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EDICIONES COMPLUTENSE

Centaurea akcadaghensis and *C. ermenekensis* (Asteracaeae), two new species from Turkey

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Abstract. Two new species of *Centaurea* subg. *Cyanus* (Asteraceae) from Anatolia are described and illustrated. *Centaurea akcadaghensis* Uysal & Şirin occurs on open *Quercus* forest of Levent Canyon (Akçadağ-Malatya) and differs from *C. matthiolifolia* Boiss. mainly in stem, leaves, central flowers and achenes measures. *Centaurea ermenekensis* Şirin & Uysal is restricted to steppes of Göktepe (Ermenek-Karaman) and can be distinguished from *C. reuteriana* Boiss. by the stem, number of capitula, involucre and median appendages measures.
Keywords: Anatolia; Asteraceae; Centaureinae; *Cyanus*; new species.

Centaurea akcadaghensis y *C. ermenekensis* (Asteracaeae), dos nuevas especies de Turquía

Resumen. Se describen e ilustran dos nuevas especies del género *Centaurea* subg. *Cyanus* (Asteraceae) de Anatolia. *Centaurea akcadaghensis* Uysal & Şirin se encuentra en el bosque abierto de *Quercus* de Levent Canyon (Akçadağ-Malatya) y difiere de *C. matthiolifolia* Boiss., principalmente, por el tipo y/o la longitud de los tallos, hojas, flores centrales y aquenios. *Centaurea ermenekensis* Şirin & Uysal está restringida a las estepas de Göktepe (Ermenek-Karaman) y se distingue de *C. reuteriana* Boiss. por el tipo y/o la longitud de los tallos, número de capítulos, involucro y apéndices medianos.
Palabras clave: Anatolia; Asteraceae; Centaureinae; *Cyanus*; nuevas especies.

Introduction

Centaurea L. (in broad sense) was represented by 194 taxa in the Check List of Flora of Turkey (Uysal, 2012) and since then, the number of taxa has reached 204, with the latest additions (Bona, 2015; Yüzbaşıoğlu *et al.*, 2015; Kültür *et al.*, 2016; Uysal *et al*., 2016; Uysal & Hamzaoğlu 2017; Uysal *et al*., 2017; Behçet *et al.*, 2017; Armağan & Uysal 2018; Şirin *et al*., 2019). Therefore, the endemism of the genus has reached 59%.

Cyanus was first described as a genus by Miller (1754). The genus was subsequently reassigned as a section of *Centaurea* by de Candolle (1838) and this rank has been widely accepted by taxonomists (Bentham, 1873; Boissier, 1875; Wagenitz, 1975). Aside from this taxonomical approach, there have been different perspectives regarding the assignment of subgroups within *Centaurea*. On the whole, it has been accepted that *Cyanus* is a subgenus within *Centaurea* (Hilpold *et al*., 2014), or rarely, it has been thought of as a group (Wagenitz & Hellwig, 1996; Garcia-Jacas *et al*., 2001). From a different perspective, some researchers have still asserted that it is a genus (Greuter, 2003; Bancheva & Greilhuber, 2006). The classification of *Cyanus* as a subgenus of *Centaurea* was accepted by the authors herein, and these two new species were arranged accordingly.

Subgenus *Cyanus* (Mill.) Cass. ex Hayek is distributed throughout central and southern Europe, North Africa, Asia Minor, and the Caucasus, with some species appearing as far east as Iran and Afghanistan, and it currently includes 36 species (Hellwig, 2004; Bancheva & Stoyanov, 2009, Kaya & Bancheva, 2009; Boršić *et al*. 2011; Ranjbar & Negaresh 2012; Olšavská *et al*. 2013; Ranjbar *et al*. 2013a-2013b; Bancheva & Kaya, 2015; Stoyanov, 2016; Kaya & Özel, 2017; Kaya *et al*. 2018; Şirin *et al*., 2019).

