

Article

A Taxonomic Revision of Two Species Complexes Belonging to the *Haplotricha* Subsection in the Genus *Onosma* (Boraginaceae): A Realistic Approach to Plant Diversity

Farzaneh Khajoei Nasab and Ahmad Reza Mehrabian * 

Department of Plant Sciences and Biotechnology, Faculty of Life Sciences and Biotechnology, Shahid Beheshti University, Tehran 1983969411, Iran

* Correspondence: a_mehrabian@sbu.ac.ir

Abstract: The taxonomy of *O. dichroantha*, *O. nervosa*, and their allied species is extremely controversial among authors. The delimitation of these species was extremely confusing, and closely related species were separated by weak and non-diagnostic morphological traits. A taxonomic revision of these taxa is presented here based on our fieldwork and a thorough study of herbaria specimens. The species *O. dichroantha* and *O. sharifii* are regarded as synonyms of *O. setosa*, and *O. maculata* is reduced to synonymy with *O. nervosa*. In addition, the typification of accepted names and relevant synonyms, detailed morphological descriptions and brief comments on the relationships between species are provided. Besides, it is accentuated that the introduction of any new species should be based on complete evidence to avoid systematic complexity. The results of this study play an important role in solving the problems of plant diversity and in the conservation of plant diversity.

Keywords: Irano–Turanian region; taxonomy; typification; plant diversity; conservation



Citation: Nasab, F.K.; Mehrabian, A.R. A Taxonomic Revision of Two Species Complexes Belonging to the *Haplotricha* Subsection in the Genus *Onosma* (Boraginaceae): A Realistic Approach to Plant Diversity. *Diversity* **2022**, *14*, 671. <https://doi.org/10.3390/d14080671>

Academic Editor: Anatoliy A. Khapugin

Received: 5 March 2022

Accepted: 11 August 2022

Published: 18 August 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The genus *Onosma* Linnaeus (1762: 196) is one of the largest genera of the Boraginaceae tribe Lithospermeae, encompassing approximately 240 species [1] distributed mainly in the mountainous habitats of the Irano–Turanian region. The geographic distribution of the genus ranges from Mount Taibai in the southwest of Shaanxi Province, China (in the east) to the west of Souss–Massa–Daraâ in Morocco (in the west) and from Central Siberia and the Altai Mountains in Russia (in the north) to Doi Hua Mot WS in the north of Thailand (in the south) (see the occurrence data on the GBIF website: <https://www.gbif.org/species/2925854>) (accessed on 20 May 2020). Most *Onosma* species grow in sunny and xeric habitats, including rock and sandy soils and diverse geological formations including serpentine subgroup rocks [2–5]. The main diversity centers, as well the areas of endemism of *Onosma*, occur in Turkey and Iran [6–16]. The species in this genus share scorpioid cymes, tubular-campanulate or clavate corolla, calyx parted to or nearly to the base with linear or linear-lanceolate lobes, un-appendage, nectariferous throat glands, and erect achene. *Onosma* as a taxonomic complex group includes many complicated species [2,3,17–20]. Determining the boundaries of the species of this genus has created many problems because of the high rate of hybridization and several ploidy levels [18], as well as several morphological variations and large geographical distributions. The first taxonomic arrangements of *Onosma* were based on morphological characters, i.e., calyx characteristics and features of the leaf trichome [21–23]. The type of leaf indumentum is still an important diagnostic characteristic in this genus [24], but on its own it cannot solve the problems of the complex groups within this genus [2,20].

The genus *Onosma* is represented by 107 taxa in Turkey, 54 (50%) of which are endemic [25]. After Turkey, Iran is the second largest center of species diversity of this taxon in the world, and the Zagros Mountains, especially the Central Zagros, are home to many

rare and local endemic species [11,16,19,26–29]. During the taxonomic revision of the genus in Iran, two complex groups were identified for which the determination of species boundaries was extremely confusing, and closely related species were separated by restricted morphological traits.

