

ONOSMA SAFAIE-FARI (BORAGINACEAE), A NEW SPECIES FROM WESTERN IRAN

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Onosma safaie-fari (of *O.* subsect. *Asterotricha*) is described as a new species from western Iran. *Onosma safaie-fari* is morphologically similar to *O. iranshahrii*, but it is distinct in terms of the shape of sterile shoots and cauline leaves; length of fruiting calyx, shape, and width of calyx lobes; and color of the corolla. In addition, *O. safaie-fari* is similar to *O. bisotunensis*, but it is distinguished by the shape and length of lower bracts; length of the fruiting calyx; color and length of the corolla; length of the free part of filaments; the position of filaments arising from the corolla, and length of anthers. *Onosma safaie-fari* is close to *O. shehbazii*, but it can be distinguished from it based on the shape and length of sterile shoots and cauline leaves, length of lower bracts, length of fruiting calyx, color and length of the corolla, length of anthers, and the presence of a hairy nectary ring. Detailed descriptions, diagnostic characters, original photographs, illustrations, a geographical distribution map, habitat information, an image of the holotype specimen, and an identification key are presented.

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Onosma safaie-fari از خانواده گل گاوزبان (Boraginaceae)، یک گونه جدید از غرب ایران

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گونه‌ی جدید *Onosma safaie-fari* از زیربخش *Asterotricha* از غرب ایران شرح داده می‌شود. این گونه از لحاظ صفات ریخت‌شناسی به گونه *O. iranshahrii* شبیه است، اما با آن در شکل برگ‌های قاعده‌ای و ساقه‌ای، اندازه کاسبرگ در زمان میوه، شکل و پهنای دندان‌های کاسه و رنگ جام گل متفاوت است. علاوه بر این، *O. safaie-fari* با *O. bisotunensis* دارای شباهت ظاهری است. اما با آن در شکل و اندازه برگ‌ها، های پایینی، اندازه کاسبرگ در زمان میوه، رنگ و طول جام، طول بخش آزاد میله پرچم، موقعیت قرارگیری میله پرچم در جام و طول بساک‌ها متمایز است. همچنین، *O. safaie-fari* دارای قرابت نزدیک با *O. shehbazii* است، اما با آن در شکل و اندازه برگ‌های قاعده‌ای و ساقه‌ای،

اندازه برگ‌های پایینی، اندازه کاسبرگ در زمان میوه، رنگ و طول جام، طول بساک‌ها و حلقه نوشجای کرک‌دار متفاوت است. در این مطالعه شرح کامل، صفات تشخیصی، تصاویر دقیق، نقشه پراکنش جغرافیایی، رویشگاه، عکس نمونه تیپ و کلید شناسایی ارائه می‌شود.

INTRODUCTION

Onosma L., which belongs to the Boraginaceae family, is a highly diverse genus and is typically found in the Irano-Turanian phytogeographical region. Recent studies have identified over 250 species within this genus (He & al. 2020; Attar & al. 2020, 2021, 2023; Mehrabian & al. 2022a, 2022b). *Onosma* species are primarily distributed in Northwest Africa, Western and Central Asia, Europe, and the Mediterranean regions, often inhabiting steppe and open areas with rocky or sandy soils. Turkey and Iran are particularly important centers of diversity for *Onosma*, with 104 and 72 taxa respectively (Teppner 1991; Binzet 2012; Advay & al. 2022, 2023; Attar & al. 2020, Firat and Binzet 2021). Early taxonomic studies on *Onosma* categorized the genus into two sections: *Eu Onosma* DC. and *Aponosma*. DC. based on characteristics such as calyx lobes, corolla, and indumentum of tubercles (De Candolle 1846). Subsequent studies focused on indumentum features as the primary diagnostic characteristic for distinguishing *Onosma* species (Schur 1866; Borbás 1877). Boissier (1879) further classified *Onosma* based on trichome types, dividing the genus into three groups: *Haplotricha* Boiss. (setae tubercle glabrous), *Heterotricha* Boiss. (possessing an intermediate indumentum type), and *Asterotricha* Boiss. (setae tubercles with stellate rays). Riedl (1967) defined three sections for *Onosma* in Flora Iranica: *Protonosma* Popov (including *O. rostellata* Lehm.), *Podonosma* (Boiss.) Gurke (including *O. orientalis* L.), and *Onosma* with two subsections: *Onosma* (comprising 50 taxa) and *Asterotricha* (Boiss.) Gurke (comprising 14 taxa). Later *Onosma orientalis* was changed to *Podonosma orientalis* (L.) Feinbrun, (Feinbrun 1976). Iran, particularly the Alborz and Zagros Mountain ranges, as well as the central plateau mountains, exhibit a high diversity of *Onosma* species (Attar & al. 2020). According to Flora Iranica (59 species) and the Flora of Iran (37 species) of *Onosma* respectively, belonging to different sections and subsections (Riedl 1967; Khatamsaz 2002) occur in Iran.

