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TAXONOMIC NOTES ON *ONOSMA* SECT. *APONOSMA* FROM IRAN (BORAGINACEAE)

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Onosma mahabadensis Ranjbar & Almasi (Boraginaceae), a new species endemic to Iran, is described. This species belongs to *Onosma* sect. *Aponosma* DC. and is confined to the western part of Iran (West Azerbaijan Province). It is closely related to *Onosma sericea* Willd. and is distinguished by its subpatent-bristly indumentum (vs. appressed-sericeous) with sparse short hairs (vs. dense), and bracts 14–16 mm long (vs. 6–8 mm long). A cytogenetic analysis indicates that *Onosma mahabadensis* is a tetraploid species, $2n = 4x = 32$, consistent with the proposed base number of $x = 8$ for *Onosma* sect. *Aponosma*.

Keywords. Boraginaceae, meiotic behaviour, new species, *Onosma*, tetraploid.

Introduction

Onosma L. is a species-rich genus of Boraginaceae, tribe Lithospermeae Dumort., comprising about 150 species, although new species are still being discovered. The genus is widespread from Spain and Morocco to China, with areas of high diversity in Turkey (Anatolia), Iran and Central Asia (Riedl, 1967, 1979; Teppner, 1991, 1996; Khatamsaz, 2002; Peruzzi & Passalacqua, 2008; Cecchi & Selvi, 2009; Weigend *et al.*, 2009; Mehrabian *et al.*, 2011; Ranjbar & Almasi, 2013). In Iran there are 51 species of *Onosma*, 20 of which are endemic. Since the genus was revised for *Flora Iranica* (Riedl, 1967; Khatamsaz, 2002), new species have been described and there have been several new records for Iran. These include *Onosma ambigens* Lacaita, *O. bisotunensis* Attar & Hamzeh'ee, *O. cornuta* Riedl, *O. estahbanensis* Ranjbar & Almasi, *O. iranshahrii* Ghahr. & Attar, *O. khorassanica* Attar & Joharchi, *O. kurdica* Teppner, *O. procera* Boiss., *O. rechingeri* Riedl, *O. soltanabadensis* Ranjbar & Almasi, *O. straussii* (Riedl) Khat. and *O. tschichtatschevii* Popov (Teppner, 1980; Khatamsaz, 1992; Ghahreman & Attar, 1996; Attar & Joharchi, 2006; Attar & Hamzeh'ee, 2007; Ranjbar & Almasi, 2013).

De Candolle (1846) segregated *Onosma* into two sections: (1) *Aponosma* DC. with dense appressed white sericeous hairs; (2) *Euonosma* DC. predominantly with spreading hairs. Boissier (1879) divided *Onosma* into three sections: (1) *Haplotricha*, with basal leaves covered by simple setae only (haplotrichous indumentum); (2) *Asterotricha*, with basal leaves covered by stellate bristles (asterotrichous indumentum); (3) *Heterotricha*,

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with both simple setae and asterotrichous setae on the leaves. Riedl (1962) divided the genus into two sections: *Onosma* sect. *Onosma* and *Onosma* sect. *Protonosma* Popov, plus a number of subsections and series. He included *Onosma* sect. *Haplotricha* and *Onosma* sect. *Heterotricha* in *Onosma* sect. *Onosma* subsect. *Onosma* and reduced *Onosma* sect. *Asterotricha* to *Onosma* sect. *Onosma* subsect. *Asterotricha* (Boiss.) Gürke (Riedl, 1962). The sectional delimitation of the genus is still not settled and the problem has been made more confusing by a lack of consensus on the correct placement of the type species of the genus. Using an informal adaptation of Boissier's system, karyological work has shown that $x = 6$ and $x = 8$ are found in Haplotrichous *Onosma* as the dominant chromosome count in Europe and Asia, respectively, and $x = 7$ is reported for Asterotrichous *Onosma* in Europe. The third group, Heterotrichous *Onosma*, is characterised by bimodal chromosome sets $2n = 12L + 14S$ and $2n = 12L + 8S$ (L and S denote large and small chromosomes, respectively) and probably originated via hybridisation between taxa of Haplotrichous ($2n = 12L$) and Asterotrichous *Onosma* ($2n = 14S$) (Teppner, 1971, 1972; Vouillamoz, 2001; Peruzzi & Passalacqua, 2004, 2008; Mártonfi *et al.*, 2008; Kolarčik *et al.*, 2010).