The first controversial species is the complex of *O. dichroantha* Boiss. In 1849, Edmond Boissier described a new species similar to *O. setosa* Ledeb. and named it *O. dichroantha* [30]. A few years later (1879), he cited this taxon as a variety of *O. setosa* [*O. setosa* Ledeb. var. *dichroantha* (Boiss.) Boiss.] [31]. Later researchers, including Popov (1953) [32], Riedl (1967) [23], and Khatamsaz (2002) [33], synonymized *O. setosa* Ledeb. var. *dichroantha* with *O. dichroantha* and accepted it as a separate taxon. Riedl (1967) described *O. sharifii* Riedl as a new endemic species for the flora of Iran [23]. This species also has morphological characters quite similar to those of *O. dichroantha* and *O. setosa*. Our field studies and the protologues of the species show that these three species, in addition to having similar taxonomic features, are found mostly in similar habitats in the highlands near the Caspian Sea. Therefore, a careful review to determine their taxonomic value is essential.

The second group of doubtfully distinct species is the complex of *O. nervosa* Riedl and *O. maculata* Ranjbar & Almasi. In 1962, Riedl named *O. nervosa* as a new species for Flora Iranica [34]. This species grows in Iran and Iraq. Recently, *O. maculata* has also been described as a new Iranian *Onosma* species very similar to *O. nervosa* [35]. Given that only tenuous characteristics separate these species from one another, more investigation to determine their actual circumscription is needed. Therefore, the present study is intended to provide an updated taxonomic revision of the mentioned complex groups to clarify the nomenclature status and taxonomic relationships among them

2. Materials and Methods

The present study is primarily based on the consultation of the relevant literature, field surveys, and examination of specimens from the following herbaria: HSBU, IRAN, TARI, and W, WU. In addition, high-resolution digital images of specimens were obtained from 22 other international herbaria including JE, MPU, B, BM, C, E, G, GH, HAL, K, LD, LINN, M, MA, MEL, MO, P, PRC, S, TU, US, UPS, and WAG; herbarium acronyms follow Thiers (2020) [36]. Extensive field collecting was conducted in different parts of Iran from 2009 to 2019. The collected specimens were kept at HSBU. The morphology of the specimens was also studied carefully in the present study.

3. Results and Discussion

3.1. *O. dichroantha* Complex Group

In the present study, we examined in detail more than 115 specimens of the *O. dichroantha* complex. Detailed morphological studies of specimens revealed that the main diagnostic characters of this complex group are broadly linear or oblanceolate basal leaves, pedicels elongated in fruit, setae with hispid tubercles, glabrous nectaries, shiny and strongly gibbous nutlets.

3.1.1. Taxonomic Treatment

Onosma setosa Ledeb. (1820: 70).

Lectotype:—RUSSIA. Astrachan, sine die, F. Blum, (designated by Popov 1953: 214) (LE); Neotype:—: neotype, designated here) LE [LE01042916, digital image!].
 ≡ *O. dichroantha* Boiss. (1849:107), *O. setosa* var. *dichroantha* (Boiss.) Boiss. (1879:181).
 Type:— TRANSCAUCASIA. Iberia prope Baku, C.A. Meyer s.n. (G); N. IRAN. in monte Demavend prope Ask, 1843, Kotschy 383, (syntype: K [K000958673, digital image!], BM [BM001014474, digital image!], BM [BM001050253, digital image!], W [W0030927, digital image!], W [W0030928, digital image!], LE [LE01071798, digital image!], LE [LE01071799, digital image!]), P [P04069538, P04069539, P04069540, digital images!], (lectotype: LE [LE01071799, digital image!]; isolectotype: LE [LE01071798, digital image!]). *syn. nov.*

= *O. sharifii* Riedl. (1967: 198). Type:—IRAN. Mazandaran: Hazar Jarib, *Sharif 505* (holotype: W, 1966–0020231!). *syn. nov.*