Based on recent studies, sect. *Onosma* has 72 species belonging to three subsections., *Asterotricha* (with 27 species), *Heterotricha* (with 8 species), and *Haplotricha* (with 37 species) in Iran (Attar &

Joharchi 2007; Attar & Hamzeh'ee 2007; Mehrabian & al. 2014; Ranjbar & Almasi 2014; Naqinezhad & Attar 2016; Attar & al. 2020, 2021; Mehrabian & al. 2022a, 2022b; Advay & al. 2022, 2023). The western parts of Iran are particularly important for this genus as they contain many endemic species of *Onosma* (Naghizadeh & al. 2017; Moradi Zeinab & al. 2020). The Hawraman region is situated between Kurdistan and Kermanshah provinces and has a narrow geographic range. It is also one of the species-rich regions of *Onosma* in Iran, comprising approximately 28% of all reported *Onosma* species in the country (Advay & al. 2023).

MATERIALS AND METHODS

The first author collected specimens of *O. safaiefari*. during extensive fieldwork from 2020 to 2022 in Hawraman Mountain, Kurdistan province (North Zagros, Iran), (Fig. 1). The specimens of *O. safaiefari*. were collected during extensive fieldwork from 2020 to 2022 in Hawraman Mountain, Kurdistan province (North Zagros, Iran) by the first author. The specimens were compared with diagnostic keys of various floras such as (Parsa 1949; Popov 1953; Riedl 1967, 1979; Khatamsaz 2002) and recent new species in the *Onosma* subsect. *Asterotricha* (Ghahreman & Attar 1996; Mehrabian & al. 2013, 2022a, 2022b; Mehrabian & Mozaffarian 2018; Attar & al. 2007, 2020, 2021; Advay & al., 2022, 2023). The images of the type specimens from various virtual herbaria (BM, K, MPU, P, W) were examined and compared with the new specimens. Furthermore, these specimens were compared with the related taxa in TUH, TARI, HKS, and IRAN (acronyms as in Holmgren & al. 1981). The quantitative and qualitative morphological key characters of the species were measured (Table 1). The indumentum and nutlet were profiled and photographed using a Dino-Lite digital microscope AM413T, while the upper and lower surface of the dried basal leaves as well as pollen grains directly were mounted on stubs using double-sided adhesive tape and coated with gold using a desktop DC Magnetron sputter coater. The samples were then photographed with a Scanning Electron Microscope (Cam Scan TESCAN VEGA3). The holotype has been deposited and preserved in the TUH Herbarium.



Fig. 1. Distribution map of *Onosma safaie-fari* ■, *O. iranshahrii* ▲, *O. shehbazii* ● and *O. bisotunensis* ■

RESULTS & DISCUSSION

Onosma safaie-fari Advay, Attar & Ahmad *sp. nov.*, (Figs. 2 A-C, 3 A-I, 4 A-I, 5, 6 A-E & 7).

Sect. *Onosma*, subsect. *Asterotricha*

Type: Iran, Kurdistan province, Marivan to Paveh, Avroman (spelled Hawraman) Mountains (Tata passive), 2120 m a.s.l., 35°12'13" N, 46°16'35" E, 30 June 2020, Advay 48718 (holotype TUH!).

