

***ONOSMA ONUR-KOYUNCUI* SP. NOV. (BORAGINACEAE), A NEW SPECIES FROM KÜTAHYA, TURKEY**

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Abstract

Onosma onur-koyuncui (Sect. *Onosma* subsect. *Asterotricha*) is described and illustrated as a new species from Kütahya (Turkey). New species grows on calcareous base rock between 1000-1100 m. Diagnostic features are given comparison with the related species, *O. lycaonica* Hub.-Mor., especially in the indumentum, habit, inflorescence, bracts, calyx, corolla, nutlets and leaves. The geographical distribution of the new and related species is also provided. Key for *O. onur-koyuncui* and *O. lycaonica* is provided. Notes about conservation status [CR: B2ab(i)] of *O. onur-koyuncui* according to the IUCN criteria and its ecology are also presented.

Key words: Boraginaceae, *Onosma*, Endemic, Kütahya, Turkey.

Introduction

The Boraginaceae family is widely distributed in tropical, subtropical and mild regions is represented with approximately 1600 taxa (Kolarčik, 2010; Chacon *et al.*, 2016; Luebert *et al.*, 2016). The family which has also a great spread area in Turkey borders is among our richest families with its 44 genus and 375 species (Binzet, 2012).

Onosma Linnaeus (1762: 196), one of the most important genus of Boraginaceae which spreads in Mediterranean region and in the mild parts of Asia and Europe continents, is represented by about 230 species (Teke & Binzet, 2017). Turkey is very rich in *Onosma* species. 102 *Onosma* species show distribution within the borders of Turkey and this number is more than the number of *Onosma* taxa of many countries. 59 of these 102 species are endemic to Turkey and endemism ratio of the species is ca. 60% (Riedl, 1978; Davis *et al.*, 1988; Yıldırım, 2000; Riedl *et al.*, 2005; Binzet & Orcan, 2007; Kandemir & Türkmen, 2010; Aytaç & Türkmen, 2011; Koyuncu *et al.*, 2013; Binzet, 2016(a,b); Cecchi *et al.*, 2016; Binzet & Eren, 2018).

Indumentum, leaf and flower show the most significant characters used in classifying the *Onosma* taxa. Apart from this, many systematic characters belonging to *Onosma* genus, mainly pollen morphology of the genus, have emerged through the studies conducted by domestic and foreign researchers recently. With the help of these studies, it became possible to clarify the boundaries between taxa (Binzet *et al.*, 2018; Teke & Binzet, 2017; Binzet *et al.*, 2014; Binzet & Teke, 2014; Binzet & Akçin, 2012; Binzet, 2011; Akçin & Binzet, 2011; Binzet *et al.*, 2010; Akçin & Binzet, 2010; Binzet & Akçin, 2009 (a,b); Binzet & Orcan, 2009).

In May 2017, *Onosma* samples were collected by the author at the entrance of village Sökmen during the field works carried out within the boundaries of Kütahya province. As a result of detailed morphological analysis of these samples, it was revealed that the population of the collected specimen was a new *Onosma* taxon that was closely associated with *O. lycaonica* Huber-Morath

(1971: 200). With this taxon new for the world of science, the number of *Onosma* species of Turkey reached 103.

In this study, *Onosma onur-koyuncui* was described as a new *Onosma* species from Kütahya province (Turkey) and its diagnosis, descriptive, distributional features, conservation status and identification key are given.

Material and Methods

Onosma onur-koyuncui was found by the author during a field excursion which was performed at Sökmen village (Central Anatolia-Kütahya) in May 2017. Collected specimens of *O. onur-koyuncui* from study area were tried to be identified with Flora of Turkey and the East Aegean Islands and after these floras of the neighboring countries such as Greece, Syria, Palestine, USSR, Iran and Iraq were checked (Boissier, 1849 & 1879; Dinsmore, 1932; Popov, 1951 & 1974; Ball, 1972; Riedl, 1964, 1967 & 1978; Davis *et al.*, 1988; Teppner, 1991 & 1996). But, these investigated specimens were prominently different from all other *Onosma* species which were given in these floras. As a consequence, these unidentified specimens were compared with close *Onosma* taxa from Turkish herbaria; OUFE, ANES, GAZI, ANK and the Herbarium of Mersin University. In the end, all findings of this investigation showed that the specimens closely resembled with *O. lycaonica* but they had important morphological dissimilarities between them (Figs. 1-2).

To determine whether these morphological dissimilarities are variation or not, populations of *O. onur-koyuncui* were monitored from 2017 to 2018. During this time, different specimens were collected from different points of the population and investigated every year.

Pollen and nutlet specimens were retrieved from dried plant materials that are at the Osmangazi University Science and Art Faculty Department of Biology Herbarium (OUFE). Pollen grains of 10–15 different flowers were used for each specimen.

Scanning electron microscopy (SEM) and light microscopy (LM) were used for the examination of pollen and nutlet morphology. Terminology of Faegri and Iversen's was used for naming the exine layers (Faegri & Iversen, 1975). For the analyzes in light microscope, preparation of the pollen grains was performed according to Wodehouse (1935) and Erdtman (1969), $10\times$ and $40\times$ plan objectives were used for counts and identifications. On the purpose of the identifying morphological features of pollen grains, a $100\times$ immersion objective was used. At the identifications and counts of pollen grains, a Nikon binocular microscope was used. Each space of the ocular micrometer is $0.98\ \mu\text{m}$. Thickness of the intine and exine layers of all investigated pollen grains was measured 20 to 50 times. Microphotographs were taken at the Osmangazi University Science and Art Faculty Department of Biology, using a digital camera and a Nikon 80i-type microscope. The photograph dimensions were $100\ \mu\text{m}$.

For SEM investigations, non-acetolyzed pollen grains were directly put onto metallic stubs and coated with gold. These preparations were analysed with a Hitachi Regulus brand SEM (Walker, 1974a, b). Faegri & Iversen and Wodehouse terminologies were used for pollen morphology (Faegri & Iversen, 1975; Wodehouse, 1935; Binzet, 2011; Binzet *et al.*, 2014).

For statistical analysis, 25 seeds and 25 pollen grains of each taxon were measured. The statistical analysis of the measurement data was done by using SPSS 16.0 for Windows.