The present study focused on detailed morphological characters to distinguish two new species belonging to *Centaurea* subg. *Cyanus*.

Material and Methods

In the first step of this research, the morphology of 60 samples, belonging to two interesting specimens and their relatives (*Centaurea reuteriana* and *C. matthiolifolia*), were examined. Within this scope, the stem, leaves, involucre, appendages, achenes, and pappus were measured. Floral and involucre features were sampled from the terminal capitula. The measurements were performed using dried herbarium materials and their flexibility while pressing was taken into consideration. The border was included in the appendage measurements, but never in the involucral bracts. The morphologic examinations were mostly done using a binocular microscope (type and trademark/manufacturer).

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For the scanning electron microscopy (SEM) measurements, the achenes were first dehydrated in a series of alcohol solutions (70%, 80%, 96%, and 100%, respectively). Next, the samples were coated with gold and their surface was observed using a ZEISS EVO LS-10 scanning electron microscope (Oberkochen, Germany) operated in high-vacuum mode at 30X, 1000X, and 2000X magnification. The terminology used for the achene characteristics was in accordance with that reported by Stearn (1992) and Koul *et al*. (2000).

Results

Centaurea akcadaghensis Uysal & Şirin, *sp. nova* (Figures 1–3)

Holotypus: Turkey, Malatya, Akçadağ, Levent Canyon, Çayözü Village, open *Quercus* forest, 1171 m, 28 April 2018, *T. Uysal 3612* (holotype KNYA, isotype ANK).

Figure 1. *Centaurea akcadaghensis*. A, Habit; B, Capitula; C, Achene. Scale bar: 1 mm.