Diagnose

Onosma safaie-fari has some similarities with *O. iranshahrii* Ghahreman & Attar, but it can be distinguished by its elliptical-lanceolate sterile shoots and cauline leaves (vs. to ovate, obovate, or spatulate leaves); setae with sub densely short and irregular hairs (vs. setae with densely long and regular); corolla 15-18 mm long, yellow, occasionally pinkish at the apex, and rarely changing blue-whitish (vs. 10-20 mm, yellow, reddish, or pinkish changing bluish-brownish); anthers 7-8 mm long (vs. 8-8.5 mm),

(Table 1). Additionally, *O. safaie-fari* shares some similarities with *O. bisotunensis* Attar & Hamzeh'ee, but it can be distinguished by its elliptical-lanceolate sterile shoots and cauline leaves (vs. ovate-spathulate leaves); fruiting calyx 15-17 mm long (vs. 12-13 mm), corolla occasionally pinkish at the apex, and rarely changing blue-whitish, (vs. 18-19 mm, yellow changing to dark blue); free part of the filaments 1-2 mm long (vs. 2-3 mm). Also, *O. safaie-fari* is closely related to *O. shehbazii* Advay, Attar & Ahmad; but it can be distinguished by its elliptical-lanceolate sterile shoots and cauline leaves (vs. ovate-lanceolate, lanceolate, ovate-oblongate); fruiting calyx 15-17 mm long (vs. 10-12 mm); corolla 15-18 mm long, yellow occasionally pinkish at the apex, and rarely changing blue-whitish (vs. 10-12 mm, yellow not changing to blue); hairy nectary ring (vs. glabrous), (Table1).



Fig. 2. *Onosma safaie-fari*. A, plant habitat; B, cauline leaves; C, part of inflorescence, (Photos by: Advay).

Perennial, woody at base, with several stems, 30-35 cm tall. Stem erect, greenish to yellowish, and covered with appressed setae, densely pubescent. Basal and lowermost leaves broadly elliptic or elliptic-lanceolate, acute $3-6 \times 2-3$ cm; middle and upper cauline leaves sessile, lanceolate or elliptic-ob lanceolate $2.5-5 \times 0.5-2$ cm. Indumentum consists of dense appressed setae with small stellate-hairy tubercles; rays numerous short to long, irregular, with short dense hairs between the setae. Inflorescence

scorpioid 4-6 cm long, elongating to 8-10 cm in the fruiting stage, cymes dense with 8-12 flowers, sometimes with sterile flowers at the terminal cymes. Lower bracts linear 7-8 mm long; pedicels 3-7 mm long. Flowering calyx 10-12 mm long and elongating to 15-17 mm in the fruiting stage. Calyx lobes lanceolate, spreading with densely setaceous outside, especially at the base, with two lobes united near the apex. Corolla 15-18 mm long, cylindric-campanulate, yellow, occasionally pinkish and changing to whitish

or blue at the apex, pubescent outside in upper half, but glabrous inside; corolla lobes rounded, 1.5-3 mm long and 1-2 mm wide, with a few short setae at the apex. Free part of the filaments 1-2 mm long and arising from near the base of the corolla; anthers 7 mm long and with a bifid sterile apex. Nectary ring hairy (Figs. 2, 3, 5, 6). Nutlets ovoid, 1-2.6 × 3-3.7 mm, ventral surface keeled, rostrate, grayish. Pollen heteropolar, tricolporate, prolate, polar axis 14.2-14.8 μm , mean: 14 μm ; equatorial axis 12-12.3 μm , mean: 12.15 μm ; exine granulate: 0.17-0.20 μm thick (Fig. 4).

