ONOSMA SAFAEI-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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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 Northwestern Africa, Western and Central Asia, Europe, and the Mediterranean regions, often inhabiting steep 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 DC. and Podonosma DC. based on 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 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. safai-fari, during extensive fieldwork from 2020 to 2022 in Hawraman Mountain, Kurdistan province (North Zagros, Iran), (Fig. 1). The specimens of O. safai-fari 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.
RESULTS & DISCUSSION

Onosma safae-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 safae-fari has some similarities with O. iranshahrii Ghahreman & Attar, but it can be distinguished by its elliptical-lanceolate sterile shoots and cauline leaves (vs. ovate, obovate, or spathulate 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. safae-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. safae-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-ob lanceolate); 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), (Table I).
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 × 2-3 cm; middle and upper cauline leaves sessile, lanceolate or elliptic-oblanceolate 2.5-5 × 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 scorioid 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 phytogeographic 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* Royce., *Elymus hispidus* (Opiz) Melderis subsp. *barbulatus* (Schur) Melderis, *Eryngium billardieri* F. Delaroche., *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.
A new species of Onosma from Iran

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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
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), Takhté 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: Kurdeštan: Marivan to Pave, Gardan -e Tat between Dezli and Haneğarmle 1800-2600 m, 9/7/1995, Gahreman & 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.

<table>
<thead>
<tr>
<th>Species Characters</th>
<th>O. safaie-fari</th>
<th>O. iranshahrii</th>
<th>O. bisotunensis</th>
<th>O. shehbazii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterile shoot, leaves shape and length (cm)</td>
<td>elliptic-lanceolate, 3-6</td>
<td>ovate or obovate or spatulate, 5-7</td>
<td>ovate or spatulate, 2-4</td>
<td>ovate-lanceolate 3-4</td>
</tr>
<tr>
<td>Stem leaves shape and size (cm)</td>
<td>elliptic-oblancoate</td>
<td>spatulate or lanceolate, 5-7</td>
<td>ovate, 2-3 × 0.8-1.3</td>
<td>lanceolate, ovate-oblancoate 2-3.5 × 1-1.2</td>
</tr>
<tr>
<td>Rays of tubercles (stellate hairs)</td>
<td>dense or sparsely hairy, short, irregular</td>
<td>densely long hairy, regular</td>
<td>densely long hairy, sparsely or sub-densely long hairy, irregular</td>
<td>densely long hairy, sparsely or sub-densely long hairy, irregular</td>
</tr>
<tr>
<td>Inflorescence shape and length (cm)</td>
<td>Scoploïd, 4-6, elongating to 8-10</td>
<td>Scoploïd, 4-8</td>
<td>Scoploïd, 4-8</td>
<td>Scoploïd, 4-8</td>
</tr>
<tr>
<td>Lower bracts length (mm) &amp; shape</td>
<td>up to 10, lanceolate</td>
<td>up to 10, lanceolate</td>
<td>up to 10, lanceolate</td>
<td>up to 10, lanceolate</td>
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<tr>
<td>Pedicel length (mm)</td>
<td>3-7</td>
<td>2-3 (-9)</td>
<td>2-3-3- (-9)</td>
<td>2-3-3- (-9)</td>
</tr>
<tr>
<td>Fruiting calyx length (mm)</td>
<td>15-17</td>
<td>18-20 (-30)</td>
<td>12-13</td>
<td>12-13</td>
</tr>
<tr>
<td>Calyx lobes width (mm) and connection</td>
<td>1-2, two lobes united near apex</td>
<td>3-5 to 8, two or three lobes united near the apex</td>
<td>ca. 2, two or three lobes united near the apex</td>
<td>ca. 2, two or three lobes united near the apex</td>
</tr>
<tr>
<td>Corolla length (mm) and color</td>
<td>15-18, yellow, rarely pinkish at apex, changing to whitish or blue</td>
<td>10-20, yellow, reddish-brownish, changing to dark blue, brownish</td>
<td>ca. 19, yellow, sometimes changing to dark blue</td>
<td>ca. 19, yellow, sometimes changing to dark blue</td>
</tr>
<tr>
<td>Free part of filaments length (mm)</td>
<td>1-2</td>
<td>2-3</td>
<td>6-7</td>
<td>1-2</td>
</tr>
<tr>
<td>Anthers length (mm)</td>
<td>7-8</td>
<td>8-8.5</td>
<td>8-8.5</td>
<td>5-6 mm</td>
</tr>
<tr>
<td>Nectary ring</td>
<td>hairy</td>
<td>hairy</td>
<td>hairy</td>
<td>glabrous</td>
</tr>
</tbody>
</table>

Table 1. Comparison of diagnostic morphological characters of Onosma safaie-fari and its related species.
Fig. 6. *Onosma safiae-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 safiae-fari*, Hawraman Mountains, (Photos by: B. Sharifi).
REFERENCES


Mehrabian. A. R. & Mozaffarian. V. 2018: Seven new Species of *Onosma* L. (Boraginaceae) with emphasis on their habitats in Iran. -Taiwania 4: 366-388.


