was 1.13 µm, while the longest was 1.99 µm and the haploid chromosome length was 15.07 µm. The karyotype formula of this species consisted of 20 median pairs. Satellites were located on the eighth chromosome. As for the karyotype asymmetry, the karyotype of this new taxa was classified according to the symmetry classes of Stebbins (1971), as 4A. The M_{CA} was 11.25 and the CV_{CL} was 14.45. The karyogram is shown in Figure 5b and the idiogram in Figure 5c.

This study showed that the chromosome number of *C. bourgaei* was $2n = 4x = 40$ (Figure 5d). The shortest chromosome length was 0.98 µm, while the longest was 1.81 µm and the haploid chromosome length was 26.01 µm. The karyotype formula of this species consisted of 40 median pairs. As for the karyotype asymmetry, the karyotype of this new taxa was classified according to the symmetry classes of Stebbins (1971), as 4A. The M_{CA} was 9.92 and the CV_{CL} was 19.03. The karyogram is given in Figure 5e, and the idiogram in Figure 5f.

3.5. SEM observations

Achene surface pattern of *C. uysalii* was irregularly sulcate, cells and cell walls distinct, areole lateral-basal and scattered hairy (Figures 6a–6c). In contrast, the achene surface pattern of *C. bourgaei* was regularly sulcate, cells and cell walls distinct, areole lateral-basal and densely hairy (Figures 6d–6f).

3.6. Etymology

The species is dedicated to Prof. Dr. Tuna UYSAL, who is a Turkish taxonomist especially interested in the genus *Centaurea*.

3.7. Proposed Turkish name for the new species

We propose the name Uysal Gökbaş.

4. Discussion

Based on the latest definitions, the genus *Centaurea* includes 3 subgenera: *Centaurea* (especially the Jacea group), *Acrocentron* and *Cyanus*. The relationships between the subgenera *Cyanus* and *Centaurea* have been

Table. Morphological, micromorphological, and karyological comparison of *C. uysalii*, *C. bourgaei*, *C. pichleri*, and *C. reuteriana*.

→Taxa	<i>C. uysalii</i>	<i>C. bourgaei</i>	<i>C. pichleri</i>	<i>C. reuteriana</i>
↓Characters				
Morphology				
Stem (cm)	12-20	3-10	6-12	4-17
Involucre (mm)	Ovoid-subglobose	Ovoid	Ovoid to funnel shaped	Ovoid to nearly cylindrical
Marginal flowers (mm)	12-13 × 9-11 Blackish violet or yellowish white 20-21	15-17 × 10-13 Violet- to rose-purple or yellowish white 25-26	11-20 × 7-13 Blue 13-30	13-18 × 10-13 Purple or whitish 16-28
Central flowers (mm)	13-14	16-17	11-18	12-16
Median phyllaries (mm)	Obtuse, 8-9 × 2-3	Acute, 9-10 × 3-4	Acute, 7-10 × 2-3.5	Acute, 6-10 × 2-3
Median appendages (mm)	7-10 × 2.5-3	9-11 × 2.5-3.5	10-14 × 3.5-5	9-13 × 2-5
Achene (mm)	3.6-3.9 × 1.6-1.9	4.5-5 × 2.5-2.9	3.5-5.1 × 1.8.5-2.1	3.5-4.5 × 1.5-2.
Micromorphology				
Achene surface ornamentation	Irregularly sulcate	Regularly sulcate*	Irregularly sulcate*	Fine sulcate*
Areole hairs	Scattered	Dense*	Scattered*	Dense*
Karyology				
Chromosome numbers	2n = 20	2n = 4x = 40**	2n = 4x = 40**	2n = 20**
CV _{Cl}	14.45	19.03**	12.607**	13.298**
M _{CA}	11.25	9.92**	9.72**	18.46**
Satellite	Present	Absent**	Present**	Present**

*According to Şirin et al. (2017)