Ecology and phenology

O. safaie-fari is distributed in western Iran on the

border mountains between Iran and Iraq (Fig. 1). It belongs to the Irano-Turanian phytogeographical region, and grows in mountainous steppe habitats. The species is typically found in areas where snow is melting, at altitudes ranging from 2000-2500 m a.s. l., in association with *Achillea aleppica* DC., *Astragalus brachycalyx* Fisch. ex Boiss., *Cerasus microcarpa* (C.A.Mey.) Boiss., *Daphne mucronata* Royle., *Elymus hispidus* (Opiz) Melderis subsp. *barbulatus* (Schur) Melderis, *Eryngium billardieri* F. Delaroché., *Marrubium* spp., *Prangos ferulacea* (L.) Lindl., *Scorzonera* spp. *Onosma safaie-fari* is known to occur in only a few localities. The flowering and fruiting time for this plant has been recorded as June.



Fig. 3. *Onosma safaie-fari*. A, inside of corolla; B, nectary ring hairy; C, calyx lobes; D, nutlet; E & F, indumentum of upper leaf surface showing appressed setae with irregular stellate-hairy tubercles, (Photos by: Advay).

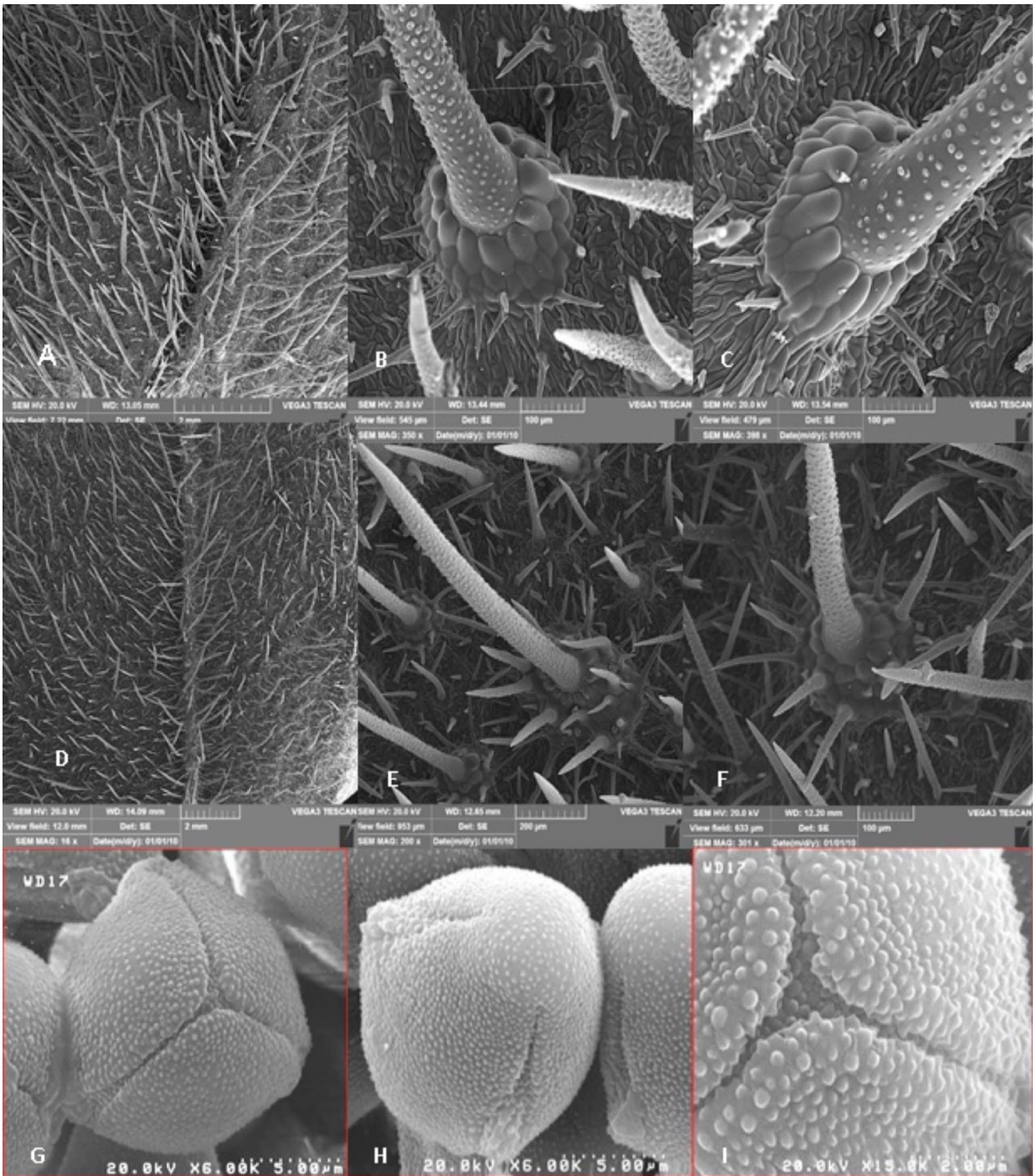


Fig.4. Scanning electron micrographs of *Onosma safaie-fari*: A-C, indumentum of basal leaves in the upper surface; D-F, indumentum of basal leaves in the lower surfaces; G-I, pollen in polar and equatorial views.