3.1.2. Emended Description

Biennial or perennial; **Stems** solitary or several, 15–70 cm high, erect or ascending, usually green or slightly reddish, sometimes bluish, with dense long spreading bristles, with branches terminated by inflorescences in the upper half, covered with short, rather dense, coarse down between long horizontal bristles; **Indumentum** cover with setae 1–4 mm long and tubercles, glabrous or pubescent, shorter hairs less than 0.5 mm long. **Basal leaves** elongate, broadly linear or oblanceolate, 100–250 × 4–15 mm, base attenuate, apex often obtuse; **Cauline leaves** sessile, oblanceolate or linear 25–100 × 5–10 mm; **Inflorescence** terminal, elongated after flowering; **Pedicels** short, to 7 mm in flower, elongated in fruit; Bracts lanceolate; **Calyx** 10–25 mm in flower, to 30 mm in fruit, outside with spreading white or yellow bristly hairs, divided nearly to base; lobes linear-lanceolate; **Corolla** yellow at first, becoming purplish or light brown, 25–40 mm long, tubular-campanulate, glabrous both sides or pubescent in curved teeth or sub glabrous inside, with small, triangular, curved teeth; **Style** 20–30 mm, exserted from corolla, **Anthers** connate at base, 8–10 mm, **Annulus** glabrous; **Nutlets** shiny, yellow-brown, 4–6 mm, strongly gibbous.

3.1.3. Taxonomic Notes

O. setosa was described as a new endemic species for the Caspic-caucasian region [37]. This species is characterized with the following description: Rosette leaves elongated, linear, lanceolate. Corolla yellow, spatulate, broadly tubular-campanulate. Setae tuberculate. Nectaries glabrous. Cauline leaves lanceolate, to ovate, acute-acuminate; Setae white, spreading bristly hairs. Inflorescence broadly paniculate to solitary, calyx floriferous and double in length. Stigma bilobed. Nutlets, shining, quadrate or triangular.

In 1849, Edmond Boissier described a new species with morphological traits closely similar to *O. setosa* and named it *O. dichroantha*. A close examination of the original descriptions of these two species showed that these two diagnostic traits of *O. dichroantha* are in the morphological range of the *O. setosa* species, and no significant morphological differences were observed between these two species (Figures 1 and 2). Therefore, according to our observations of the herbaria specimens of these taxa, the investigation of the original descriptions, and reviews of syntypes, we propose that *O. dichroantha* be recognized as a new synonym of *O. setosa*. Furthermore, the original descriptions of *O. setosa* and *O. sharifii* are completely congruent, and these species share the same morphological traits. Our evaluations based on the original taxonomic description of *O. sharifii* as well as the diagnostic characteristics of the investigated populations of *O. setosa* suggest that this taxon must also be reduced to synonymy with *O. setosa*.

3.1.4. Neotypification of *O. setosa*

In the protologue, Ledebour mentioned the specimens from the Caspian habitats near the city Astrakhan of Russia as the original material of *O. setosa* [37]. The type material of *O. setosa* was said to be deposited in the Leningrad herbarium according to Flora USSR [32]; however, it was not found there, and no relevant information about it is available in the herbarium database (Petr Efimov, T. Lebedeva, LE staff, by e-mail, April 10 and 11, 2018, and Irina Illarionova by e-mail, 3 May 2018). Moreover, our search in the following herbaria yielded no results: C, B, BM, E, G, GH, HAL, JE, K, LD, LINN, M, MA, MEL, MO, MPU, MW, P, PRC, S, TU, UPS, US, WAG and WU. As there is no illustration or syntype of this taxon in the protologue, it is necessary to introduce a neotype. In our opinion, the best candidate for designating a neotype should be selected from the Ledebour collection and the location of the type. Six digital images of this species, thought to be type specimens, were sent to us by the Vascular Plants Herbarium of the Komarov Botanical Institute (LE) (Figure 3).

