

New taxa of *Onosma* L.
(Boraginaceae, Lithospermeae)
from Iran

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New taxa of *Onosma* L. (Boraginaceae, Lithospermeae) from Iran

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ABSTRACT

This study describes three new species within the genus *Onosma* L. (Boraginaceae), from sect. *Onosma*, subsect. *Asterotricha* (Boiss.) Gürke, in Iran. These species, determined as *O. ligniclada* Attar & Mirtadzadini, sp. nov., *O. elymaitica* Attar & Mirtadz., sp. nov., and *O. farsistanica* Attar & Mirtadz., sp. nov., were distinguished based on detailed morphological and phylogenetic evidence. *Onosma ligniclada* Attar & Mirtadzadini, sp. nov. and *O. elymaitica* Attar & Mirtadz., sp. nov., originating from Ilam province, display distinct morphological features that differ from their closest known species, *O. albo-rosea* Fisch. & C.A.Mey., *O. iranisharii* Ghahr. & Attar and *O. bilabiata* Boiss. & Buhse respectively. This differentiation is marked by variations in habit, corolla color and size, and leaf morphology on sterile shoots and indumentum of leaves. In contrast, *O. farsistanica* Attar & Mirtadz., sp. nov. identified in the *Quercus* L. forests of Fars province (*Quercus brantii* var. *Persica* (Jaub. & Spach) Zohary), exhibits notable distinctions from their closely related species, *O. bilabiata*, particularly in terms of habitat, growth form, tubercle characteristics, calyx and corolla dimensions. Additionally, the manuscript provides photographic documentation, a distribution map, IUCN conservation assessments, and a diagnostic key for these newly identified species.

KEY WORDS

Asterotricha,
endemic species,
morphology,
Flora of Iran,
new species.

RÉSUMÉ

Nouveaux taxons d'Onosma L. (Boraginaceae, Lithospermeae) d'Iran.

Cette étude décrit trois nouvelles espèces du genre *Onosma* L. (Boraginaceae), appartenant à la section *Onosma* L., sous-section *Asterotricha* (Boiss.) Gürke, en Iran. Ces espèces, identifiées comme *O. ligniclada* Attar & Mirtadzadini, sp. nov., *O. elymaitica* Attar & Mirtadzadini, sp. nov. et *O. farsistanica* Attar & Mirtadzadini, sp. nov., ont été distinguées sur la base de preuves morphologiques et phylogénétiques détaillées. *Onosma ligniclada* Attar & Mirtadzadini, sp. nov. et *O. elymaitica* Attar & Mirtadz., sp. nov., originaires de la province d'Ilam, présentent des caractéristiques morphologiques distinctes de leurs espèces les plus proches connues, à savoir *O. albo-rosea* Fisch. & C.A.Mey., *O. iranisharii* Ghahr. & Attar et *O. bilabiata* Boiss. & Buhse respectivement. Cette différenciation repose sur des variations concernant l'habitus, la couleur et la taille de la corolle, ainsi que la morphologie foliaire des pousses stériles et l'indument des feuilles. En revanche, *O. farsistanica* Attar & Mirtadz., sp. nov., identifié dans les forêts de *Quercus* L. de la province de Fars (*Quercus brantii* var. *persica* (Jaub. & Spach) Zohary), se distingue nettement de son espèce la plus apparentée, *O. bilabiata*, notamment en termes d'habitat, de port, de caractéristiques des tubercules, ainsi que de dimensions du calice et de la corolle. En outre, cet article fournit une documentation photographique, une carte de distribution, des évaluations de conservation selon les critères de l'UICN et une clé diagnostique pour ces nouvelles espèces.

MOTS CLÉS
Asterotricha,
espèces endémiques,
morphologie,
flore d'Iran,
espèces nouvelles.

INTRODUCTION

Onosma L. (Linnaeus 1762) (Lithospermae, Boraginaceae) is a diverse genus comprising approximately 250 taxa worldwide (Chacón *et al.* 2016; Naqinezhad & Attar 2016; Attar *et al.* 2023; Advay *et al.* 2023). Its distribution spans from north-west Africa to Europe and Asia, with a notable prevalence in Turkey and Iran (Kadereit *et al.* 2016; Chacón *et al.* 2016; Cecchi *et al.* 2016; Binzet & Eren 2018; Attar *et al.* 2020; Firat & Binzet 2021; Noroozi *et al.* 2022, 2024).

The morphology of *Onosma* species is varied, yet they commonly exhibit characteristics such as being herbaceous perennials or biennials, with some species manifesting as annuals. Typically, these plants have erect stems ranging from 10 to 100 cm in height, depending on the species. The leaves are alternately arranged along the stem, often possessing a rough texture due to their setose nature. A defining feature of *Onosma* species is their funnel-shaped, cylindrical or clavate flowers, comprising five fused petals that form a tube with five triangular or rounded lobes. The flower color varies, commonly presenting in shades of blue, purple, pink, or yellow. These flowers are arranged in cymes, either terminal or axillary, with five epipetalous stamens. The filament length varies among species; bases can be either glabrous or hairy (sect. *Protonosma* Popov). The nectariferous annulus may also be glabrous or hairy. Nutlets in these species are generally smooth, rugose, or mamillate.