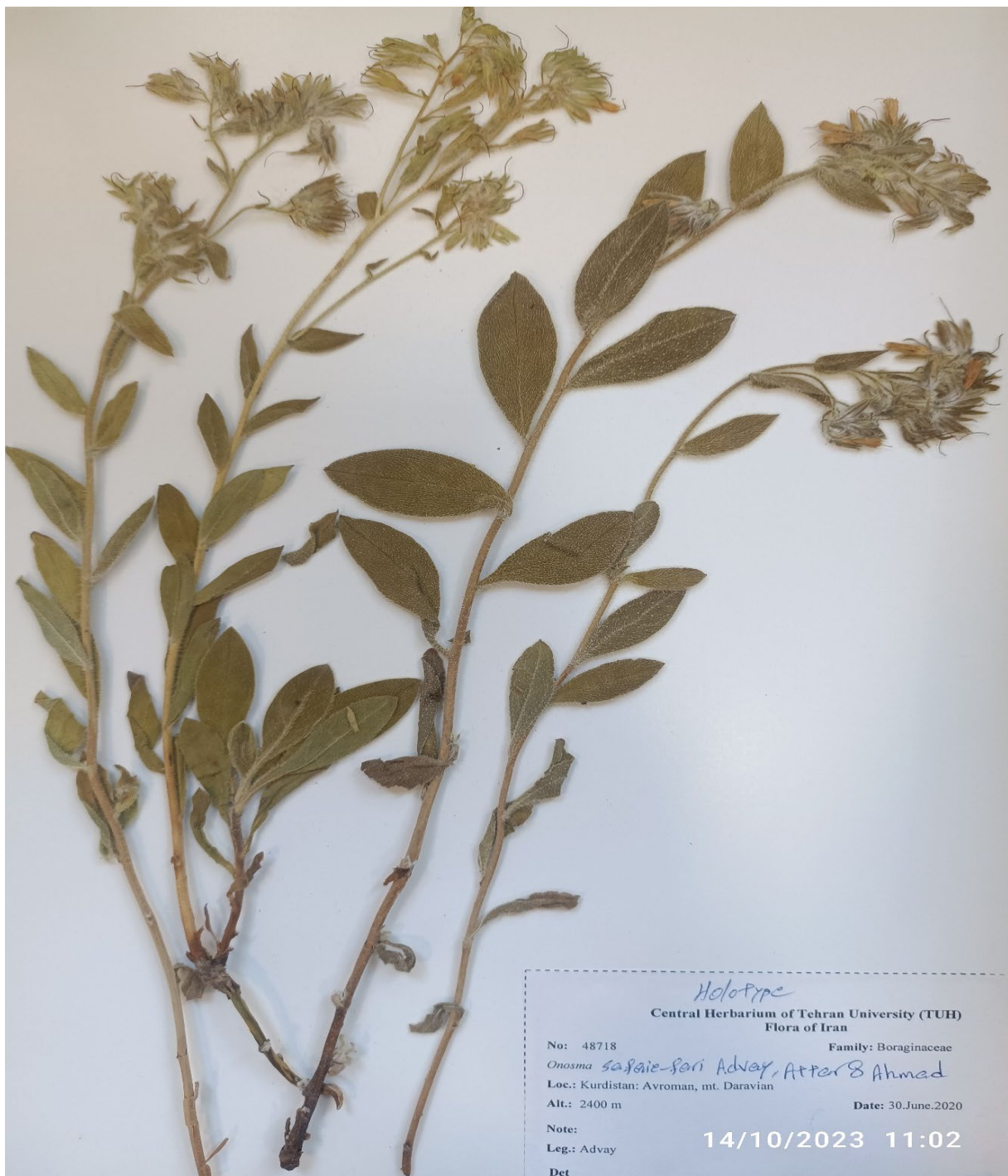


Fig. 5. Holotype specimen of *Onosma safaie-fari* Advay, Attar & Ahmad.

Table 1. Comparison of diagnostic morphological characters of *Onosma safaie-fari* and its related species.

Species Characters	<i>O. safaie-fari</i>	<i>O. iranshahrii</i>	<i>O. bisotunensis</i>	<i>O. shehbazii</i>
Sterile shoot, leaves shape and length (cm)	elliptic-lanceolate, 3-6	ovate or obovate or spatulate, 5-7	ovate or spatulate, 2-4	ovate-lanceolate 3-4
Stem leaves shape and size (cm)	elliptic-ob lanceolate 2.5-5 × 0.5-2	spatulate or lanceolate, 2.5-5×1-2	ovate, 2-3 × 0.8-1.3	lanceolate, ovate-ob lanceolate 2-3.5 × 1-1.2
Rays of tubercles (stellate hairs)	dense or sparsely hairy, short, irregular	dense long hairy, regular	densely long hairy, irregular	sparsely or sub-densely, long hairy, irregular
Inflorescence shape and length (cm)	scorpioid, 4-6, elongating to 8-10	Scorpioid, 4-8	densely congested, sub capitate, 2-4	short capitate-subscorpioid 4-6
Lower bracts length (mm) & shape	7-8, linear	up to 10, lanceolate	10-18 × 1.5-6 mm lanceolate	5-6, linear
Pedice l length (mm)	3-7	2-3 (-9)	2-3	3-5
Fruiting calyx length (mm)	15-17	18-20 (-30)	12-13	10-12