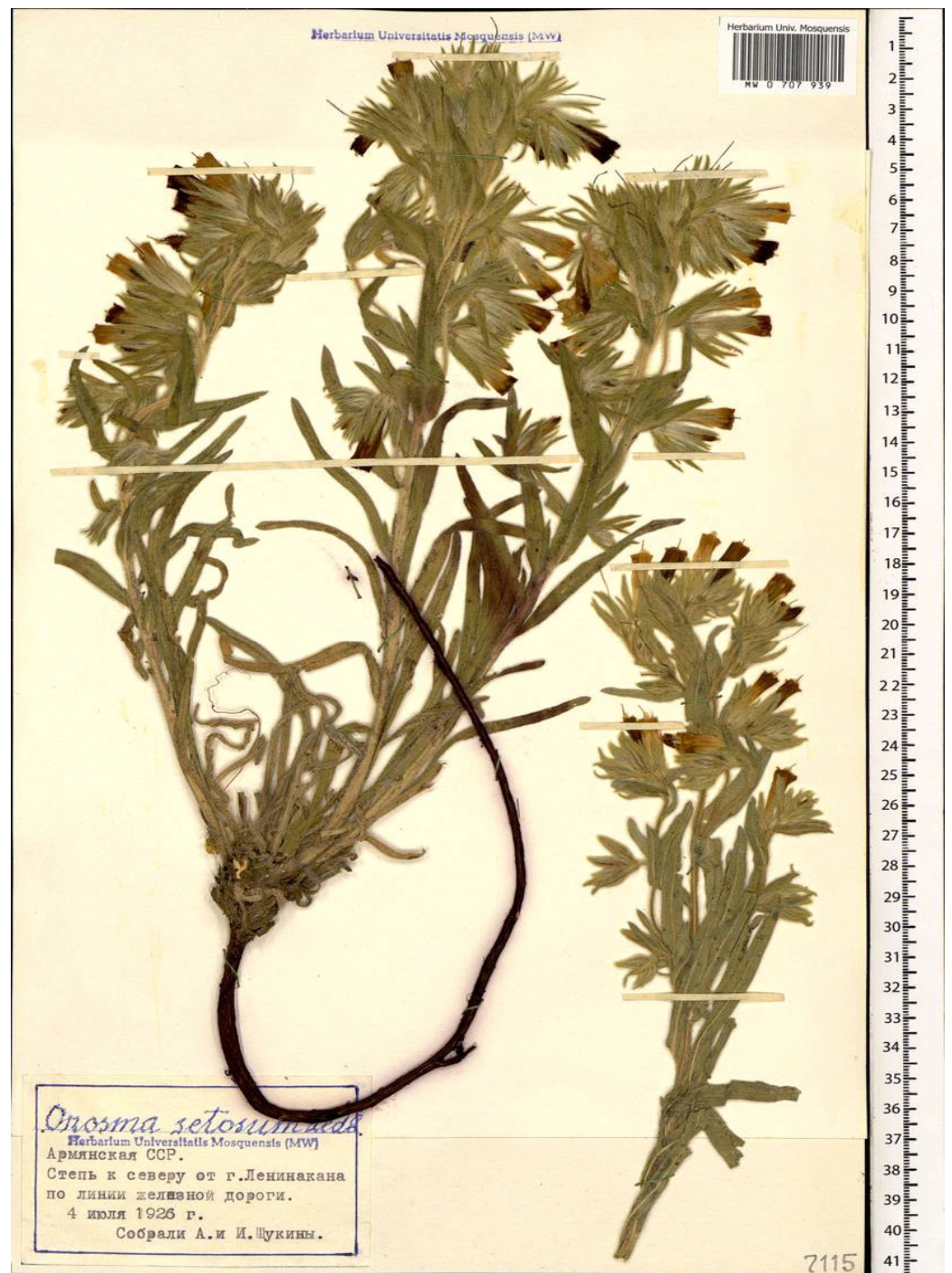


Figure 1. *Onosma setosa* Ledeb. collected from Central Asia.