The Flora Iranica mentions ten species belonging to subsect. *Asterotricha* from Iran, including *O. albo-rosea* Fisch. & C.A.Mey. (with four varieties), *O. armena* DC., *O. bilabiata* Boiss. & Buhse, *O. caerulea* Boiss., *O. cardiostegia* Bornm., *O. dasytricha* Boiss., *O. hebebulba* DC., *O. kurdica* Teppner, *O. latifolia* Boiss. & Hausskn. ex Boiss., and *O. rascheyana* Boiss.

Teppner (1980) also described *O. kurdica* from Mt Hamzeh-arab in Kurdistan province. Subsequently, two new species, *O. iranisharii* Ghahr. & Attar (Ghahreman & Attar 1996)

and *O. bisotunensis* Attar & Hamzeh'ee (Attar & Hamzeh'ee 2007), and also *O. safaie-fari* Advay, Attar & S.A.Ahmad (Advay *et al.* 2023), *O. shebbazii* Advay, Attar & S.A.Ahmad (Advay *et al.* 2023) were described from the west of Iran, along with *Onosma mozaaffarianii* Mehrabian (Mehrabian *et al.* 2013) from Kermanshah, *O. targevarensis* Mozaff. & Mehrabian (Mehrabian & Mozaffarian 2018) from Azerbaijan province and *O. wendelboi* Mehrabian & Mozaff. (Mehrabian & Mozaffarian 2018) from Lorestan Province, *O. madjnoniani* Mehrabian & Naghizadeh (Mehrabian *et al.* 2022), *O. pseudohebebulba* Mozaff. & Mehrabian (Mehrabian *et al.* 2022), *O. atrii* Mehrabian & Khajoei Nasab (Mehrabian *et al.* 2022), *O. persica* Mehrabian & Naghizadeh (Mehrabian *et al.* 2022), *O. bozghushica* Mozaff. & Mehrabian (Mehrabian *et al.* 2022).

All species in subsect. *Asterotricha* have white, yellow, pink, and red corolla that become dark blue when dry in most species. This is an important characteristic for distinguishing between species. According to Riedl (1967, 1979) and Khatamsaz (2002), the center of diversity for subsect. *Asterotricha* is in the west of Iran and Turkey. With the recent additions of new taxa, the number of species belonging to subsect. *Asterotricha* in the Flora of Iran has increased to 30. During several field works and herbarium studies conducted by the authors of this study for a taxonomic treatment of *Onosma*, they discovered some specimens that were previously unknown to science.

MATERIAL AND METHODS

NEW SPECIES

Three specimens were collected from different populations in Ilam and Fars provinces in Iran (Fig. 1 and Table 1), which were identified as new species. To determine the taxonomic status of the collected specimens, relevant literature including Parsa (1949), Riedl (1967, 1979), Popov (1974), and

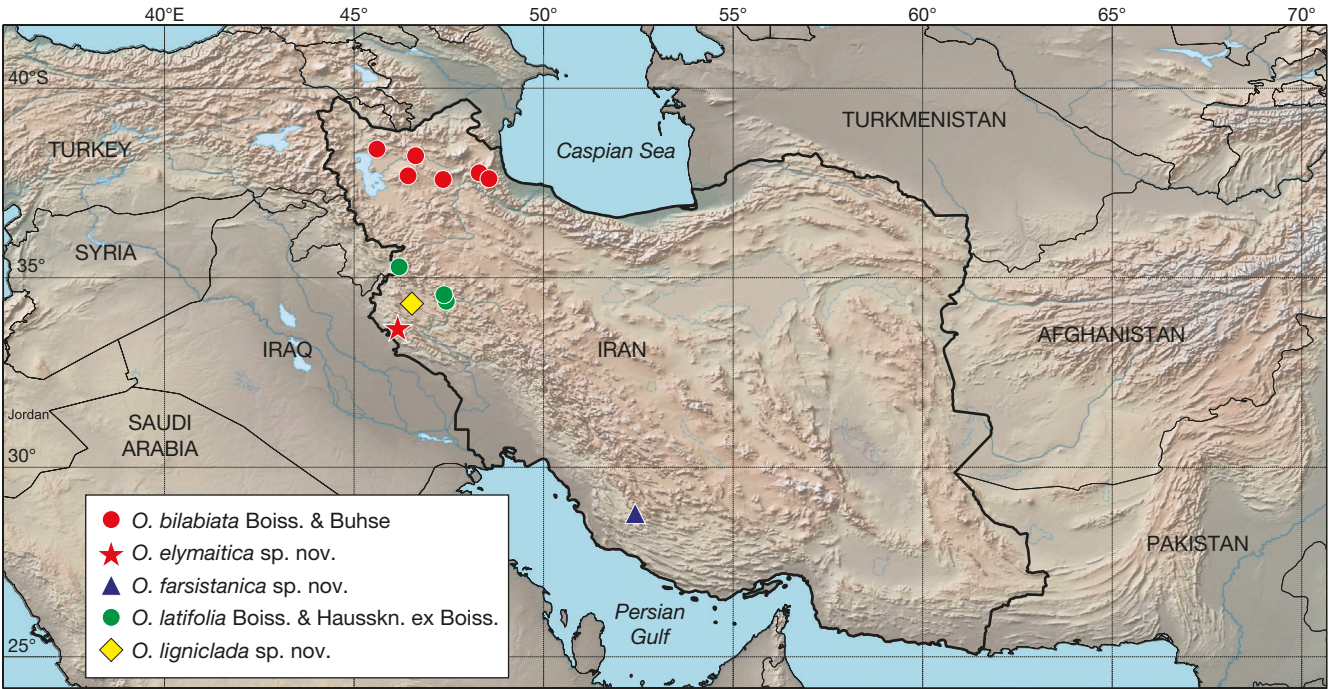


FIG. 1. — Distribution map of three new species, *O. ligniclada* Attar & Mirtadzadini, sp. nov., *O. elymaitica* Attar & Mirtadzadini, sp. nov. et *O. farsistanica* Attar & Mirtadz., sp. nov., and their related species.