Calyx lobes width (mm) and connection	1-2, two lobes united near apex	3-5 to 8, two or three lobes united near the apex	ca. 2, two or three lobes united near the apex	1-2, lanceolate, two lobes united at the middle of calyx
Corolla length (mm) and color	15-18, yellow, rarely pinkish at apex, changing to whitish or blue	10-20, yellow, reddish-brownish, changing to dark blue, brownish	ca. 19, yellow, sometimes changing to dark blue	10-12, yellow, not changing to blue
Free part of filaments length (mm)	1-2	2-3	6-7	1-2
Anthers length (mm)	7-8	8-8.5	8-8.5	5-6 mm
Nectary ring	hairy	hairy	hairy	glabrous

Distribution and suggested conservation status

Onosma safaie-fari is known from a restricted area in Avroman (Hawraman), Kurdistan province, with an estimated area of occupancy (AOO) of less than 50 km². Its Endangered status (EN) has been proposed following the IUCN

Diagnostic key to the new species and its relatives

1. Nectary ring hairy 2
- Nectary ring glabrous *O. shehbazii*
2. Fruiting calyx length more than 18 mm, corolla yellow, reddish, finally dark blue *O. iranshahrii*
- Fruiting calyx length less than 18 mm long, corolla yellow 3
- 3- Fruiting calyx 12-13 mm long, free part of filament length 7 mm *O. bisotunensis*
- Fruiting calyx 15-17 mm long, free part of filament broader toward the base, 1-2 mm long.....
..... *O. safaie-fari*