During recent floristic studies in western Iran, a species of *Onosma* was collected that could not be identified to an existing species. After thorough consultation of the relevant floristic literature (Boissier, 1879; Riedl, 1967, 1979; Popov, 1974; Riedl *et al.*, 2005; Binzet & Orcan, 2007; Kandemir & Türkmen, 2010; Aytaç & Türkmen, 2011), it was concluded that our material belonged to *Onosma* sect. *Aponosma* (using the early sectional treatment by De Candolle (1846)) and was most similar to *Onosma sericea* Willd. After a comparison with specimens in the herbaria at B, E, G, TARI, W and WU it was decided to describe the material as a new species. Important differences between the new species and *Onosma sericea* are presented in Table 1.

TABLE 1. Diagnostic morphological and cytological characters of *Onosma mahabadensis* and *O. sericea*

Character	*O. mahabadensis*	*O. sericea*
Colour of plant	Green	Silvery to grey
Stem	Up to 40 cm	Up to 20 cm
Indumentum	Subpatent-setose	Appressed-sericeous
Density of bristles	Loose	Strongly dense
Density of short hairs	Sparse	Dense
Length of bracts	14–16 mm	c.7 mm
Calyx length	12–13 mm	Up to 10 mm
Calyx lobes	Mostly coherent	Free
Calyx texture	Herbaceous	Chartaceous to membranous
Chromosome number	$2n = 32$	$2n = 16$
Distribution	Iran (West Azerbaijan Province)	Turkey, Iran, Iraq, Armenia, Georgia, Lebanon, Ukraine (Crimea)

Material and Methods

Morphology

Plants from different populations of *Onosma* sect. *Aponosma* in Iran were collected and vouchers were preserved in BASU. These species were also studied in the field. Several other sheets have been examined from the herbaria at B, E, G, K, W and WU.

Meiotic studies

Fifteen young flower buds from at least five plants of the new taxon were collected and fixed in 96% ethanol, chloroform and propionic acid (6:3:2) for 24 hours at room temperature, and then washed and preserved in 70% ethanol at 4°C until used. Microsporocytes were prepared by squashing and stained with 2% acetocarmine. Chromosome counts were made from intact cells with well-spread metaphasic chromatids. Photographs of chromosomes were taken on an Olympus BX-51 photomicroscope at an initial magnification of 1000×.

Key to species of the Onosma sericea *group in Iran*

1a. Calyx with patent indumentum in basal parts; rosette leaves attenuate into the petiole _____ *O. subsericea* Freyn
1b. Calyx with appressed indumentum in basal parts; rosette leaves sessile _____ 2

2a. Stem up to 20 cm tall; indumentum strongly densely sericeous; most bracts c.7 mm long; calyx up to 10 mm, sepals free; $2n = 16$ _____ *O. sericea*
2b. Stem up to 40 cm tall; indumentum loosely subpatent-bristly; most bracts 14–16 mm long (lowest up to 20 mm); calyx 12–13 mm, sepals mostly coherent; $2n = 32$ _____ *O. mahabadensis*

Species Description

Onosma mahabadensis Ranjbar & Almasi, **sp. nov.** (Sect. *Aponosma* DC.).

Closest to *Onosma sericea* in habit, size and shape of leaves and colour of corolla but differing in the colour of the plant (green in *Onosma mahabadensis* vs. silvery to grey in *O. sericea*), density of indumentum (sparse vs. dense) and bract length (14–16 mm vs. c.7 mm). – Type: Iran, West Azerbaijan, 35 km from Mahabad toward Sardasht, 1605 m, 18 v 2011, *Ranjbar & Almasi* 25196 (holo BASU; photo W).

Perennial, subshrub to nearly herbaceous, green. *Rhizome* divided into several long, subterranean, slender branches with dark reddish-brown bark and sometimes a few leafy scales. *Stems* 30–40 cm, erect to ascending, straw-coloured when dry,