Khatamsaz (2002), as well as type photos (K, TARI and W Herbaria) of closely related species, were consulted. Field photographs were taken of all collected species. The indumentum and nutlet were photographed using a Dino-Lite digital microscope AM413T. The holotypes, isotypes, and paratypes were deposited in IRAN, MIR, and TUH (Attar Collection) herbaria (Thiers 2017).

Moreover, to examine specific morphological features, meticulous observations were conducted utilizing a scanning electron microscope (SEM).

RESULTS AND DISCUSSION

MORPHOLOGY

Our investigations of several *Onosma* specimens from herbaria and field collections have revealed three previously undescribed species within the genus *Onosma*, specifically in the section *Onosma* and the subsection *Asterotricha*. These species are identified as *O. ligniclada* sp. nov., *O. elymaitica* sp. nov., and *O. farsistanica* sp. nov. Detailed morphological comparisons showed that these new species exhibit distinct differences from their closest relatives.

Onosma ligniclada sp. nov. and *O. elymaitica* sp. nov., both originating from Ilam province, display unique morphological features that distinguish them from their closest known species, *O. albo-rosea*, *O. iranisharii*, and *O. bilabiata*. These differences include variations in habit, corolla color and size, and leaf morphology on sterile shoots, as well as the indumentum of leaves.

TABLE 1. — Localities of identified *Onosma* L. species.

Species	Locality
<i>O. ligniclada</i> sp. nov.	Iran, W, Kermanshah, c. 11 km to the crossroad of Gilan-e Gharb and Sumar, alt. 1050 m, 34°16'30"N, 46°32'12"E
<i>O. elymaitica</i> sp. nov.	Iran, W, Ilam, c. 15 km to Badreh from Ilam, alt. 844 m, 33°36'58"N, 46°09'6.83"E
<i>O. farsistanica</i> sp. nov.	Iran SW, Fars, between Shiraz and Kazerun, Dasht-e Arjan, 29°39'41.33"N, 51°58'59.36"E

In contrast, *O. farsistanica* sp. nov., identified in the Quercus forests of Fars province (*Quercus brantii* var. *persica*), shows notable distinctions from the closely related *O. bilabiata*. These distinctions are evident in habitat preference, growth form, tubercle characteristics, and calyx and corolla dimensions.

Family BORAGINACEAE Juss.
Tribe Lithospermae (DC.) Gürke

Onosma sect. *Onosma* subsect. *Asterotricha* (Boiss.) Gürke

DIAGNOSIS. — The basal leaves of these species have stellate hairy setae tubercles, consisting of numerous oblong or rounded cells arranged in one, two, or three series. The number and length of hairs on the tubercles vary widely in length and density and may exhibit regular or irregular patterns. These characters, along with other vegetative and reproductive traits, are highly important in species delimitation.



FIG. 2. — Holotype specimen of *Onosma ligniclada* Attar & Mirtadz., sp. nov.

Onosma ligniclada Attar & Mirtadzadini, sp. nov.
(Figs 2; 3)

TYPE MATERIAL. — Iran • W, Kermanshah, c. 11 km to the crossroad of Gilan-e Gharb and Sumar; 1050 m alt.; 34°16'30"N, 46°32'12"E; 28.V.2016; Attar, Mirtadzadini & Raie Niaki 46689; holotype: TUH!; isotype: MIR! • same location; 2.V.2019; Attar & Habibi 48901; paratype: TUH!.

DIAGNOSIS. — Differt ab *Onosma albo-rosea* Fisch. & C. A. Mey.: *Caules* usque 50 cm (nec 10-20 cm); *folia basalia* late elliptica, 20-45 × 7-17 mm (nec obovato-spathulato lanceolata, 20-60 × 6-12[-15] mm); *pedicellus* 2-4 mm longus (nec 1-3 mm longus); *corolla alba* (nec alba, rosea); *filament* ± 2.5 mm longa (nec 8-9 mm longa); *nuculae* 8 mm longae (nec 6-7 [-8] mm longae).

RECOGNITION. — *Onosma ligniclada* sp. nov. is related to *Onosma albo-rosea*, which belongs to the sect. *Onosma* subsect. *Asterotricha* (Riedl 1967; Khatamsaz 2002). *Onosma albo-rosea* is distributed in Iran, Turkey, Iraq and Syria. These two species have some morphological differences such as the height of the plant, the size and color of the corolla, and size of leaves of sterile shoots. Further differences are outlined in Table 2.

DISTRIBUTION, HABITAT AND PHENOLOGY. — *Onosma ligniclada* sp. nov. grows on the dry hillside steppes, at elevation of 1050 m. It is an endemic species of Iran. The species that are associated with this species in the area include: *Avena* sp., *Chardinia orientalis* (L.) Kuntze, *Echinops kermanshabensis* Mozaff., *Hirschfeldia incana* (L.) Lagrèze, *Oliveria decumbens* Vent., *Onopordum acanthium* L., *Zoegea* sp. Flowering in April to June, fruiting in May to July.