Figure 2. (A,B). *Onosma setosa* Ledeb. with yellow coloring corolla (C,D). Floral color change in some taxa belong to *Onosma setosa* Ledeb. (Their habitats in the mount Damavand, near Rineh).



Figure 3. The specimens of *O. setosa* Ledeb. from the LE Herbarium: (a) LE (LE 01042913), (b) LE (LE 01042915), (c) LE (LE 01042911), (d) LE (LE 01042916), (e) LE (LE 01042912), (f) LE (LE 01042914).

By carefully examining the information of the place and year of collection and the name of the collector, it was determined that only two specimens, those with barcodes LE 01042916 and LE 01042911, are in the Ledebour collection. The specimen with the barcode LE 01042911 was collected from Turcomania (area S of Georgia; wrong region) and thus is not a suitable candidate for neotype design. Finally, we conclude that the specimen with the barcode LE 01042916 collected from the Eastern Europe sector of the Caspian lowland desert can be designated as a neotype for *O. setosa*. We believe the protologue does not refer to a specimen only as the original material of this species; perhaps LE 01042916 is part of it and can be a candidate to select a neotype (ICN Art. 9.16-18). This sample is present in the LE herbarium and its location closely matches the location information of the original material mentioned by Ledebour.

- **Phenology:**—Flowering from mid-May to mid-July, fruiting from June to early August.
- **Distribution:**—Caucasus, Iran, Central Asia.
- **Specimens examined:**—IRAN. Azarbaijan: Ca. 25 Km SE. of Jolfa, Kiamaki protected area, Gheshlagh village, Kuh-e Gelenj, 2100–2700 m, 19 June 1988, *M. Assadi & A. Shahsavari* 65746 (TARI!); Mountains of SW. of Ahar, 2500 m, 22 June 1988, *M. Assadi & A. Shahsavari* 65936 (TARI!); Bostan Abad to Tabriz, 5 June 1962, *P. Furse* 12550 (W!); Ahar, Sarichaman, Vanatan, *F. Termeh* (IRAN!); Golestan: Golestan National Park, Tangerah, Ghorbangali, Sararbaghi, *M. Ghorbani et al.* 2017204 (HSBU!); Gorg: Golestan