**According to Şirin et al. (2019)

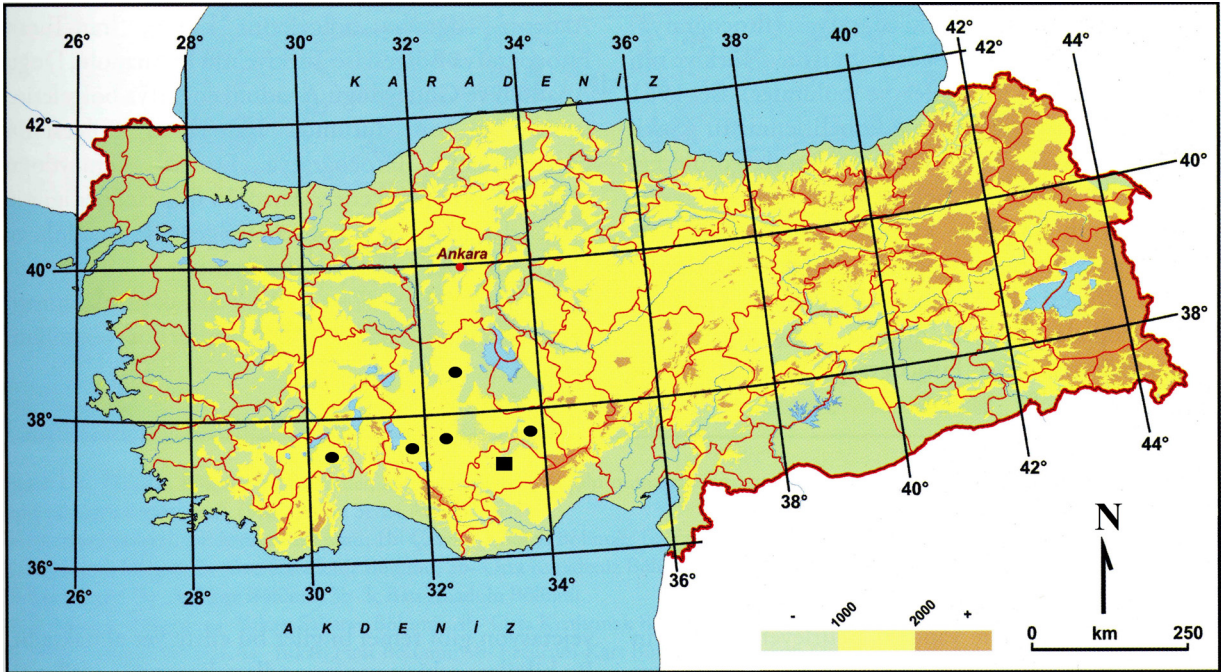


Figure 4. Distribution maps of *C. uysalii* (■) and *C. bourgaei* (●).

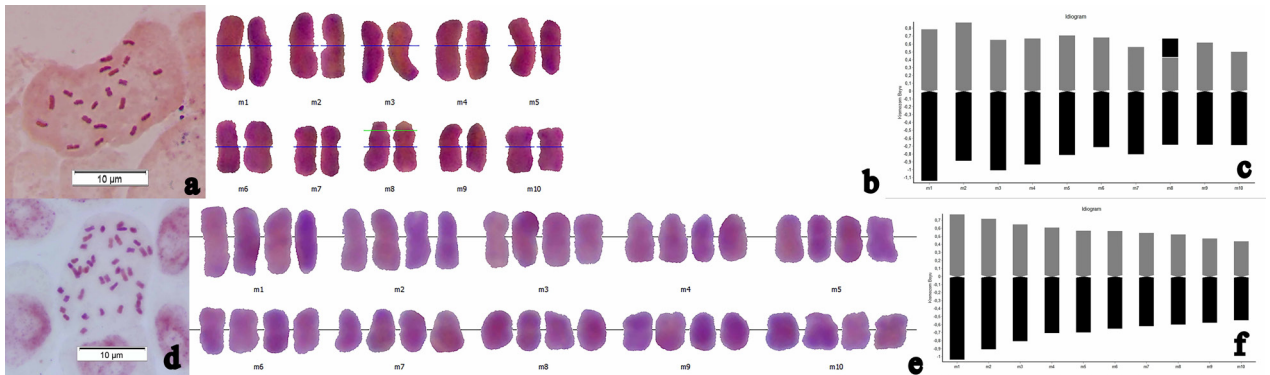


Figure 5. Metaphase plate, karyotype, and idiogram of *C. uysalii* Şirin & Çeçen (a-c) and *C. bourgaei* Boiss. (d-f).

fully determined; however, the connections between these 2 subgenera and *Acrocentron* remain unclear (Susanna and Garcia-Jacas, 2009). As a result of these current molecular studies (Hilpold et al., 2014a, 2014b) *Cyanus* was herein considered a subgenus and new species was added to it.