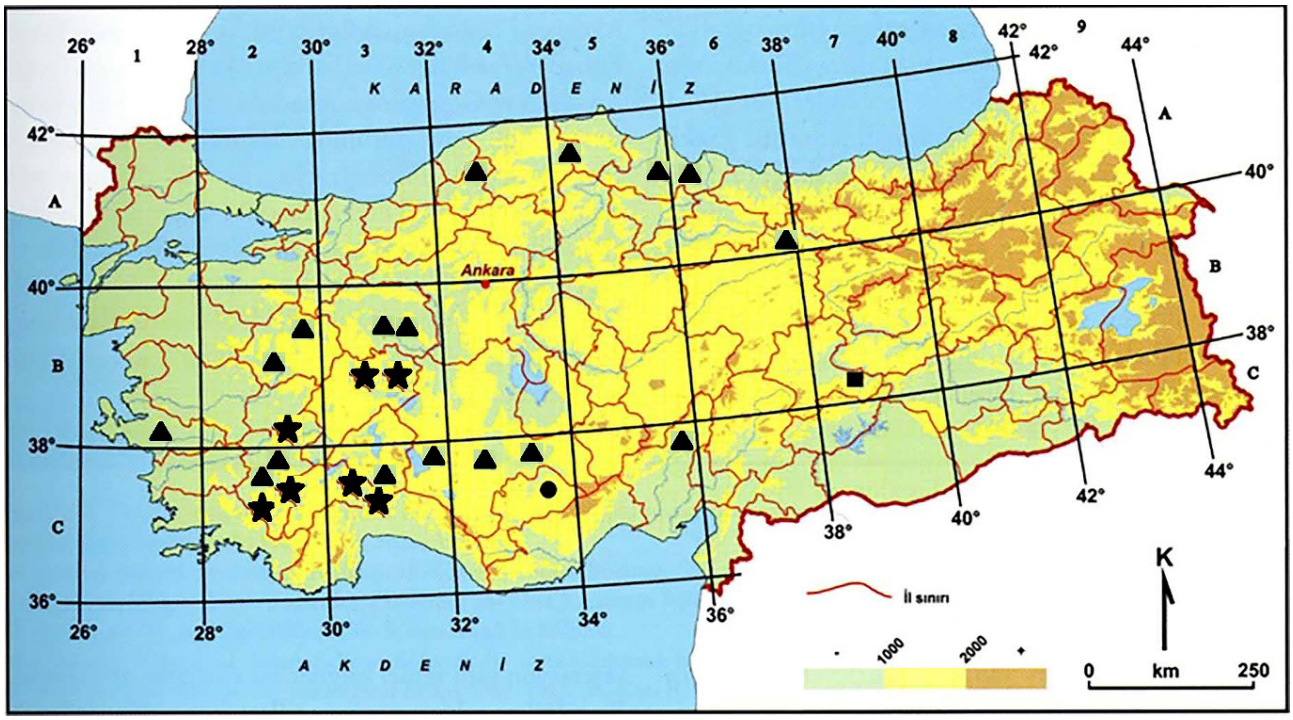

Figure 2. Distribution map of *C. akcadaghensis* (■), *C. ermenekensis* (●), *C. reuteriana* (▲) and *C. matthiolifolia* (★).