FIG. 3. — *Onosma ligniclada* Attar & Mirtadz., sp. nov.: **A**, stems and inflorescence; **B**, nutlet; **C**, **D**, upper and lower surface of leaves respectively. Scale bars: B, 2 mm; C, 0.5 mm; D, 0.2 mm.

TABLE 2. — Comparing the morphological characters between *Onosma ligniclada* Attar & Mirtadzadini, sp. nov. and its related *O. albo-rosea*.

Characters	<i>O. ligniclada</i> sp. nov.	<i>O. albo-rosea</i>
Height of plant	c. 50 cm	10-20 cm
Habit	Erect	Prostrate
Shape of basal leaves of flowering shoot	Broad elliptic	Obovate, spatulate-lanceolate
Pedicle length (mm)	2-4	1-3
Calyx length in flowering and fruiting (mm)	± 20, 30-32	14-16, 25
Corolla color	White, becoming blue	White, pink, becoming blue
Corolla length (mm)	26-29	18-30
Anther, filament length	c. 8, ± c. 3 mm	7, 8-9
Filament connection point	Middle of corolla	Below middle
Nutlet length and width (mm)	8	6-7(-8)
Nutlet shape and color	Trigonal, shortly apiculate, ±smooth, shining white	Smooth or indistinctly rugose

ETYMOLOGY. — The specific epithet is derived from the woody base of the plant, referring to the lignified structure present either at the base of the stem or at the lower parts of the branches.

CONSERVATION STATUS. — *Onosma ligniclada* sp. nov. is currently known from a single locality with a small population. Considering its very restricted area of occupancy (AOO), occurrence at one location, and an inferred continuing decline in habitat quality, we assess it as Endangered (EN) under criterion B2ab(iii) (IUCN 2012).

DESCRIPTION

Perennial, woody at base, up to 50 cm high. Stem branched, white or sometimes brownish with sterile shoots at the base, erect,

covered with white and ±patent setae. Leaves of sterile shoots broad ovate-elliptic, acute, 10-20 × 3-8 mm (including a c. 5 mm long petiole); basal leaves of flowering shoots ovate-elliptic, acute, 20-45 × 7-17 mm; middle and upper leaves similar to the lower ones, subsessile; indumentum consists of white tubercle-based adpressed dense setae on the upper surface and lax on the lower surface; tubercles stellate hairy, rays long and numerous, regular; midrib prominent, adpressed-setose on the abaxial leaf surface. Petiole 2-4 cm long. Cymes few-flowered, 5-8 cm long. Bracts linear-lanceolate, 20 × 3-4 mm. Pedicels 5 mm long in flower, to 7 mm long in fruit, with spreading setae. Calyx ±20 mm



FIG. 4. — Holotype specimen of *Onosma elymaitica* Attar & Mirtadz., sp. nov.

long in flower, 3-5 mm wide, accrescent, 30-32 mm long in fruit, 7-8 mm wide in the fruiting state; calyx lobes 5, divided to near the base, united for 5 mm, outside covered with sparse white patent setae, tubercles stellate hairy, pubescent between them, inside similar outside but fewer. Corolla cream at first, turning bluish towards upper, 26-29 mm long, campanulate-cylindrical; lobes triangular, obtuse, 2.5 mm wide and 2 mm long, pubescent outside, glabrous inside. Annulus 0.5 mm wide, glabrous, lobulate, crescent. Anthers sagittate, included, c. 8 mm long. Filaments c. 3 mm long, arising from approximately the middle of the corolla tube. Nutlets 8 × 7 mm, often solitary, cream, smooth, shiny, ovate-three-faced, with dorsal keel, with a middle vein on the adaxial surface, gradually beaked (Figs 2; 8).

Onosma elymaitica Attar & Mirtadz., sp. nov.
(Figs 4; 5)

TYPE MATERIAL. — Iran • W Ilam, c. 15 km to Badreh from Ilam; 844 m alt.; 33°36'58"N, 46°09'6.83"E; 15.V.2015; Attar & Zamani 46138; holotype: TUH!

DIAGNOSIS. — *Differt ab* *O. bilabiata* Boiss.: *folia basalia elliptico-orbicularia, excluso petiolo 15-20 × 13-18 mm (nec oblanceolato-obovata, petiolo excluso 25-100 × 7-25 mm); corolla ± 15 mm longa (nec 25-30 mm longa); corolla flava, in sicco coerulea (nec flavo-alba et in sicco coerulea); filament ± 2.5 mm longa (nec 2-3 mm longa); nuculae 7 mm longae, distincte rugosae (nec 6 mm longae, foveolato-punctatae).*



FIG. 5. — *Onosma elymaitica* Attar & Mirtadz., sp. nov.: **A, B**, stems and inflorescence; **C**, nutlet; **D, E**, upper and lower surface of leaf respectively. Scale bars: C, 2 mm; D, 0.5 mm; E, 0.2 mm.

RECOGNITION. — *Onosma elymaitica* sp. nov. is closely related to *O. bilabiata* which belongs to the sect. *Onosma* subsect. *Asterotricha* (Riedl 1967; Khatamsaz 2002). The new species is distinguished from *O. bilabiata* by the shape and size of basal leaves, size, and color of the corolla in a dry state and nutlet characters (Table 3).