National Park: between Sharlegh & Tcheshmeh-ye Khan, *B. Zehzad* 2017202 (HSBU!); Gorgan, Park-e Meli, 11 Km Sulgerd, 1520 m, 16 July 1991, *F. Matin & F. Termeh* 18997 (IRAN!); Golestan National Park, 1750 m, 19 June 1974, *P. Wendelbo & H. Foroughi* 17903 (W!); Gorgan, 2400–2600 m, 26–27 July 1948, *K. H. Rechinger* 6835 (W!); Kuh-e Aghaman, 1100 m, 18 May 1975, *M. Renz* 05739 (W!); National Park of Golestan, Almeh, 1200 m, 5 June 1979, *K. H. Rechinger* 05733 (W!); National Park of Golestan, Almeh, 1500–1800 m, s.c. 13434 (W!), Almeh, 1850 m, 8 May 1972, *H. Foroughi* 3746 (TARI!); Park-e Golestan, Almeh, 1350–1700 m, 5 June 1987, *V. Mozaffarian & Abouhamzeh* 59051 (TARI!); Almeh, 1200–1300 m, 7 June 1975, *F. Termeh* 2759 (IRAN!); Almeh, 1630–1750 m, 18 July 1991, *F. Matin & F. Termeh* 18998 (IRAN!); Almeh, 1550–1850 m, 21 June 1993, *F. Matin & F. Termeh* 60088 (IRAN!) Khorassan: Hezar Masjed, 2000–2600 m, 8–9 July 1948, *P. Allen* 5652 (W!); Esfarayen, Kuh-e Shah Jahan, Saracheshmeh village, 1700 m, *V. Mozaffarian* 48407 (TARI!); Ca. 45 Km of N. of Shirvan, Golool-Sarani protected area, 1600–2300 m, 26 May 1984, *M. Assadi & A. A. Maasoumi* 50512 (TARI!); Between Ghouchan & Darreh-Gaz, Tandooreh National Park, Shekarab, 2300 m, 27 May 1984, *M. Assadi & A. A. Maasoumi* 50602 (TARI!); Esfarayen, N.slope Kuh-e Shah Jahan from Darparchin-e Bala village, 1700–2500 m, 7 June 1984, *V. Mozaffarian* 48444 (TARI!); 5 Km Mozduran to Sarakhs, 650 m, 26 April 1989, *V. Mozaffarian* 67617 (TARI!); Shahpasand to Shahrud, 1800–1950 m, 18 May 1978, *P. Wendelbo & M. Assadi* 29686 (TARI!); Ca. 30 km between Esfarayen to Bojnurd, 1800–2000 m, 29 June 1984, *V. Mozaffarian* 48722 (TARI!); Fariman, 1429 m, 16 May 2003, *M. Assadi & M. Amirabadi* 84534 (TARI!); Mountains of N. of Ghouchan, above the village Zubarán, 1950 m, 19 July 2003, *M. Assadi & S. M. M. Hamdi* 85632 (TARI!); Bojnurd, near Chamanbid, 21270 m, 9 May 1984, *H. Foroughi* 3744 (TARI!); Dargaz, 35 Km of Daroongar village, 13 June 1988, *A. Vafae* 227 (TARI!); Kopet Dagh, 45 km NE. of Shirvan, Gulul Valley, 2300 m, 30 June 1973, *R. Edmondson* 1185 (TARI!); Golal Sarani Area, 2100–2300 m, 12–13 June 1975, 13432 (W!); Neyshabur, Akhlamad waterfall, 1600–1800 m, 30 May 1948, *K. H. Rechinger & P. Allen* 6838 (W!); Between Mashhad and Sarakhs, 1000 m, 25 May 1977, *K. H. Rechinger* 07776 (W!); 24 Km south of Bojnord to Esfarayen, 1700–1800 m, 15 June 1975, 13430 (W!); N. Shirvan, 2200 m, 12 June 1975, *K. H. Rechinger* 13431 (W!); Kopet Dagh, Northeast Shirvan, 2300 m, 30 June 1973, *R. Edmondson* 28885 (W!); Between Shahrud and Bojnourd, 800 m, 23 May 1977, *K. H. Rechinger* 08098 (W!); Shahpasand vers Bojnurd, Almeh, 10 June 1975, *F. Termeh* 2762 (IRAN!); Esfarayen to Bojnurd, 25 Km Bojnurd, 16 June 1975, 1700 m, *F. Termeh* 2754 (IRAN!); Shirvan, Namanlu, Kuhhay Gulul, 2200–2500 m, 14 June 1975, *F. Termeh* 2760 (IRAN!); Fariman to Torbat-e Heydariyeh, 1200–1400 m, 25 June 2009, *A.R. Mehrabian* 2017200 (HSBU!); Mashhad south area, 1200 m, 13 June 2010, *A. R. Mehrabian* 2017203 (HSBU!); Quchan to Dargaz, 80 Km Dargaz, 14 July 2019, *M. Arabameri* 2017330 (HSBU!) Mazandaran: Inter Gach-i-sar et Chalus, 0–3000 m, 18 May 1956, *F. Schmid* 5795 (W!); Chalus, 10 Km from Vissar on road to Marzanabad, 1250 m, 18 April 1978, *V. Mozaffarian* 27348 (TARI!); Siah-bisheh, 2500 m, *M. Assadi* 76689 (TARI!); Mazandaran, Haraz road to Abgarm, 2250 m, 23 June 1971, *M. Assadi & V. Mozaffarian* 33144 (TARI!); Tehran, Tunle Kandavan, 2220 m, 27 June 1973, *K. Bazargan & GH. Amin* 1428 (TARI!); Tehran, S. slope of Demavand Mout., 3300–3800 m, *M. Khatamsaz et al.* 04718 (TARI!); Chalus valley, below Siah Bisheh, 2000 m, 24 May 1974, *P. Wendelbo & A. Shirdelpour* 11694 (TARI!); Firoozkooh, Veresk Bridge, 1690 m, 12 May 1971, *Gheissari* 1348 (TARI!); Kelardasht, Rudbarak, 1980 m, 10 June 1973, *R. Fotovat* 10141 (TARI!); Kelardasht, Kalalur, 1200 m, 14 May 1971, *H. Foroughi* 1371 (TARI!); Firoozkooh, Veresk Bridge, *Bazargan & Arazm*, 1600 m, 10 June 1973, 1430 (TARI!); Siahbisheh, 2500 m, *M. Assadi* 76689 (TARI!); Firoozkooh, Veresk Bridge, 2000 m, 25 June 1974, *P. Wendelbo & H. Foroughi* 22163 (W!); Chalus road, 2000 m, 25 July 1964, *K. H. Rechinger* 16890 (W!); Alborz, between Chalous and Karaj, 2190 m, 24 June 1966, *J. C. Archibald* 17333 (W!); Mazandaran, Chalous, 2400 m, 9 June 1937, *K. H. Rechinger* 889 (W!); between Kandavan and Elika, Duna village, 2550 m, 23 June 1979, *M. Assadi & V. Mozaffarian* 32901 (TARI!); Alborz, Kandovan, 2700–3000 m, 26