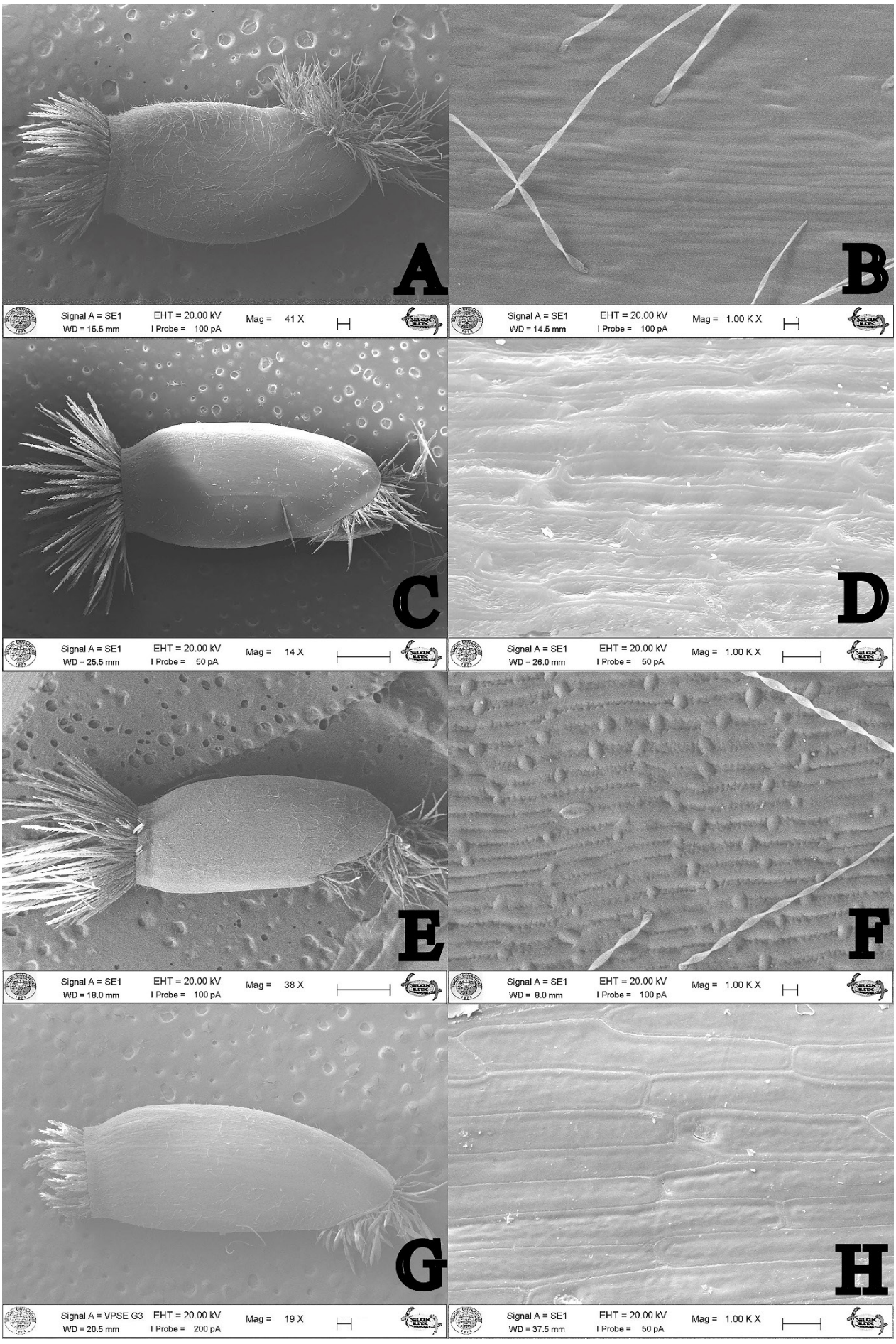

Figure 3. Scanning electron micrographs of achenes: A-B, *C. akcadaghensis*; C-D, *C. matthiolifolia*; E-F, *C. ermenekensis*; G-H, *C. reuteriana* var. *reuteriana.* Scale bars: 0.2 mm (A, G); 0.01 mm (B, D, F, H); 1 mm (C, E).

Description. Perennial herbs, root dimorphic and stolon present, underground stolons with cataphylls. Stem ascending, 10.5–17.5 cm, simple or with 1–2 branches. Leaves heteromorphic: basal leaves pinnatifid to pinnatipartite with 3–4 pairs of lateral lobes, 3.6–4.1 × 0.2–0.9 cm, stem leaves decurrent, lanceolate, adpressed greytomentose, acute, linear to linearlanceolate with crenate margine or pinnatifid to pinnatipartite with 3–4 pairs of lateral lobes, 1.5–3.7 × 0.3–0.5 cm. Capitula solitary. Involucre ovoid, 13–17 × 10–12 mm. Bracts usually in 3–4 series. Appendages cartilaginous and glabrous, laceration absent, strongly decurrent, with 6–7 silvery cilia 1–2 mm long; outer appendages ovateorbicular, 4–7 × 4–5 mm, median appendages ovateoblong, 8–12 × 1.5–2 mm, inner appendages linearlanceolate, 12–13 × 1–1.5 mm; outer phyllaries ovoid, 2–4 × 1–2.5 mm, median phyllaries ovoidoblong, 7–10 × 1.5–2 mm, inner phyllaries linearlanceolate, 9–10 × 1–2 mm. Flowers bicoloured, marginal flowers violet, central flowers purple, marginal flowers radiant, 20–23 mm, sterile, with 5 linearlanceolate and acute lobes 6–7 mm long, central flowers hermaphrodite, 10–12 mm, with 5 lobes 4.5–5 mm long, anther tubes purple. Achene 3.1–3.6 × 1.4–1.9 mm, ovoid-oblong, compressed, creamy brown, pericarp sericeous, not pitted, rounded at base, ornamentation irregularly sulcate; insertion areole lateral-basal and densely hairy. Pappus barbellate-scabrous, creamy brown, outer pappus 0.8–1.3 mm and the inner 0.4–0.6 mm.

Centaurea ermenekensis Şirin & Uysal, *sp. nova* (Figures 2–4)

Holotypus: Turkey, Karaman, Ermenek, West of Göktepe, 1300 m, steppe, 19 June 2017, K. Ertuğrul 5377, T. Uysal & M. Bozkurt (holotype KNYA, isotype ANK).

Figure 4. *Centaurea ermenekensis*. A) Habit; B) Capitula; C) Achenes. Scale bar: 1 mm.