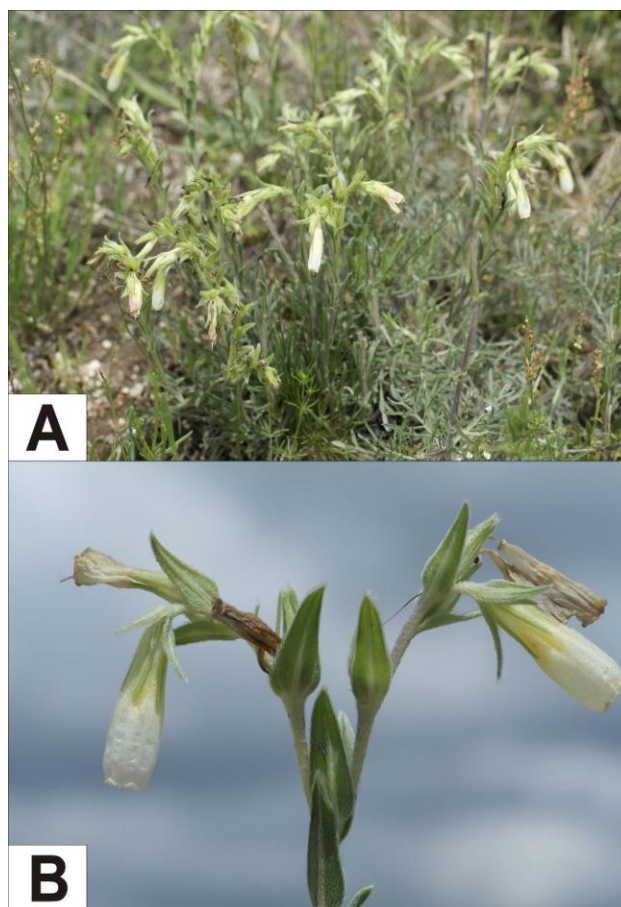


Fig. 1. A: The general appearance of *Onosma onur-koyuncui* in nature; B: The flower of *O. onur-koyuncui* in nature.



Fig. 2. Distribution map of *Onosma onur-koyuncui* (★) and *O. lycaonica* (Indicated as red) in Turkey.

Taxonomy

Onosma onur-koyuncui Sezer sp. nov. (Sect. *Onosma* subsect. *Asterotricha*), (Figs. 3-8).

Holotype:—Turkey, B3 Kütahya: Sökmen village, Calcareous rock and soils, 1050 m, 39° 35' 15" N - 30° 11' 43" E, 31.05.2017, *O. Sezer*, 16481 (OUFE).

Diagnosis:—*Onosma onur-koyuncui* is closely related to *O. lycaonica*. Perennial, stems 11–25 cm (not 5–11 cm), ascending to erect, branched (not simple). Strongly adpressed setose (not tightly); sparsely adpressed hairy (densely). Setae strongly tuberculate (not minute); leaves 20–75 × 1.5–4 mm (not 10–40 × 2–5 mm); linear to linear lanceolate (not linear lanceolate to lanceolate), not acute (acute), margins strongly revolute (not flat to revolute), gray with dense adpressed setae, shortly hairy, all leaves sessile (basal and lower cauline leaves are petiolate). Inflorescence of 1–2 terminal 6–10 flowered cymes (not solitary terminal). Pedicels 0.5–1 mm (not 1–2 mm). Corolla 12–16 mm (not 16–20). Clavate to campanulate, densely setulose (not densely papillose) (Table 1, Figs. 3-5).

Description:— Perennial, stems 11–25 cm, ascending to erect, branched, strongly adpressed setose and sparsely adpressed hairy, setae strongly tuberculate; leaves 20–75 × 1.5–4 mm; linear to linear lanceolate, not acute, margins are strongly revolute, gray with dense adpressed setae, shortly hairy, all leaves sessile. Inflorescence of 1–2 terminal 6–10 flowered cymes. Bracts narrowly lanceolate to linear. Pedicels 0.5–1 mm. Calyx 8–10 mm in flower, lobes narrowly lanceolate to linear. Corolla white at first, becoming creamy, 12–16 mm. Clavate to campanulate, densely setulose. Anthers included with sterile tips exerted, sagittate, shorter than filaments. Nutlets ovoid with lateral compressed beak, 2.5–3 × 1.7–2.3 mm, green to dark brown, sometimes includes dark brown patches, smooth, with ventrally and dorsally keeled. Plains on calcareous base rock, 1050 m.

Phenology:—Flowering in May to June and fruiting in June to August.

Palynology:—Pollen grains of *Onosma onur-koyuncui* are radially symmetrical, heteropolar, prolate and trisyncolporate. Margins of colpi are distinct. Amb circular shaped and margins convex. The main palynological characters and SEM micrographs of all studied taxa are presented in Table 2 and Fig. 6.

One edge of polar triangle is measured as 4.76 µm in non-acetolysed and 5.92 µm in acetolysed pollen grains. P/E ratio ranges from 1.30 to 1.41. Mean values of non-acetolysed pollen grains are 17.54 µm (P) and 12.44 µm (E). In acetolysed pollen grains, mean values were measured as 18.90 µm (P) and 14.54 µm (E). Pori length is 3.20 µm in non-acetolysed and 2.82 µm acetolysed pollen grains. The width of pori is 2.64 µm in non-acetolysed pollen grains and this measured as 7.36 µm for acetolysed pollen grains. Colpi of the pollen grains of *O. onur-koyuncui* are joining at distal pole but they are not reaching the proximal. Colpi length of non-acetolysed

pollen grains is 12.80 µm and this is measured as 14.02 µm for non-acetolysed ones. Width of colpi 3.47 µm for non-acetolysed and 3.83 µm for acetolysed pollen grains.

P/E ratio of *O. lycaonica* is measured between 1.18–1.20. Mean values of non-acetolysed pollen grains are 16.61 µm (P) and 14.12 µm (E). In acetolysed pollen grains, mean values were measured as 20.07 µm (P) and 16.68 µm (E). Pollen grains of *O. lycaonica* are radially symmetrical, heteropolar and trisyncolporate as the pollen grains of *O. onur-koyuncui*. However pollen grains of *O. lycaonica* are sub-prolate shaped and amb tri-angular. One edge of polar triangle is measured as 6.93 µm in non-acetolysed and 8.02 µm in acetolysed pollen grains. These values are clearly higher ($p < 0.05$) than *O. onur-koyuncui*.

Exine thickness of studied taxa varies between 0.40–0.97 µm and exine ornamentation is typically scabrate in *O. onur-koyuncui* and scabrate-rugulate in *O. lycaonica*. Intine thickness of both taxa is too close and intine thickness of them is measured between 0.76–0.81 µm.

Taxonomy of the *Onosma* which is one of the biggest genus of the Boraginaceae has problems due to insufficient morphological characters and high number of closely related taxa. Additional taxonomic characters should be used for clearly distinguishing of closely related taxa and proper identification (Riedl, 1978). Recent palynological studies on *Onosma* taxa show that, palynological characters are most important tools for the classification of *Onosma* taxa associated with other taxonomic characters (Binzet *et al.*, 2010, Binzet *et al.*, 2014). It is seen that in the light of micromorphological data obtained from pollen grains belonging to investigated taxa, there are significant differences found between *O. onur-koyuncui* and *O. lycaonica*.