DISTRIBUTION, ECOLOGY AND PHENOLOGY. — This species is collected from a hillside small area near Ilam. Vegetation is limited to annual grasses and scattered shrubs and bushes. Due to low elevation, summer is too warm and severe for perennial plants in this region. The following species are presented in their habitat: *Amygdalus haussknechtii* (C.K.Schneider.) Bornm. var. *pubescens* Bornm., *Anchusa strigosa* Labill., *Bromus tectorum* L., *B. danthoniae* Trin. in C.A.Mey. var. *danthoniae*, *Cerastium inflatum* Link ex Desf., *C. intricata* Boiss. subsp. *kermanshahensis* Wagenitz, *Cephalaria dichaeophora* Boiss., *Cousinia jaccobsii* Rech.f., *C. calocephala* Jaub. & Spach, *Daphne mucronata* Royle, *Ferulago angulata* Schlecht. & Boiss. subsp. *angulata*, *Heteranthelium piliferum* (Banks & Soland.) Hochst., *Onopordon carduchorum* Bornm. & Beauv., *Onosma albo-rosea* Fisch. & C.A.Mey. var. *albo-rosea*, *O. albo-rosea* Fisch. & C.A.Mey. var. *macrocarpa* Bornm., *Stachys benthamiana* Boiss., *Quercus brantii* Lindl., var. *persica* (Jaub. & Spach) Zohary, *Stipa* sp. Flowering April to May, fruiting May to June.

ETYMOLOGY. — The specific epithet refers to the type locality “Elyma or Elymais” the ancient name of today Ilam [and most parts of Khuzestan] province in the west of Iran.

CONSERVATION STATUS. — *Onosma elymaitica* sp. nov. is restricted to a very small area near Ilam and is known from a single, small population. Based on its limited AOO, occurrence at one location, and an inferred continuing decline in habitat quality, we assess it as Endangered (EN) under criterion B2ab(iii) (IUCN 2012).

DESCRIPTION

Perennial, woody at base, up to 25 cm high, with horizontal stolon, with several sterile rosettes at the base. Stem erect-ascending, covered with white appressed setae. Leaves of sterile shoots broad elliptic, shortly mucronate, blade 15–20 × 13–18 mm, petiole 6–15 cm long; basal leaves of flowering shoots elliptic-orbicular, acute, 15–18 mm long, 7–12 mm wide, shortly petiolate; middle and upper leaves obovate, remote, subsessile; indumentum yellowish-greyish; upper surface consists of indistinctly tubercle-based appressed very dense setae; lower surface covered by lax tubercled setae; tubercles stellate hairy, rays long and numerous; between setae shortly pubescent. Cymes scorpioid, many-flowered, 3.5–5 cm long in fruiting time. Bracts lanceolate, 10 × 4 mm. Pedicels setose, to 5 mm long in fruit. Calyx 10 × 3 mm, accrescent at fruiting time, 15–17 mm long, lobes broad lanceolate, divided to near the base, outside densely setose, tubercles



FIG. 6. — Holotype specimen of *Onosma farsistanica* Attar & Mirtadz., sp. nov.

with irregular stellate hairs, pubescent between them, inside similar to outside but sparse. Corolla cylindrical to indistinctly campanulate, *c.* 15 mm long, pubescent outside, at first deep yellow, becoming pink, red, and blue in the upper part or becoming blue; lobes triangular, acute, 2.5 mm wide, 0.5 mm long, glabrous inside. Annulus 0.5 mm wide,

glabrous, lobulated-crescent. Anthers included, 6 mm long. Filaments *c.* 2.5 mm long, arising from approximately the middle of the corolla. Nutlets 7 × 5 mm, ovate, three-faced, milky-white, irregularly deeply rugose, slightly dorsal keel, with a middle vein on the adaxial surface, shortly beaked (Figs 4; 5; 8).