Centaurea s. lato was represented by 194 taxa in the Check List of Flora of Turkey (Uysal, 2012) and since then, the number of the taxa has reached 203, with the latest additions (Bona, 2015; Yüzbaşıoğlu et al., 2015; Kültür et al., 2016; Uysal et al., 2016; 2017a, 2017b; Uysal & Hamzaoğlu 2017; Behçet et al., 2017; Armağan and Uysal 2018). Therefore, the endemism of the genus has reached 59%.

The life cycle, involucre dimensions, bracts and appendages, flower colour, and rosette leaves are

considered very important characters in separating close species of *Cyanus* (Wagenitz, 1975).

Some taxa are easily distinguished from others by some unusual morphological characteristics: *C. nigrofimbria* has a blackish border on its appendages; *C. woronowii* has linear marginal flowers; *C. cheiranthifolia* has the largest involucre; *C. depressa* has the longest pappus; *C. pinardii* has no pappus; *C. cyanus* has the shortest achene and only *C. tchihatcheffii* has red or pink flowers (Wagenitz, 1975).

Centaurea uysalii is similar to *C. bourgaei* in terms of the pairs of lateral segments in its rosette leaves and fusiform roots, but it differs by general view (rosette leaves/stem ratio), involucre size, karyomorphology, and achene micro- and macromorphology.

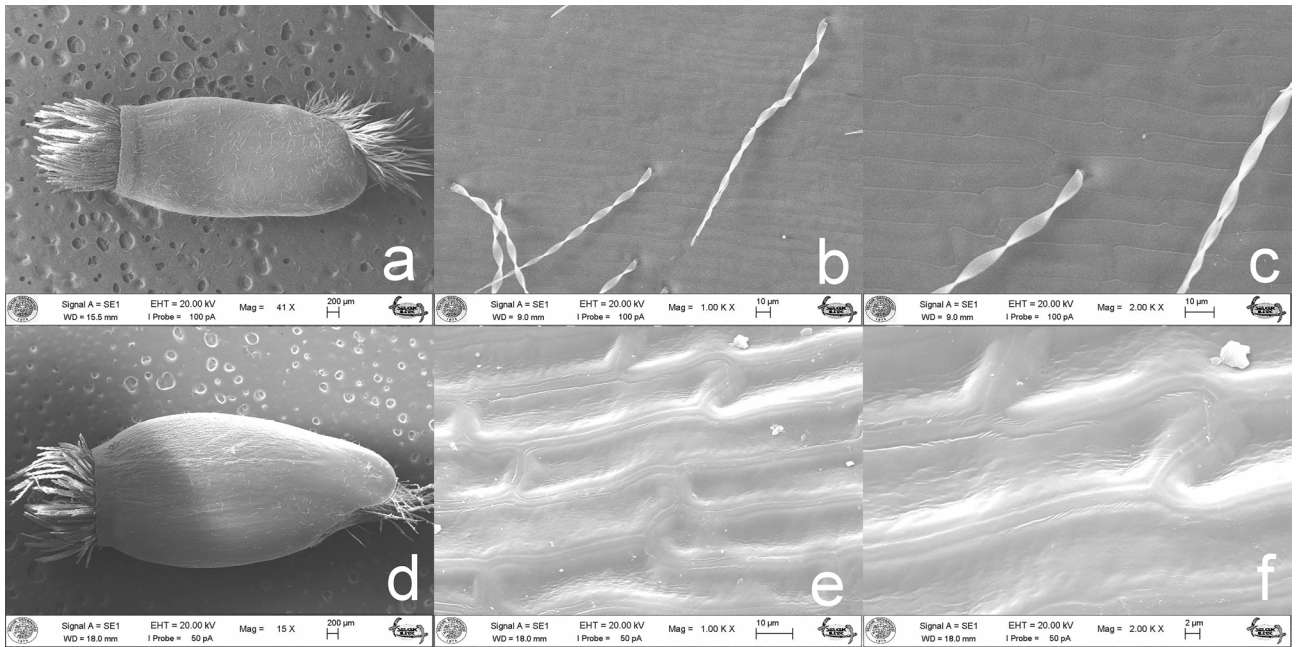


Figure 6. Scanning electron micrographs of the achenes of *C. uysalii* Şirin & Çeçen (a–c) and *C. bourgaei* Boiss. (d–f).