Nutlet morphology:—Nutlets ovoid with lateral compressed beak. In term of the seed measurements, seed sizes range between 2.5–3 mm length and 1.7–2.3 mm width. Immatured nutlets are green colored and sometimes they include pale to dark brown patches. Matured nutlets can be from pale to dark brown colored. Surface of the nutlets are smooth, ventrally and dorsally keeled. The seed coat is rugose pattern formed by elongated and polygonal shaped cells.

According to the Riedl (1978), nutlet characters like size, shape, colour and ornamentation have limited taxonomic value. So only these are not sufficient to reveal phylogenetic relations. Besides, recent studies on the seed morphology of *Onosma* taxa showed that the external nutlet characters, especially surface ornamentation, could be useful for the classification *Onosma* in the future (Binzet & Akçin, 2009a; Akçin & Binzet, 2011). When *Onosma onur-koyuncui* was compared with *O. lycaonica* in terms of morphological characters, it was identified that there are distinctive differences between morphological characters of seeds (Table 1, Figs. 7-8).

Distribution and ecology: *Onosma onur-koyuncui* endemic to Turkey, is distributed in Central Anatolia and occurs within the limits of the Irano-Turanian phytogeographic region. At the end of realised field surveys, no population belonging to this taxon except from the type locality was encountered. *O. onur-koyuncui* shows expansion especially on the plain areas where it was found on the upper side of the rocky peak having high CaCO₃.

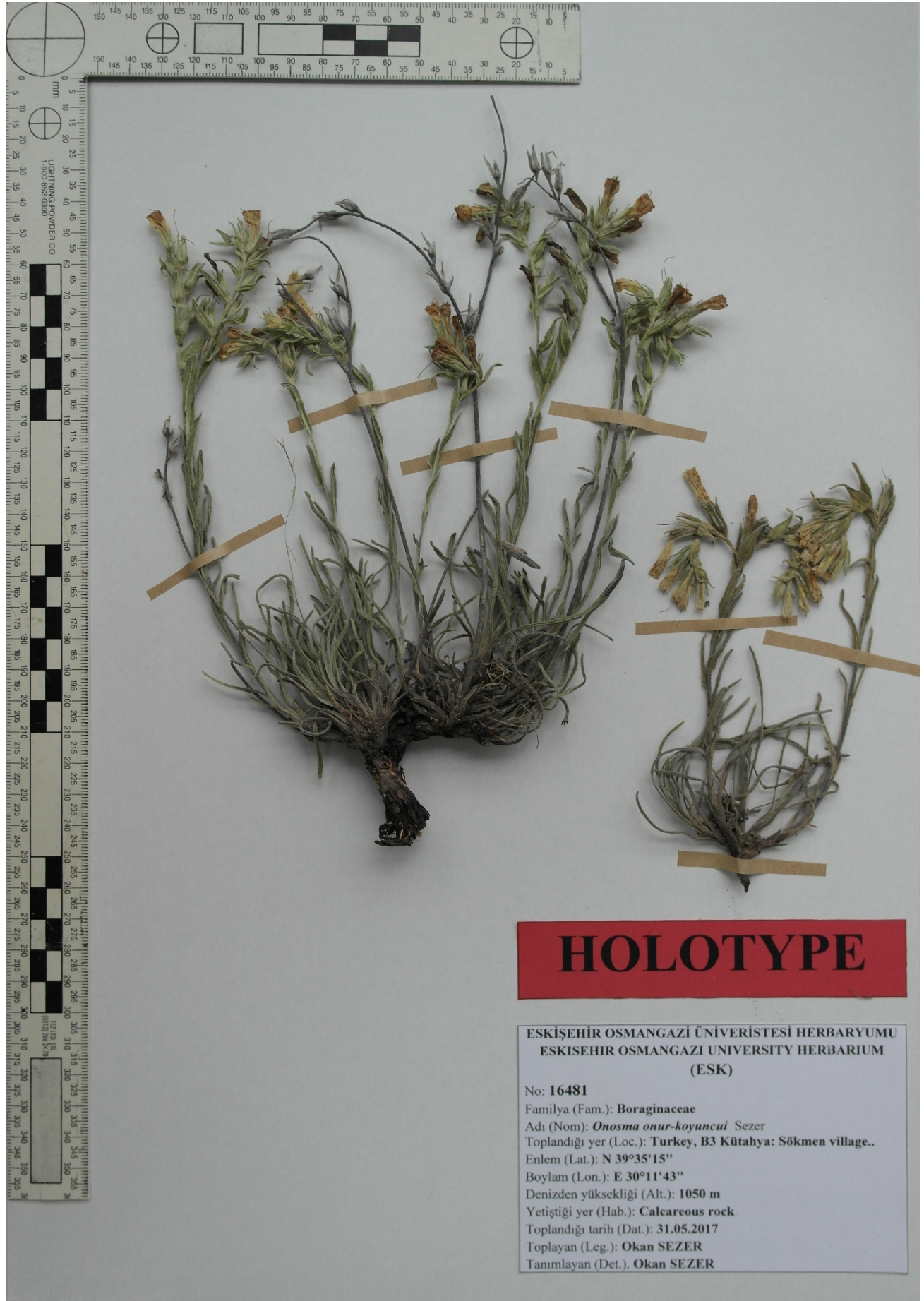


Fig. 3. The holotype of *Onosma onur-koyuncui* from the herbarium OUF: OUF 16481.