Description. Perennial herbs, 5.5–11 cm, root dimorphic and stolon present. Stem decumbent rarely ascending, with longitudinally lineate and tomentose, branched in upper part, 1–2 mm diameter in base. Leaves heteromorphic: rosette leaves lyrate with 4–6 lanceolate, ovate or suborbicular lateral segments, sometimes lanceolate, 2.5–6.9 × 0.9–1.5 cm; stem leaves decurrent, tomentose, obtuse, with prominent veins, stem leaves oblanceolate, 2–2.5 × 0.5–0.8 cm. Capitula 1–4. Involucre nearly cylindric to ovoid, 12–14 × 5–7 mm, rotund at base. Bracts usually with 4–5 series. Appendages cartilaginous and glabrous or tomentose, laceration absent, strongly decurrent, with brown border and 9–10 silvery cilia 0.5–1.5

mm long, outer appendages ovate, 4–5 × 2–2.5 mm, median appendages ovate-oblong, 8–12 × 1.5–2 mm, inner appendages linear-lanceolate, 12–13 × 1–2 mm; outer phyllaries ovate-triangular, 3–4 × 2–2.5 mm, median appendages ovate-oblong, 7–9 × 2 mm, inner phyllaries linear-lanceolate, 9–10 × 1–2 mm. Flowers concolorous and purple or rosepurple (sometimes fading to pale pink when dry), marginal sterile and slightly radiant, 18–20 mm, with 5 linear-lanceolate and acute lobes 5 mm long, central hermaphrodite 12–13 mm, with 5 lobes 5–6 mm long, anther tubes purple. Achenes 3.6–4.3 × 1.6–2.1 mm, ovoid-oblong, compressed, pericarp wholly brown, sericeous, not pitted, rounded at base, ornamentation irregularly sulcate; insertion areole lateral–basal and densely hairy. Pappus scabrous, creamy brown, outer 1.6–2.4 mm, inner 0.8–1.2 mm).

Discussion

In the key by Wagenitz (1975), a flowering stem lateral at the base of a rosette or terminal out of a central rosette was used as the main character to differentiate between the two groups of the perennial species of *Cyanus*. *Centaurea akcadaghensis* is positioned in the second group, while *C. ermenekensis* in the first, and comparisons were made in light of this information.

Olšavská *et al*. (2016) claimed that the perennial allopatric taxa of subgenus *Cyanus* were localized geographically in only a restricted area. Contrarily, the observations made herein indicated that the perennial taxa of *Cyanus* taxa were not solely allopatric taxa, and it could be advocated that they might also display sympatric distribution in Turkey. In this regard, an interesting projection was observed on the Ilgar Pass of Ardahan Province, where three different species (*C. cheiranthifolia* Willd., *C. nigrofimbria* K. Koch, and *C. triumfettii* All.) grow. *Centaurea akcadaghensis* differs from *C. matthiolifolia* Boiss. by its stem, leaves, central flowers, and achenes, while *C. ermenekensis* is distinguished from *C. reuteriana* Boiss. by its stem, number of capitula, involucre, and median appendages. Many of these characters are used to identify different species in the subgenus *Cyanus* (Wagenitz, 1975). These characters have been used to define a new stable species within the already known species, and they have also been used to describe some other species (Kaya & Bancheva, 2009;; Ranjbar & Negaresh 2012; Ranjbar *et al*. 2013a-2013b; Bancheva & Kaya, 2015; Kaya & Özel, 2017; Kaya *et al*. 2018; Şirin *et al*., 2019). The main differences are presented in Table 1.

Table 1. Comparison of morphological characters between *Centaurea akcadaghensis*, *C. matthiolifolia*, *C. ermenekensis* and *C. reuteriana*