Species Key*

1. Some roots thickened (fusiform); rosette leaves lyrate or pinnatipartite with 1–5 pairs of lateral segments

2. Stem 12–20 cm, rosette leaves generally pinnatipartite with 1–5 pairs of lateral segments, involucre 12–23 × 9–11 mm, marginal flowers 20–21 mm, central flowers 13–14 mm, achene 3.6–3.9 × 1.6–1.9 mm *uysalii*

2. Stem 3–10 cm, rosette leaves generally lyrate with 3–4 pairs of lateral segments, involucre 15–17 × 10–13 mm, marginal flowers 25–26 mm, central flowers 16–17 mm, achene 4.5–5 × 2.5–2.9 mm *bourgaei*

1. Without thickened roots; rosette leaves undivided or lyrate with 1–2 pairs of lateral segments

3. Marginal flowers blue; rosette leaves undivided or lyrate with lanceolate terminal segment. *pichleri*

3. Marginal flowers purple or whitish; rosette leaves mostly or lyrate with oval to nearly orbicular terminal segment *reuteriana*

*The key was adapted from that of Wagenitz (1975) and *C. uysalii* was added to it

Additional examined specimens

Centaurea bourgaei: [C3] Antalya: Elmalı, Kızlar Sivrisi climbers festival area, road sides, 1900 m, 29.06.2015, *E. Şirin* 572 & *M. Şirin* (KNYA); Antalya-Feslikan Plateau, high mountain steppe, 1993 m, 15.05.2014, *K. Ertuğrul* 4732 & *H. Dural* (KNYA); Kemer, Tahtalıdağ, upper area of Beycik Village, *Cedrus libani* forest, 700–2000 m, 10.05.1978, *H. Peşmen* 3799 (HUB); Kemer, Tahtalıdağ, Yaylakuzdere, between Peynirlik-Kızılalan, calcareous rocky, 800–1600 m, 04.05.1976, *H. Peşmen* 4641 & *A.*

Güner (GAZI); Korkuteli, Elmalı, Çam Kuyusu, 2400 m, 04.06.2000, *S. Yüzbaşıoğlu* (ISTF 37414); *Cedrus* research area, 19 km south-east of Elmalı, stony land, 1730 m, 31.05.1988, *N. Özhatay* & *E. Özhatay* (ISTE 58795); Elmalı-Finike road, Kutuboğazı, 1800 m, 30.06.1982, *G. Çakmer* & *A. Öztekin* (ISTE 49059); [C4] Antalya: Alanya, Alacami Plateau, under forest rocky areas, 1350 m, 17.05.2006, *B. Bilgili* 1853 (GAZI); İçel: Mut, Karabelen Hill, steppe, 1561 m, 15.05.2016, *E. Şirin* 622 & *M. Şirin* (KNYA); Konya: Konya-Beyşehir road, Bakışlar Hill, stony areas, 1310 m, 18.05.2016, *E. Şirin* 628 & *M. Şirin* (KNYA); Aksaklı Village, Koçluk Hill, 1450 m, 12.06.1982, *H. Dural* 883 (KNYA); Konya-Beyşehir road, Bakışlar Hill, stony areas, 1340 m, 05.05.2005, *E. Yıldıztuğay* 783 (KNYA); Konya-Karaman, Kazımkarabekir Uludere located, 1500 m, 22.05.1984, *M. Serin* 2046 (KNYA); Konya-Karaman, Kızılkaya-Hacıbaba Hill northwest slopes, stony areas, 2200 m, 30.08.1983, *M. Serin* 2047 (KNYA); Konya-Seydişehir, Gölyüzü Village, Tavuk Hill, North slope, 1350 m, 1730 m, 18.06.1980, *H. Ocakverdi* 1056 (KNYA, ANK).

Acknowledgments

We would like to thank the curators of ANK, HUB, GAZI, ISTF, ISTE, and KNYA Herbaria for their helpful assistance and express our gratitude to the Agriculture and Forestry Ministry's Department of Karaman Nature Conservation and National Parks for their support of this research areas. Our thanks also go to the Scientific Investigation Project Coordinator of Selçuk University (Project No: 15101001) for their financial sport.

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