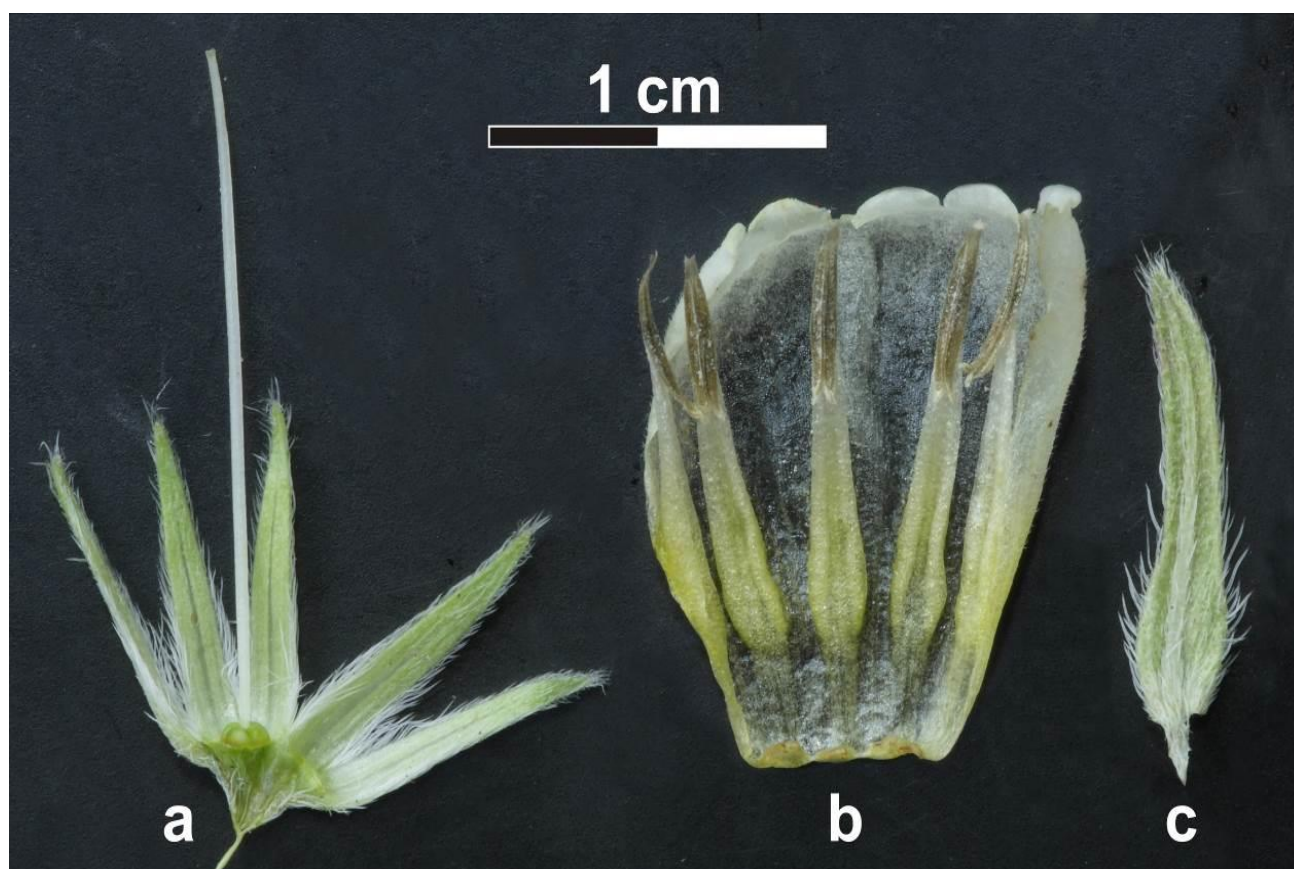


Fig. 4. Dissected flower of *Onosma onur-koyuncui* (a: calyx and gynoecium; b: corolla and androecium; c: bract).

Table 1. The morphological differences between *Onosma onur-koyuncui* and *O. lycanica*.

	<i>Onosma onur-koyuncui</i>	<i>Onosma lycanica</i>
Stems	Ascending to erect, 11–25 cm, branched	Ascending to erect, 5–11 cm, simple
Stem indumentum	Strongly adpressed setose, setae strongly tuberculate, sparsely covered with short adpressed hairs	Tightly adpressed-setose, densely covered with short adpressed hairs, setae on minute tubercles
Leaves	Sessile, 20–75 × 1.5–4 mm; linear to linear lanceolate, not acute, margins strongly revolute	Upper cauline leaves sessile, basal and lower cauline leaves petiolate, 10–40 × 2–5 mm; linear-lanceolate to lanceolate, acute, margin flat to revolute
Leaf indumentum	Gray with dense adpressed setae, shortly hairy	Whitish-grey with dense adpressed setae, shortly hairy
Inflorescence	Inflorescence of 1–2 terminal 6–10 flowered cymes; calyx 8–10 mm in flower, lobes narrowly lanceolate to linear; pedicels 0.5–1 mm	Inflorescence a solitary terminal 5–10 flowered cyme; calyx 8–10 mm in flower, lobes narrowly lanceolate to linear; pedicels 1–2 mm
Bract	Narrowly lanceolate to linear	Narrowly lanceolate to linear
Corolla	Corolla white at first, becoming creamy, 12–16 mm, clavate to campanulate, densely setulose; anthers included with sterile tips exerted, sagittate, shorter than filaments	Corolla white, 16–20 mm, clavate to campanulate, densely papillate; anthers included with sterile tips exerted, sagittate, shorter than filaments
Nutlet	Ovoid with lateral compressed beak, 2.5–3 × 1.7–2.3 mm, green to dark brown, sometimes includes dark brown patches, the surface epidermis cells are elongated rectangular and narrow to large, with ventrally and dorsally keeled	Ovoid, acute-acuminate, short beaked, 3 × 2 mm, gray, reticulate, with ventrally and dorsally keeled