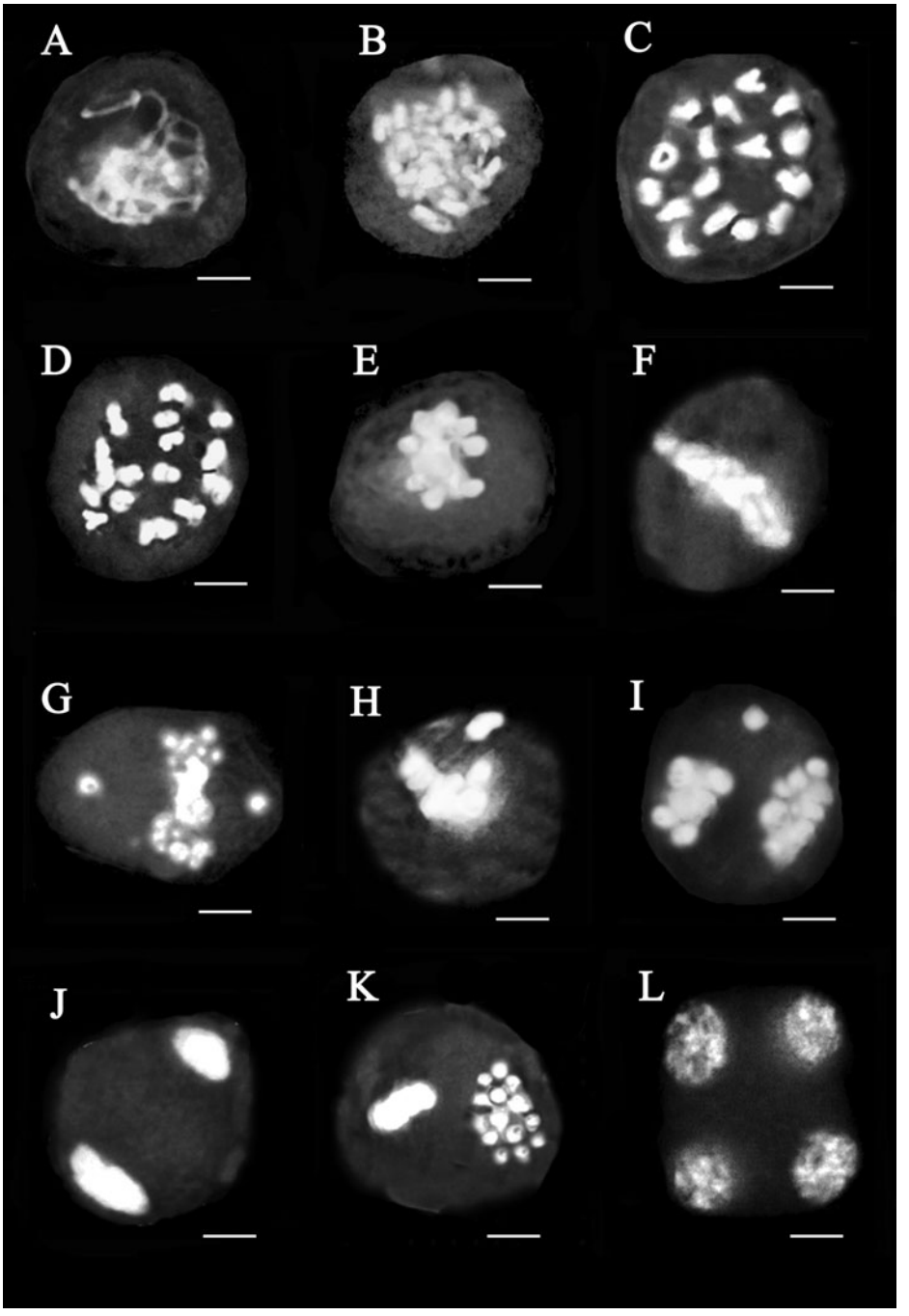

FIG. 1. Representative meiotic cells in *Onosma mahabadensis*. A, prophase of 25196; B, prophase of 31751; C, diakinesis of 25196; D, diakinesis of 31751; E, sticky chromosome in diakinesis of 25196; F, metaphase I of 25196; G, precocious migration of chromosomes

with slightly retrorse subpatent bristles, 1.5–2 mm long, arising from small white, glabrous tubercles, and with very short retrorse hairs between tubercles. Usually with a number of sterile shoots at flowering time. *Sterile shoots* short to moderately elongated, 8–15 cm long. *Rosette leaves* elliptic to oblanceolate, 4–5.5 × 1–2 cm, without secondary veins, acute at the apex, sessile, sometimes semiauriculate, loosely covered adaxially with stout bristles, 1.3–1.5 mm long, arising from white, glabrous tubercles formed by 2–3 elongated rings of convex cells, 0.25–0.5 mm wide, and sparsely retrorse short hairs between the tubercles; abaxially with tiny, slender bristles on smaller tubercles and with two rows of stout, ± patent bristles along the midrib and sparsely on other parts with dense short hairs. *Middle and upper stem leaves* elliptic without secondary veins, 3.5–4.5 × 1–1.5 cm, indumentum similar to rosette and lower ones. *Inflorescence* of 2 terminal and sometimes 1–2 lateral cymes, scorpioid, elongated in fruit. *Bracts* lanceolate, the lowest c.20 mm long, with indumentum similar to leaves, the rest 14–16 mm, with short retrorse hairs and bristles on midrib. *Pedicel* 3–4 mm in flower, with dense white bristles up to 3 mm long. *Calyx* 12–13 mm long at anthesis, herbaceous, lobes mostly coherent, with loosely subpatent white bristles, 2–3 mm long outside and denser at the base, sparsely hairy inside. *Corolla* yellow, campanulate, c.16 × 11 mm at widest point below lobes, with dense pubescence outside, lobes 2–2.2 × 2–2.5 mm, acute at apex. *Nectary* at corolla base, lobed, glabrous. *Stamens* 5, wholly included, borne c.1/3 of the way up from corolla base; anthers linear, 6–7 mm long, coherent only at base, base bilobed; filaments 2–3.2 mm long, inserted 2–2.2 mm above the anther base. *Style* 2–3 mm longer than corolla; stigma very small, distinctly bilobed. *Nutlets* not seen.