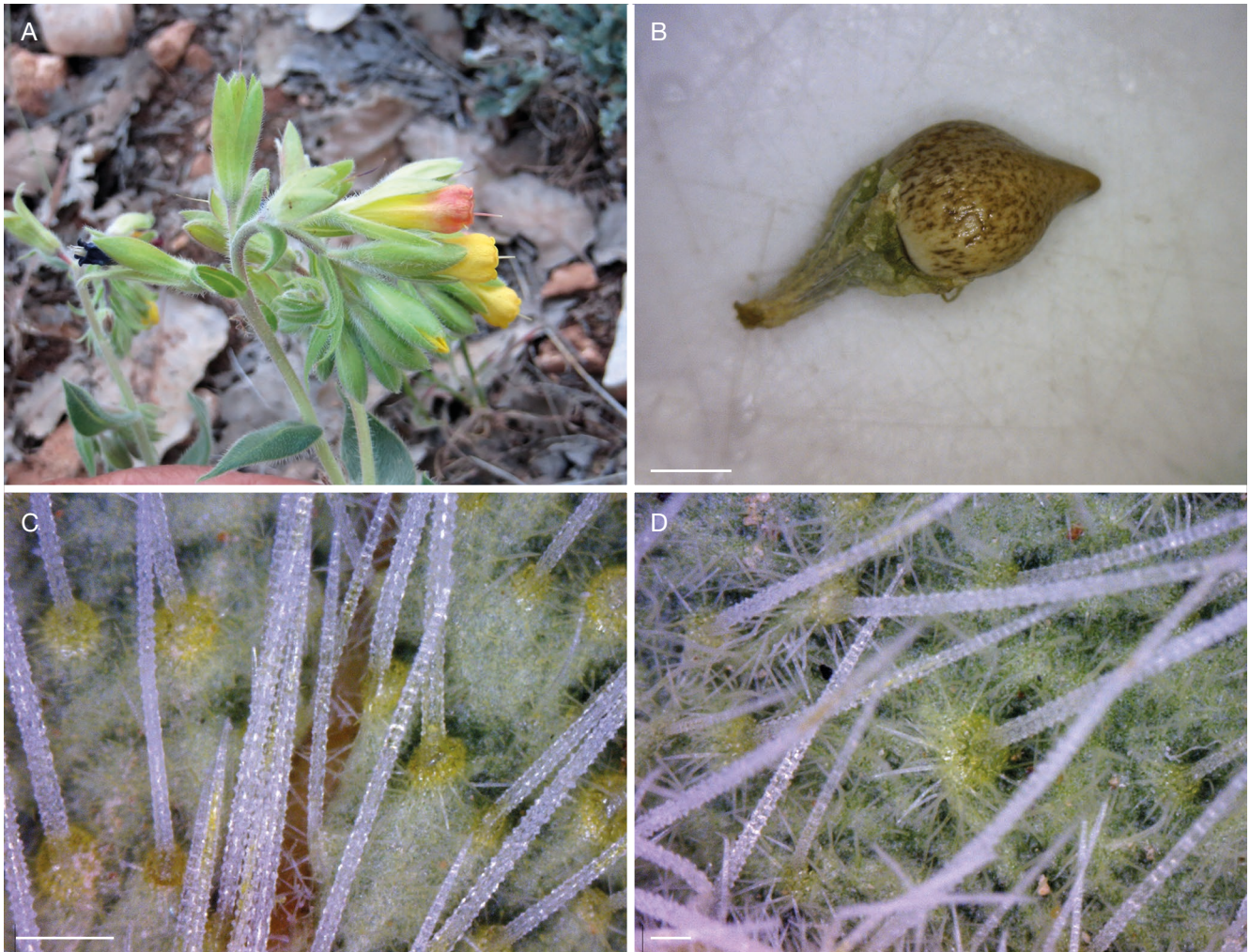


Fig. 7. — *Onosma farsistanica* Attar & Mirtadz., sp. nov.: **A**, cyme and flowers; **B**, nutlet; **C**, upper surface of the leaf; **D**, lower surface of the leaf. Scale bars: B, 2 mm; C, 0.5 mm; D, 0.2 mm.

Onosma farsistanica Attar & Mirtadz., sp. nov.
(Figs 6; 7)

TYPE MATERIAL. — Iran • SW, Fars province, between Shiraz and Kazerun, Dasht-e Arjan; 29°39'41.33"N, 51°58'59.36"E; 6.V.2016; Attar, Mirtadzadini & Raie Niaki 46769; holotype: MIR!; isotype: TUH! • Same locality; 28.IV.2011; Mirtadzadini 3124; paratype: MIR • Same locality, between Shiraz and Kazerun, Dasht-e Arjan; 27.VI.2006; Attar & Zamani 36296 (Attar collection); paratype: TUH.

DIAGNOSIS. — Differt ab *O. bilabiata* Boiss. & Buhse: folia basalia 20–40 × 5–10 mm (nec 30–11 × 7–25 mm); calyx 14–16 mm longus (nec 18–20 mm longus); corolla 20–22 mm longa (nec 25–30 mm longa) et flava vel flavo-rubra (nec pallide flava); antherae 8 mm longae (nec 9–10 mm); Nuculae 4 mm longae, 3 mm latae (nec 6 mm longae, nec 5 mm latae).

RECOGNITION. — *Onosma farsistanica* sp. nov. is related to *O. bilabiata* which is distributed in mountainous steppes of Azerbaijan in northwest of Iran. Despite that, the latter have variable characters throughout its distribution range, but their morphological differences are remarkable. The least distance between these two species is about 550 km. In addition to differences in the type of habitat and geographical distance, these two species have some important

and remarkable morphological differences including the size of the corolla, calyx and leaves (Table 3).

DISTRIBUTION, ECOLOGY AND PHENOLOGY. — *Onosma farsistanica* sp. nov. grows in the oak (*Quercus brantii* Lindl. var. *persica* (Jaub. & Spach) Zohary) woodland, at an elevation of about 2200 m in the southern Zagros mountain range. It is an endemic species to Iran. The species present in the type locality are as follow: *Astragalus* sp. sect. *Caprini*, *Pterocephalus plumosus* (L.) Coult., *Amygdalus lycioides* Spach, *A. scoparia* Spach, *A. eburnea* Spach, *Juniperus excelsa* M.B., *Quercus brantii* Lindl. var. *persica*, *Crataegus asarolus* L. subsp. *aronia* (L.) H.Riedl, *Cerasus microcarpa* (C.A.Mey.) Boiss. subsp. *diffusa* (Boiss. & Hausskn.) Browicz, *Pistacia atlantica* Desf. subsp. *atlantica*, *Paracaryum undulatum* Boiss. Flowering June–July, fruiting July–August.

ETYMOLOGY. — The epithet of “*farsistanica*” refers to type locality “Farsistan”, the old name of Fars province.