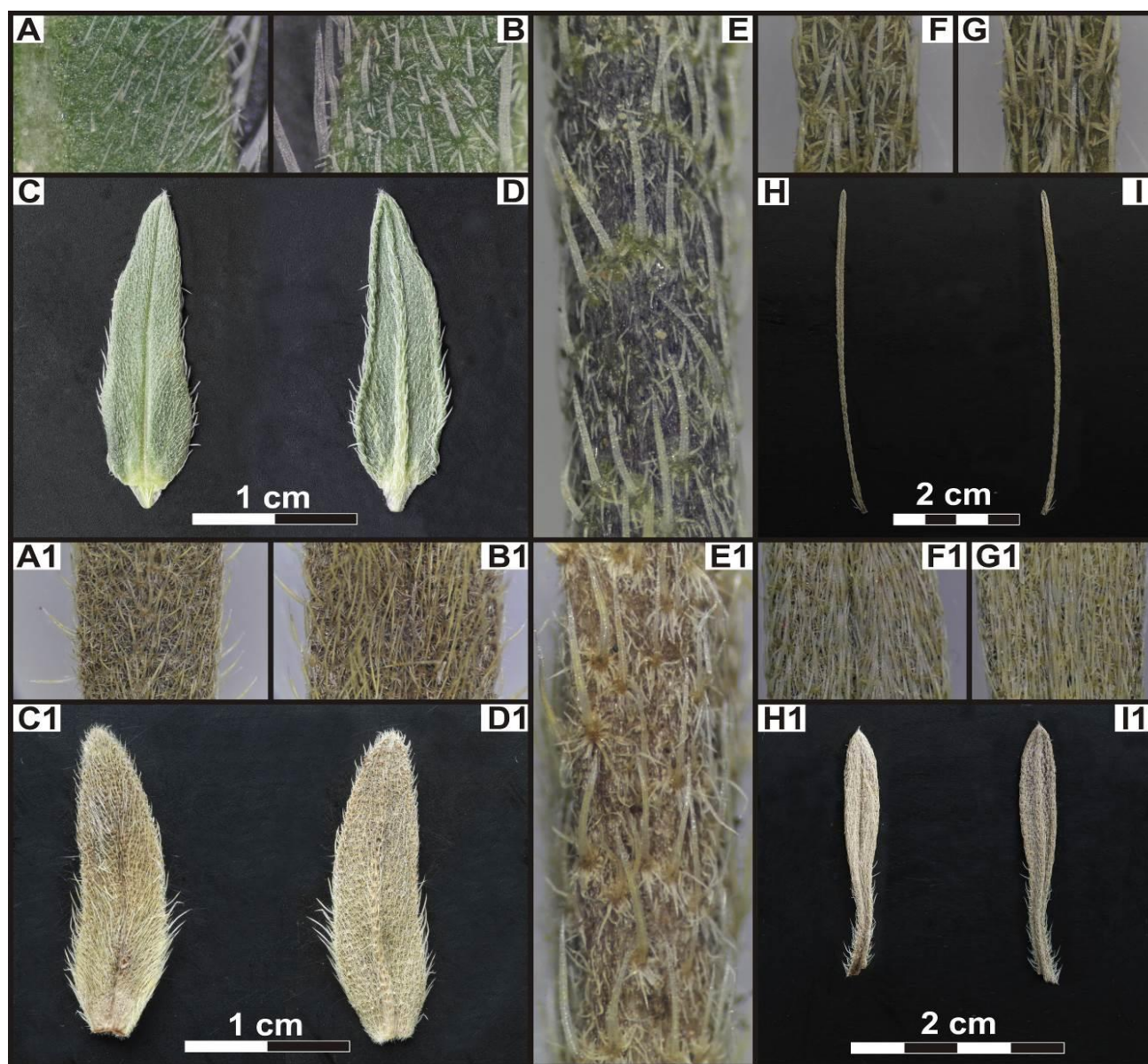


Fig. 5. Indumentum of *Onosma onur-koyuncui* (A, B, C, D, E, F, G, H, I) and *O. lycaonica* (A1, B1, C1, D1, E1, F1, G1, H1, I1) (A, A1, C, C1: Upper surface of stem leaf; B, B1, D, D1: Lower surface of stem leaf; E, E1: Stem; F, F1, H, H1: Upper surface of basal leaf; G, G1, I, I1: Lower surface of basal leaf).

Table 2. Pollen data of *Onosma onur-koyuncui* and *O. lycaonica*.

	P	E	P/E	plg	plt	clg	clt	Exine	Intine	t	Aperture number	Ornamentation	Pollen shape
<i>(O. onur-koyuncui)</i>	17.54 ± 1.50 μm	12.44 ± 1.50 μm	1.41	3.20 μm	2.64 μm	12.80 μm	3.47 μm	0.54 μm	0.81 μm	4.76 μm	3	Scabrate	Prolate
Non-Acetolysed													
Acetolysed	18.90 ± 0.96 μm	14.54 ± 0.86 μm	1.30	2.82 μm	7.36 μm	14.02 μm	3.83 μm	0.82 μm	-	5.92 μm	3	Scabrate	Prolate
<i>(O. lycaonica)</i>	16.61 ± 0.78 μm	14.12 ± 0.71 μm	1.18	3.77 μm	4.25 μm	13.40 μm	3.56 μm	0.40 μm	0.76 μm	6.93 μm	3	Scabrate-Rugulate	Sub-prolate
Non-Acetolysed													
Acetolysed	20.07 ± 1.02 μm	16.68 ± 0.63 μm	1.20	2.39 μm	8.36 μm	14.97 μm	3.21 μm	0.97 μm	-	8.02 μm	3	Scabrate-Rugulate	Sub-prolate

P: Polar diameter; E: Equatorial diameter; plg: Porus length; plt: Porus width; clg: Colpus length; clt: Colpus width; t: One edge of polar triangle