Additional specimens examined for the new species and its closest species

Onosma safaie-fari Iran: Kurdistan: Marivan to Paveh, Avroman (Hawraman), Takhte Sani Mountain,

2800 m, 23 June 2020, Advay 48739 TUH. Daravian Mountain, 2200 m, 30 June 2020, Advay 48718 TUH. Golli Mountain, 2070 m, 15 June 2022, Advay 48774 TUH. *Onosma bisotunensis* Attar & Hamzeh'ee, Iran: Kermanshah: Kermanshah-Kamyaran rd., Vermanjeh, 1500-1700 m, 15 Apr. 2001, Behnam Hamzeh'ee & Unes Asri 80844 (holotype, TARI!). *Onosma shehbazii* Advay, Attar & Ahmad, Iran, Kurdistan province, Marivan to Paveh, Avroman (Hawraman) Mountain (TaTa Pass), 2800 m, 35°13'32" N, 46°14'05" E, 30 June 2021, Advay, 48721 (holotype, TUH). *Onosma iranshahrii* Gahreman & Attar, Iran: Kurdistan: Marivan to Paveh, Gardan-e Tat between Dezli and Hanegarme le 1800-2600 m, 9/7/1995, Ghareman & Mozaffarian 18334 (holotype TUH).

Etymology

This new species has been named after Mohammad Reza Safaie-fari in recognition of his conservation activities in the Hawraman region of Kurdistan province, Iran.

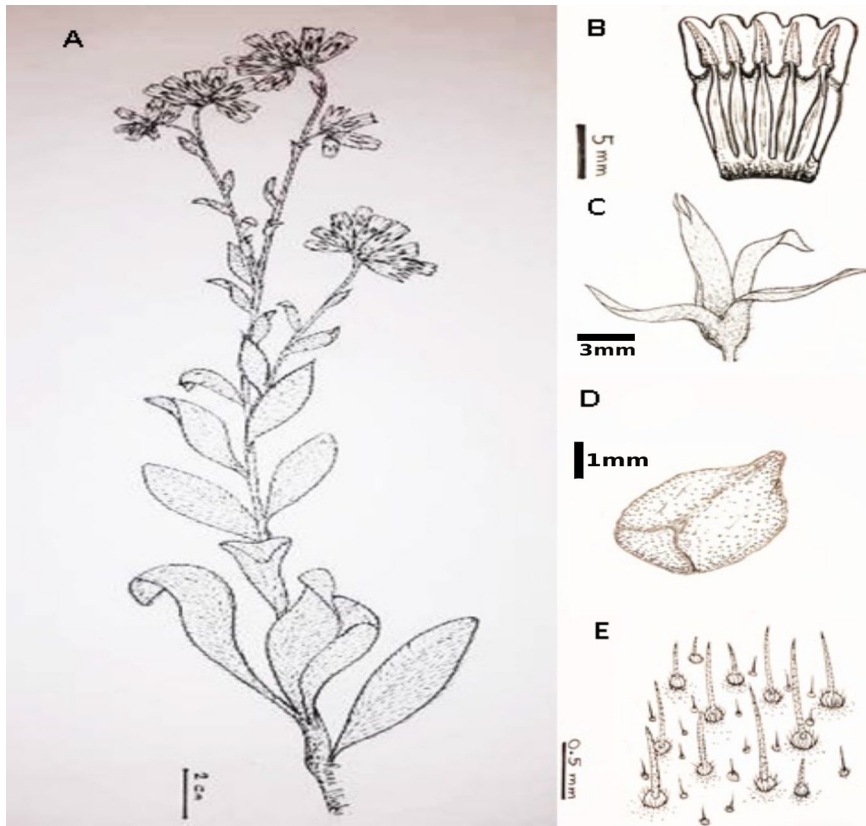


Fig. 6. *Onosma safaie-fari*. A, habit; B, opened corolla showing stamens; C, fruiting calyx; D, nutlet in adaxial view; E, hairs from the upper surface of a basal leaf.



Fig.7. Habitat of *Onosma safaie-fari*, Hawraman Mountains, (Photos by: B. Sharifi).

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