CONSERVATION STATUS. — *O. farsistanica* sp. nov. is endemic to the Dasht-e Arjan area (between Shiraz and Kazerun) and is known from few, small and scattered populations within a narrow range. Given its restricted AOO, ≤ a few locations, and an inferred continuing decline in habitat quality, we assess it as Endangered (EN) under criterion B2ab(iii) (IUCN 2012).

TABLE 3. — Comparison of the important morphological characters between the new species *Onosma farsistanica* Attar & Mirtadz., sp. nov. and *O. elymaitica* Attar & Mirtadz., sp. nov. and their related species *O. bilabiata* Boiss. & Buhse and *O. iranshahrii* Ghahr. & Attar.

Characters	<i>O. farsistanica</i> sp. nov.	<i>O. elymaitica</i> sp. nov.	<i>O. bilabiata</i> Boiss. & Buhse	<i>O. iranshahrii</i> Ghahr. & Attar
Habitat	Oak woodlands	Mountainous steppes	Mountainous steppes	Mountainous steppes
Basal leaves length × width (mm)	20-40 × 5-10	up to 25 cm	30-110 × 7-25	50-70 × 20-25
Leaf indumentums	Tubercles stellate hairy, with spreading to spreading-appressed hairs	Tubercles stellate hairy, rays long and numerous; between setae shortly pubescent	Tubercles small, irregular hairy, with short spreading hairs	Tubercles large, dense regularly hairy (stellate)
Length of bract (mm)	± 16	10	10-12 (-15)	up to 10
Pedicel length (mm)	1-2	to 5	2-3	5-9
Calyx length in flower and fruit (mm)	14-16, up to 17	10, 15-17	18-20, 25-27	18-20, up to 30
Corolla color	Yellow or yellow and red, blue in the dry state	Yellow, becoming pink or red, then blue	Whitish-yellow, blue in the dry state	Yellow, red, blue in dry state
Corolla length (mm) and shape	20-22, cylindrical, inflated in the upper part	± 15, cylindrical-campanulate	25-30, tubular, broader toward the apex	20, campanulate
Corolla outside	Pubescent	Pubescent	Pubescent	Pubescent
Corolla lobes wide × long (mm)	3.5 × 2-2.5, nearly rounded, apiculate	Triangular, acute	2 × 2, broad triangular, acuminate, often recurved	Triangular, 3-5 × 2
Anther, filament	c. 8 mm, 3 mm	c. 6, c. 2.5 mm	9-10 mm, 2-3 mm	8-8.5, 2-3
Filament connection point	Below of middle	Middle	Above of middle	Middle
Nutlet length and width (mm)	c. 4 × 3	c. 7 × 5	c. 6 × 5	c. 8 × 4.5
Nutlet shape and color	Trigonal-convex, shortly beaked, shiny brownish-white, irregularly brown dotted.	Ovate-trigonal, deeply rugose, ventral surface grooved, shortly apiculate, white	Keeled, indistinctly foveolate-punctate, shining.	Trigonal-ovate, smooth-reticulate, white, shining

DESCRIPTION

Caespitose perennial with lignified sub-horizontal thick rootstocks, with few stems, branched from the base, up to 18 cm long, with sterile shoots at the base, usually ascending, covered with white appressed setae, setae arising from stellate-hairy tubercles, between setae covered with spreading to spreading-appressed short hairs. Basal leaves 20-40 × 5-10 mm, spatulate, acute, attenuate towards base into 10-15 mm long petiole; middle leaves sessile, elliptic, 20-40 × 7-15 mm; upper leaves similar to the middle ones but smaller. Cymes terminal, many-flowered, scorpioid-capitate, c. 3 cm long, up to 4.5 cm in fruiting stage. Bracts narrowly lanceolate, 16 mm long, 1.5 mm wide. Pedicels 1-2 mm long with spreading setae. Calyx 14-16 mm long, up to 17 mm in fruiting state, covered with white dense appressed-spreading setae outside and with short hairs inside, tubercles indistinct; lobes linear or linear-lanceolate, c. 4 mm wide, sometimes, two lobes are coherent up to near the apex, with only the terminal 1 mm remaining free, acute. Corolla 20-21 mm long, cylindrical-campanulate, yellow or yellow and red, in dry state blue, pubescent outside, glabrous inside, lobes triangular, acute, 3 mm wide and 1.5 mm long. Annulus glabrous, lobulate. Anthers sagittate, included, 8 mm long, connate at base. Filaments c. 3 mm long, arising from below the middle of the corolla. Nutlets 4 × 3 mm, often solitary, ovate, yellowish-milky, shiny, irregularly brown-dotted, gradually and shortly beaked (Figs 6; 7; 9).