Characters	*C. akcadaghensis*	*C. matthiolifolia*	*C. ermenekensis*	*C. reuteriana*
Stem	simple, ascending	simple, erect	branched decumbent-ascending	simple decumbent-ascending
Stem leaves (cm)	lanceolate 1.5–3.7 × 0.3–0.5	linear-lanceolate 2.6–4 × 0.2–0.6	oblanceolate 2–2.5 × 0.5–0.8	lanceolate 1.8–2.9 × 0.2–0.9
Basal leaves (cm)	lanceolate 3.6–4.1 × 0.2–0.9	linear-lanceolate 2.9–8.5 × 0.6–1.2	oblanceolate 1.5–3.5 × 0.4–0.5	lanceolate 3.6–12.5 × 0.7–2.3
Rosette leaves	absent	absent	present	present
Capitula	single	single	1–4	single
Involucre (mm)	ovoid-subglobose 13–17 × 10–12	ovoid 15–18 × 8–12	nearly cylindric-ovoid 12–14 × 5–7	ovoid 13–18 × 10–13
Median appendages (mm)	ovate-oblong 8–12 × 1.5–2	ovate-oblong 10–12 × 6–8	ovate-oblong 8–12 × 1.5–2	ovate-oblong, 13–17 × 2–3
Median phyllaries (mm)	ovate-oblong, 6–10 × 1.5–2	ovate-oblong, 5–8 × 2.5–3	ovate-oblong, 7–9 × 2	ovate, 9–10 × 2.5–3
Marginal flowers (mm)	radiant, violet 20–23	radiant, blue or violet 16–23	slightly radiant, purple or rose purple, 18–20	radiant, creamy white, violet or rose-purple, 16–28
Central flowers (mm)	purple, 10–12	purple, 13–15	purple or rose-purple, 12–13	creamy white, violet or rose-purple, 12–16
Achene (mm)	ovoid–oblong 3.1–3.6 × 1.4–1.9	ovoid–oblong 4–4.5 (-5.5) × 2–2.5	ovoid–oblong 3.6–4.3 × 1.6–2.1	ovoid–oblong 3.5–4.5 × 1.5–2
Pappus	barbellate-scabrous	barbellate-scabrous	scabrous	scabrous
-inner series	0.4–0.6 mm	1–1.4 mm	0.8–1.2 mm	0.2–1.1 mm
-outer series	0.8–1.3 mm	(1–) 2–2.5 mm	1.6–2.4 mm	0.5–2 mm

Olšavská *et al*. (2016) performed a study on the origin of the Balkan endemics of the *Centaurea napulifera* group based on morphological, karyological, and DNA data, and discussed the evolutionary process. According to the results of their study, *Centaurea* subg. *Cyanus* species were characterized in terms of their ecological, morphological, and phenological characters. This group represents a good model for a homoploid

speciation study basically oriented by the adaptation and geographical isolation of new ecological niches. The *C. napulifera* group is characterized by rhizomatous and/or tuberous roots, and narrow stem leaves. The new species presented herein appeared to be isolated in terms of a geographical aspect, but were not related to the *C. napulifera* group in terms of their ecologic niche.

Appendix 1. Specimens examined.

Centaurea reuteriana var. *reuteriana*

Turkey: C2/3 Caria, 1843, *Pinard* (holotype G, digital image seen); B3 Afyon: Sultandağı, Büyükyayla, stony slopes, 1850 m asl, 21.05.2015, *E. Şirin 554a & M. Şirin* (KNYA); Maymun Dağı, Northwest of the Demirciköy, steppe, 1000 m asl, 08.05.1984, *Z. Aytaç 1147* (GAZI).

Centaurea reuteriana var. *phrygia*

Turkey: B3 Konya in montis Sultan-dagh regionis alpinae rupestribus, 2000 m asl, 21.06.1899, *Bornmüller 5201* (holotype G, digital image seen); A4 Karabük: Keltepe, steppe, 1800 m asl, 09.07.2015, *E. Şirin 582 & M. Yılmaz* (KNYA).

Centaurea matthiolifolia

Turkey: C2 ? Caria, 1843, *C. Pinard* (holo. G, digital image seen); B3 Afyon: Sultandağları, upper of the Dereçine, 1350 m asl, 02.06.1974, *A. Baytop et al.* (ISTE 29082); B2 Denizli: Honaz Dağı open *Pinus nigra* forest, 1829 m asl, 12.05.2016, *E. Şirin 618 & M. Şirin* (KNYA).

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