Etymology. The species is named after the location, Mahabad in Iran.

Paratype. Iran, West Azerbaijan, Mahabad toward Sardasht, 30 km to Sardasht, 1500 m, 18 v 2011, *Ranjbar & Almasi* 31751 (para BASU).

Distribution. Onosma mahabadensis is endemic to W Iran and belongs to the Irano-Turanian floristic element.

Habitat and ecology. It has been collected in the dry-steppe zone and on stony slopes of mountainous regions at altitudes between 1500 and 1600 m near Mahabad city. Flowering May to July.

Chromosome number report. The meiotic study shows that *Onosma mahabadensis* is a tetraploid species with a chromosome number of $2n = 4x = 32$ (Fig. 1).

in 25196; H, precocious migration of chromosomes in 31751; I, micronucleus in telophase I of 25196; J, telophase I of 25196; K, metaphase II of 25196; L, telophase II of 25196. Scale bars = 5 μm.

Cytogenetics

The chromosome number of *Onosma mahabadensis* was found to be $2n = 4x = 32$ (Fig. 1). A wide range of meiotic stages were observed in anthers within the same flower. A total of 383 diakinesis/metaphase I (D/MI), 442 anaphase I/telophase I (AI/TI), 37 metaphase II (MII) and 308 anaphase II/telophase II (AII/TII) cells were analysed in both populations. The general meiotic behaviour was regular, with bivalent pairing and normal chromosome segregation at meiosis. However, some meiotic abnormalities were observed, including precocious division of centromeres and sticky chromosomes in metaphase I, laggard chromosomes in anaphase I and a micronucleus in telophase I and II. Bivalents are found in two forms: open ring chromosomes and closed rod chromosomes. Ring bivalents are usually created by metacentric and sub-metacentric chromosomes. In ring bivalents chiasmata exist in each arm of homologous chromosomes, but in rod bivalents chiasmata are formed in acrocentric or telocentric chromosomes. In this case chiasmata exist in both forms (Fig. 1C, D). Precocious division of centromeres was found in 18% of metaphase cells in the population from which *Ranjbar & Almasi* 25196 was collected and 10% in the one from which *Ranjbar & Almasi* 31751 was gathered (Fig. 1G, H). Stickiness was observed in 3.2% of cells in population 25196 and 9% in 31751 (Fig. 1E). Chromosome stickiness may be caused by genetic and environmental factors, and several agents have been reported to cause chromosome stickiness (Ranjbar *et al.*, 2011). The presence of a micronucleus was only found in 2% of AI/TI cells in population 25196 and 8% in 31751.

Discussion

De Candolle (1846) proposed *Onosma* sect. *Aponosma* with three species: *O. sericea* Willd., *O. elegans* Koch and *O. tripartita* Hochst. This section was also recognised by Popov (1974) in the *Flora of the USSR*.

Onosma mahabadensis is placed in *Onosma* sect. *Aponosma* due to the following characters: perennial, entire plant covered with dense appressed white sericeous hairs, simple tubercles, a calyx with short and hairy tube and 2–4 cyme inflorescences.

Stebbins (1947) classified polyploids into autopolyploids, allopolyploids, autoallopolyploids, and segmental allopolyploids. In autopolyploids, all genomes are identical and homologous chromosomes have equal opportunities to pair at meiosis with multivalents being formed. However, the maintenance of the multivalence until metaphase I will depend on its frequency and chiasma localisation. In segmental allopolyploids the genomes are not identical. As they result from hybridisation of closely related diploid species, followed by the doubling of the chromosome numbers, bivalents are formed (Utsunomiya *et al.*, 2005; Sheidai & Jalilian, 2006). *Onosma mahabadensis* is a tetraploid species with $2n = 4x = 32$, consistent with the proposed base number of $x = 8$ for *Onosma* sect. *Aponosma*. Moreover all populations studied formed only bivalents and univalents, with no quadrivalent formation. The species can therefore be called a segmental allopolyploid.

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