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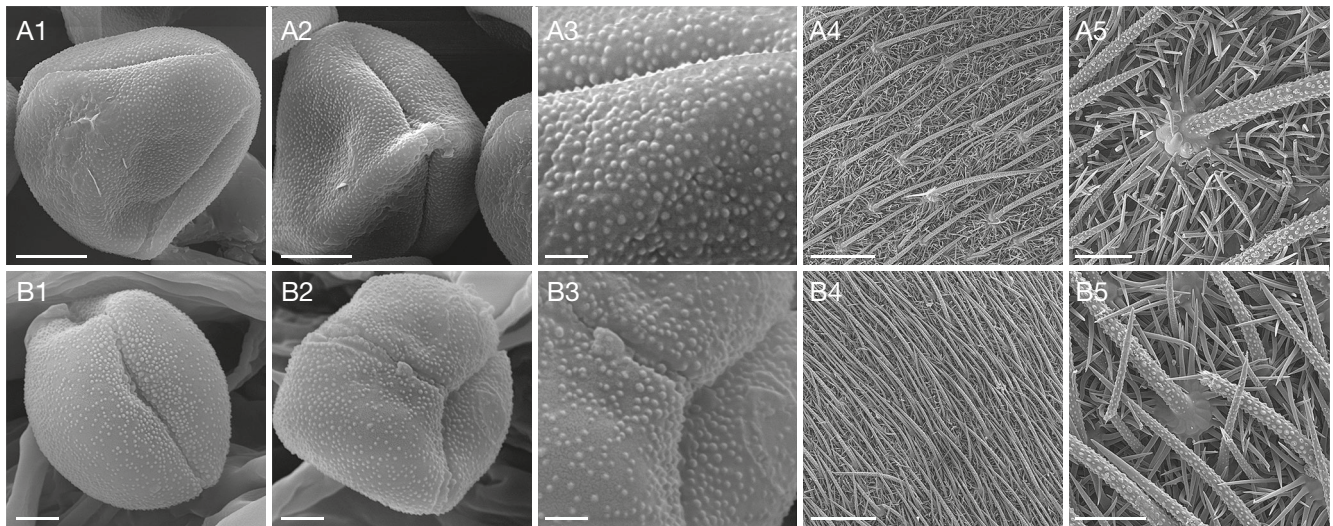


FIG. 8. — Pollen grains and indumentum type of *Onosma ligniclada* Attar & Mirtadz., sp. nov. (A) and *O. elymaitica* Attar & Mirtadz., sp. nov. (B): A1, subprolate, equatorial view; A2, polar view; A3, scabrous exine; A4, dorsal surface with appressed spreading setae; A5, setae with cellular tubercles mixed with short hairs; main setae scabrous with indistinct rays; B1, subprolate, equatorial view; B2, polar view; B3, scabrous exine; B4, dorsal surface with appressed setae; B5, setae with indistinct cellular tubercles mixed with short hairs; main setae scabrous with smooth rays. Scale bars: A1, A2, 5 μ m; A3, B3, 1 μ m; A4, B4, 1 mm; A5, B5, 200 μ m; B1, B2, 2 μ m.

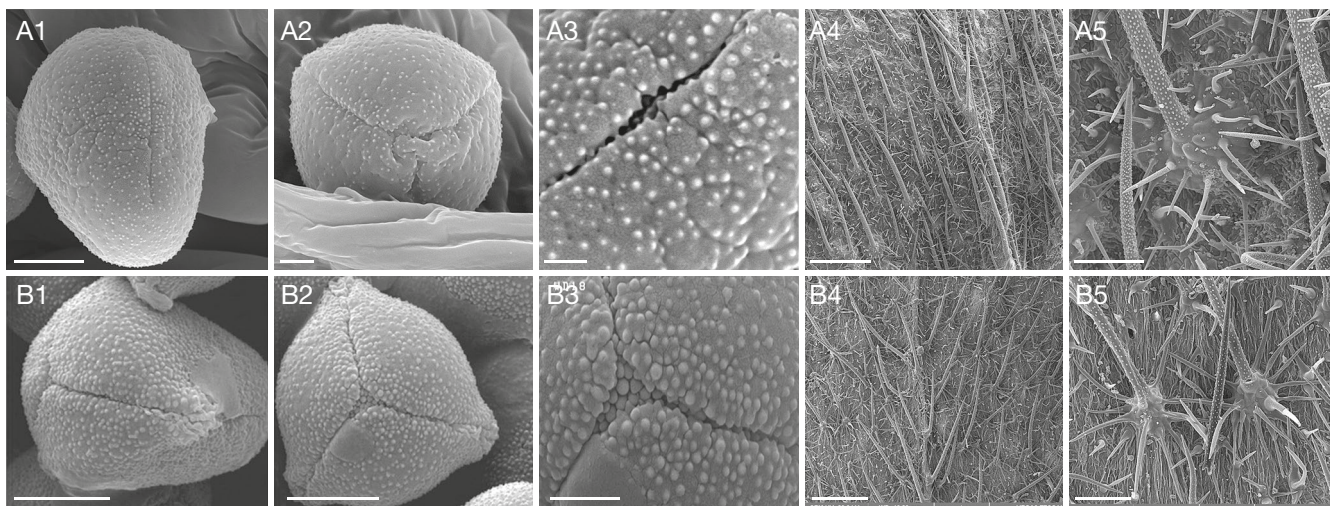


FIG. 9. — Pollen grains and indumentum type of *Onosma farsistanica* Attar & Mirtadz., sp. nov. (A) and *O. bilabiata* Boiss. (B): A1, subprolate, equatorial view; A2, polar view; A3, sparsely scabrous exine; A4, dorsal surface with spreading setae; A5, setae with cellular tubercles mixed with short hairs; main setae scabrous with scabrous rays; B1, subprolate, equatorial view; B2, polar view; B3, densely scabrous exine; B4, dorsal surface with appressed setae; B5, setae with indistinct cellular tubercles mixed with short hairs, main setae scabrous with scabrous rays. Scale bars: A1, B1, B2, 5 μ m; A2, B3, 2 μ m; A3, 1 μ m; A4, B4, 1 mm; A5, B5, 200 μ m.

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