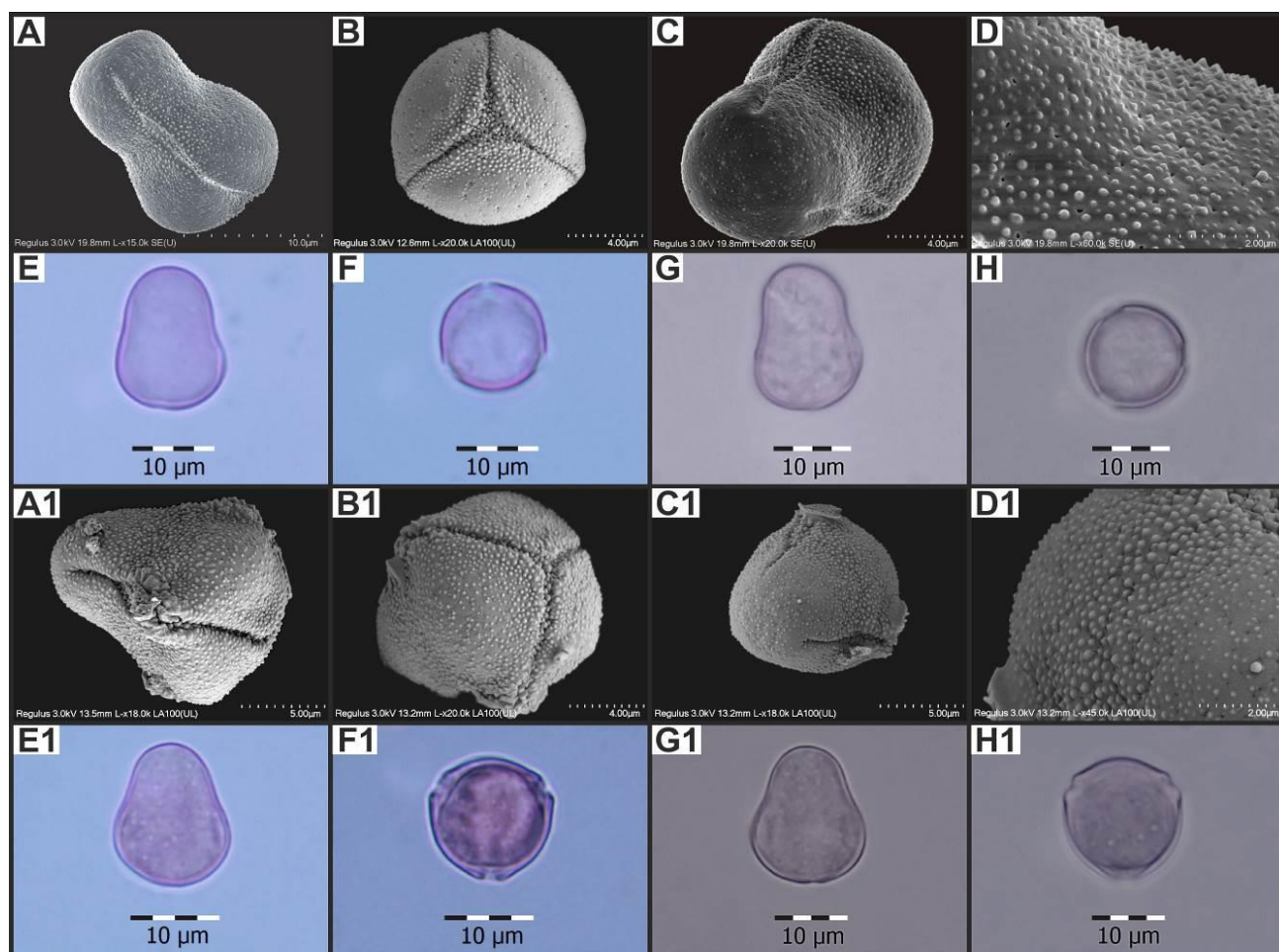


Fig. 6. Pollen microphotography of *Onosma onur-koyuncui* (A, B, C, D, E, F, G, H) and *O. lycaonica* (A1, B1, C1, D1, E1, F1, G1, H1) (A, A1: Equatorial view of a pollen in SEM; B, B1, C, C1: Polar view of a pollen in SEM; D, D1: Surface ornamentation of a pollen in SEM; E, E1: Equatorial view of a non-acetolysed pollen in LM; F, F1: Polar view of a non-acetolysed pollen in LM; G, G1: Equatorial view of an acetolysed pollen in LM; H, H1: Equatorial view of an acetolysed pollen in LM).

Recommended IUCN threat category listing: As a consequence of performed field surveys by the author, it was seen that the population of *Onosma onur-koyuncui* shows expansion at only one locality (Fig. 2). The area of occupancy (AOO) of the natural population of taxon is about 1 km² and its population size is less than 200 individuals. In the consequence of gathered data and on the basis of IUCN Red List Categories (Anon., 2017); endemism category of *O. onur-koyuncui* was proposed as “Critically Endangered [CR: B2ab(i)]”.

Etymology: This species is named in honour of Assoc. Prof. Dr. Onur Koyuncu, who is a botanist in the field of plant systematics at the Biology Department, Faculty of Science and Arts, Eskişehir Osmangazi University, Eskişehir-Turkey.

Additional specimens examined: *Onosma lycaonica*. Turkey C4 Konya: Dereköy, 8 km W Konya, 1100 m, *H. Morath*, 06 June 1948, Isotype (E00284759); Turkey C4 Mersin: Mut, between Mut and Karaman, Sertavul pass, steppe, 1600 m, *R. Binzet*, *Binzet* 88, 29 May 2004; *Binzet* 89, 19 June 2004; *Binzet* 90, 06 May 2005.

Identification key

1. Leaves densely adpressed greyish- to whitish-setose and Indumentum of leaves asterotrichous
2. Pedicels 3-4 mm in flower, to 10 mm in fruit 48. *O. isaurica*
2. Pedicels 0-3 mm in flower and fruit
3. Stems 5-11 (-25) cm; leaf margins flat to revolute
4. Stems 5-11 cm, simple; basal and lower cauline leaves petiolate, 10-40 × 2-5 mm, leaf margins flat to revolute 49. *O. lycaonica*
4. Stems 11-25 cm, branched; basal and lower cauline leaves sessile, 20-75 × 1.5-4 mm, leaf margins strongly revolute 49a *O. onur-koyuncui*
3. Stems (10-) 12-45 cm; leaf margins not revolute [...]

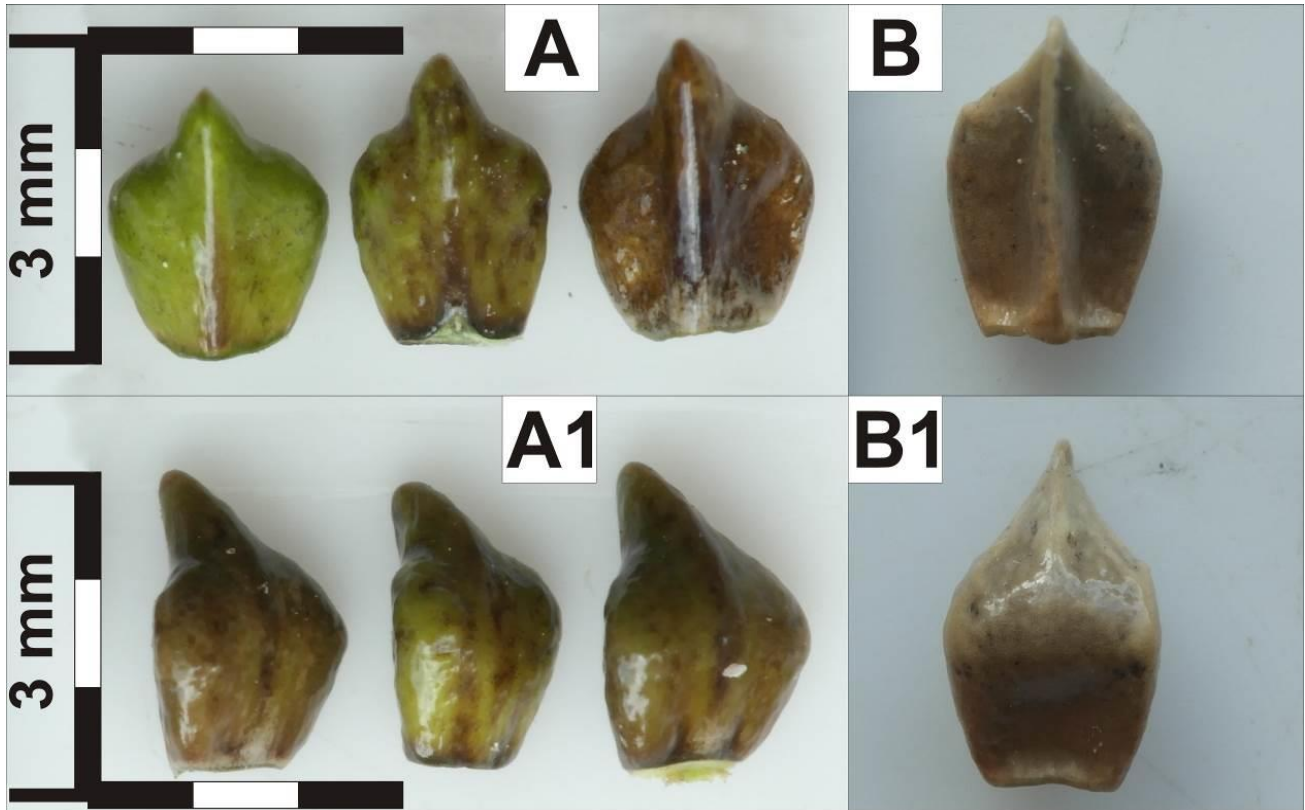


Fig. 7. General view of the nutlets of *Onosma onur-koyuncui* (A: ventrally; A1: dorsally) and *O. lycaonica* (B: ventrally; B1: dorsally).

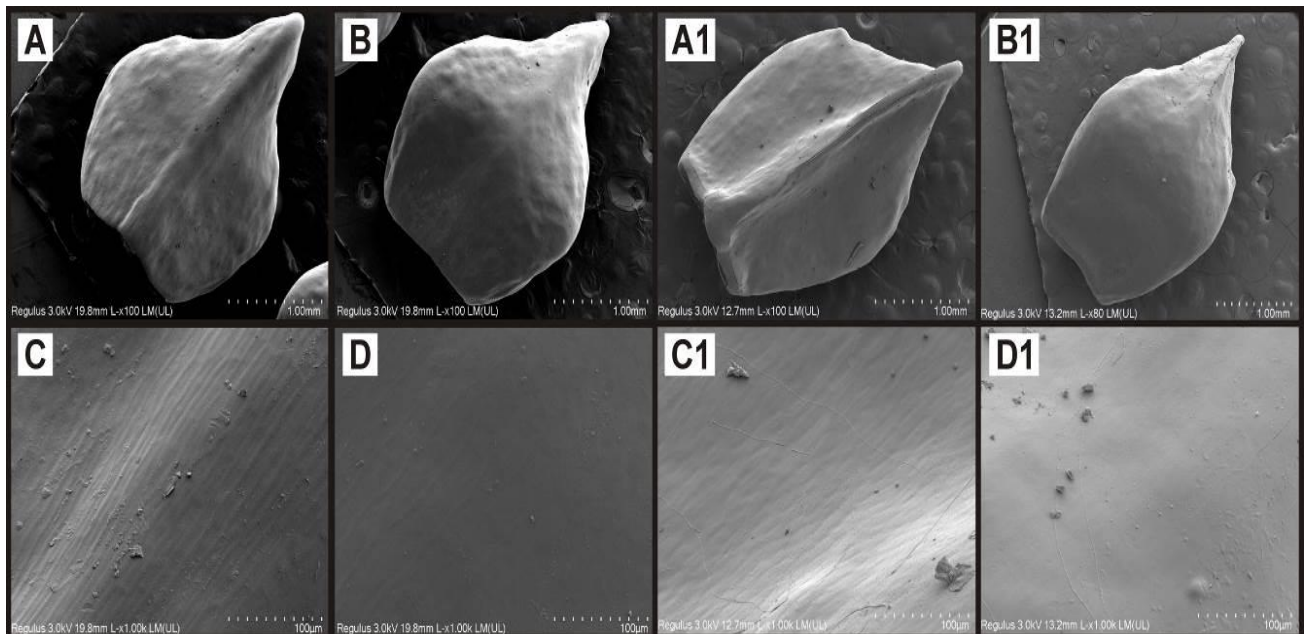


Fig. 8. General view and surface structure of the nutlets of *Onosma onur-koyuncui* (A, B, C, D) and *O. lycaonica* (A1, B1, C1, D1) in SEM (A, A1, C, C1: ventrally; B, B1, D, D1: dorsally).

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References

- Akçin, E.Ö. and R. Binzet. 2010. The micromorphological and anatomical properties of *Onosma angustissimum* Hausskn. & Bornm. and *O. cassium* Boiss. (Boraginaceae). *Bang. J. Plant Taxon.*, 17(1): 1-8.
- Akçin, E.Ö. and R. Binzet. 2011. Micromorphological studies on nutlets of some *Onosma* L. (Boraginaceae) species from Turkey. *Pak. J. Bot.*, 43(2): 743-752.
- Anonymous. 2017. Guidelines for Using the IUCN Red List Categories and Criteria. Version 13, March 2017. Available

- from: <http://cmsdocs.s3.amazonaws.com/RedListGuidelines.pdf> (accessed 6 February 2018)
- Aytaç, Z. and Z. Türkmen. 2011. A new *Onosma* L. (Boraginaceae) species from southern Anatolia, Turkey. *Turk. J. Bot.*, 35: 269-274.
- Ball, P.W. 1972. *Onosma* L. In: (Eds.): Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb. *Flora europaea: diapiasiaceae to myoporaceae*, vol. 3. Cambridge University Press, Cambridge, pp. 89-94.
- Binzet, R. 2011. Pollen morphology of some *Onosma* species (Boraginaceae) from Turkey. *Pak. J. Bot.*, 43(2): 731-741.
- Binzet, R. 2012. *Onosma* L. In: (Eds.): Güner, A., S. Aslan, T. Ekim, M. Vural and M.T. Babaç. *Türkiye Bitkileri Listesi (Damarlı Bitkiler)*. Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul, 1290 pp.
- Binzet, R. 2016a. A new species of *Onosma* L. (Boraginaceae) from Anatolia. *Turk. J. Bot.*, 40: 194-200.
- Binzet, R. 2016b. *Onosma anatolica*, a new species of Boraginaceae from Turkey. *Phytokeys*, 69: 39-49.
- Binzet, R. and H.İ. Teke. 2014. The anatomical properties of *Onosma mollis* DC. and *Onosma halophila* Boiss. & Heldr. (Boraginaceae) from Turkey. *Pak. J. Bot.*, 46(5): 1663-1668.
- Binzet, R. and N. Orcan. 2007. A new species of *Onosma* L. (Boraginaceae) from Southern Turkey. *Novon*, 17: 8-10.
- Binzet, R. and N. Orcan. 2009. Anatomical and Palynological investigations on endemic *Onosma mersinana* Riedl, Binzet and Orcan. *Pak. J. Bot.*, 41(2): 503-510.
- Binzet, R. and Ö. Eren. 2018. *Onosma erzincanica* (Boraginaceae: Lithospermeae), a new scree species from Turkey. *Phytotaxa*, 356(2): 117-130. <http://dx.doi.org/10.11646/phytotaxa.356.2.2>
- Binzet, R. and Ö.E. Akçin. 2009a. Nutlet size, shape and surface ornamentation in 14 *Onosma* species (Boraginaceae). *Acta Botanica Croatica*, 68(1): 117-126.
- Binzet, R. and Ö.E. Akçin. 2009b. The morphological and anatomical properties of two endemic *Onosma* species (*O. intertextum* and *O. sieheanum*). *Acta Botanica Hungarica*, 51(1-2): 1-9.
- Binzet, R. and Ö.E. Akçin. 2012. The anatomical properties of two *Onosma* L. (Boraginaceae) species from Turkey. *J. Med. Plants Res.*, 6(17): 3288-3294.
- Binzet, R., İ. Kandemir and N. Orcan. 2010. Palynological classification of *Onosma* L. (Boraginaceae) species from east Mediterranean region in Turkey. *Acta Botanica Croatica*, 69(2): 259-274.
- Binzet, R., İ. Kandemir and N. Orcan. 2018. Numerical taxonomic study of the genus *Onosma* L. (Boraginaceae) from eastern Mediterranean region in Turkey. *Pak. J. Bot.*, 50(2): 561-573.
- Binzet, R., İ.P. Erkara, H. Özler and S. Pehlivan. 2014. Pollen morphology and systematical contribution of some *Onosma* (Boraginaceae) taxa distribution in Turkey. *Plant Sys. & Evol.*, 300(10): 2135-2146.
- Boissier, P.E. 1879. *Flora Orientalis*, vol. 4. Geneva, pp. 178-203.
- Boissier, P.E. 1849. *Diagnoses plantarum orientalium novarum*, vol. 11. B. Herrmann, Lipsia [Leipzig], 136 pp.
- Cecchi, L., A. Coppi and F. Selvi. 2016. *Onosma juliae* (Boraginaceae), a new species from southern Turkey, with remarks on the systematics of *Onosma* in the Irano-Turanian region. *Phytotaxa*, 288: 201-213.
- Chacón, J., F. Luebert, H.H. Hilger, S. Ovchinnikova, F. Selvi, L. Cecchi, C.M. Guillian, K. Hasenstab-Lehman, K. Sutor, M.G. Simpson and M. Weigend. 2016. The borage family (Boraginaceae s.s.): a revised infrafamilial classification based on new phylogenetic evidence, with emphasis on the placement of some enigmatic genera. *Taxon*, 65: 523-546.
- Davis, P.H., R.R. Mill and K. Tan (Eds.). 1988. *Flora of Turkey and the East Aegean Islands*, vol. 10 (Suppl. 1). Edinburgh University Press, Edinburgh, pp. 184-185.
- Dinsmore, J.E. 1932. *Flora of Syria, Palestine, and Sinai*. American University Beirut Press, Beirut, pp. 230-233.
- Erdtman, G. 1969. *Handbook of palynology morphology, taxonomy, ecology. An introduction to the study of pollen grains and spores*. Hafner Pub., New York, 486 pp.
- Fægri, K. and J. Iversen. 1975. *Textbook of pollen analysis*. Edition 3, Hafner Pub., New York, 295 pp.
- Huber-Morath, A. 1971. Novitiae florum anatolicarum IX. *Bauhinia* 4: 197-222.
- Kandemir, A. and Z. Türkmen. 2010. A new species of *Onosma* (Boraginaceae) from eastern Turkey. *Turk. J. Bot.*, 34: 277-282.
- Kolarčík, V., J. Zozomová-Lihová and P. Mártonfi. 2010. Systematics and evolutionary history of the Asterotracha group of the genus *Onosma* (Boraginaceae) in central and southern Europe inferred from AFLP and nrDNA ITS data. *Plant Sys. & Evol.*, 291: 21-45.
- Koyuncu, O., Ö.K. Yaylacı, K. Özgüşi, O. Sezer and D. Öztürk. 2013. A new *Onosma* (Boraginaceae) species from Central Anatolia, Turkey. *Plant Sys. & Evol.*, 299: 1839-1847.
- Linnaeus, C. 1762. *Species Plantarum, Editio Secunda*, vol. 1. Impensis Laurentii Salvii, Stockholm, 784 pp.
- Luebert, F., L. Cecchi, M.W. Frohlich, M. Gottschling, C.M. Guillian, H.H. Hilger, K.E. Hasenstab-Lehman, J.S. Miller, M. Mittelbach, M. Nazaire, M. Nepi, D. Nocentini, D. Ober, R.G. Olmstead, F. Selvi, M.G. Simpson, K. Sutor, B. Valdés, G.K. Walden and M. Weigend [Boraginales Working Group]. 2016. Familial classification of the Boraginales. *Taxon*, 65: 502-522.
- Popov, M.G. 1951. Ad cognitionem meliorem generis *Onosma* L. *Botanicheskie materialy gerbariya Botanicheskogo Instituta Im. V.L. Komarova Akademii Nauk SSSR [In Russian: Ботанические материалы Гербария Ботанического института им. В. Л. Комарова Академии наук СССР]* 14: 277-304.
- Popov, M.G. 1974. Boraginaceae. In: (Ed.): Shishkin, B.K. *Flora of the U.S.S.R.*, Vol. XIX. Jerusalem, Israel: Israel Program for Scientific Translations, pp. 97-691.
- Riedl, H. 1964. Boraginaceae L. In: (Ed.): Rechinger, K.H. *Flora of lowland Iraq*. Weinheim, J. Cramer, pp. 511-513.
- Riedl, H. 1967. Boraginaceae L. In: (Ed.): Rechinger, K.H. *Flora Iranica*, vol. 48. Akademische Druck-und Verlagsanstalt, Graz, pp. 1-281.
- Riedl, H. 1978. *Onosma* L. In: (Ed.): Davis, P.H. *Flora of Turkey and the East Aegean Islands*, vol. 6. Edinburgh University Press, Edinburgh, pp. 237-437.
- Riedl, H., R. Binzet and N. Orcan. 2005. A new species of *Onosma* (Boraginaceae-Lithospermeae) from southern Turkey. *Edinburg J. Bot.*, 61: 127-130.
- Teke, H.İ. and R. Binzet. 2017. Anatomical, morphological and palynological studies of some *Onosma* L. (Boraginaceae) taxa endemic to Anatolia. *Pak. J. Bot.*, 49(2): 579-588.
- Teppner, H. 1991. *Onosma* L. In: (Eds.): Strid, A. and K. Tan. *Mountain Flora of Greece*, vol. 2. Edinburgh University Press, Edinburgh, pp. 26-39.
- Teppner, H. 1996. Blüten und Blütenbesucher bei *Onosma* (Boraginaceae-Lithospermeae). *Fedd. Repert*, 106: 525-532.
- Walker, J.W. 1974a. Evolution of exine structure in the pollen of primitive angiosperms. *Amer. J. Bot.*, 61: 891-902.
- Walker, J.W. 1974b. Aperture evolution in the pollen of primitive angiosperms. *Amer. J. Bot.*, 61: 1112-1137.
- Wodehouse, R.P. 1935. *Pollen Grains*. McGraw-Hill Book Company, New York, 574 pp.
- Yıldırım, Ş. 2000. The chorology of the Turkish species of Boraginaceae family. *The Herb J. Sys. Bot.*, 7(2): 257-272.