May 1937, *K. H. Rechinger* 888 (W!); Chalous to Pol-e Zangouleh, 2300 m, 21 June 1974, *K. H. Rechinger* 13565 (W!); Gachsar, Pol-e Zangouleh, 1500 m, 29 June 1997, *S. Shirzadian et al.* 60061 (IRAN!); Noor, 1000 m, 22 June 2017, *A. R. Mehrabian* 2017201 (HSBU!); Yoosh & Baladeh 3000 m, 1 July 2013, *A. R. Mehrabian* 2017204 (HSBU!); 3 km Siyah Bisheh, 2189 m, 27 July 2017, *A. Neemati* 2017205 (HSBU!); Noor, Baladeh, 2 Km Kamarbon village, 2409 m, 27 July 2017, *A. Neemati* 2017206 (HSBU!); Veresk bridge, 2400 m, 14 July 2016, *A. R. Mehrabian & F. Khajoei Nasab* 2017301 (HSBU!); the road of Chalus to Kamarbon village, 2417 m, 27 July 2017, *A. Neemati* 2017207 (HSBU!); the road of Chalus to Kamarbon village, 2497 m, 27 July 2017, *A. Neemati* 2017208 (HSBU!); the road of Chalus, 45 Km Baladeh, 2705 m, 27 July 2017, *A. Neemati* 2017209 (HSBU!); The road of Baladeh after Kamarbon village, 2835 m, 27 July 2017, *A. Neemati* 2017210 (HSBU!); 30 Km Baladeh in the Kamarbon road, 2837 m, 27 July 2017, *A. Neemati* 2017211 (HSBU!); The road of Baladeh, after Kamarbon village, 2974 m, 27 July 2017, *A. Neemati* 2017212 (HSBU!); The road of Baladeh, after Kamarbon village, 3059 m, 27 July 2017, *A. Neemati* 2017213 (HSBU!); Noor, Baladeh, Nesen village, 2589 m, 28 July 2017, *A. Neemati* 2017214 (HSBU!); South of Damavand, toward Meiandeh, 1658 m, 28 July 2017, *A. Neemati* 2017215 (HSBU!); 1 Km Deladasht from Miyandeh, 1918 m, 28 July 2017, *A. Neemati* 2017216 (HSBU!); Amol, Larijan, Nandal village, 2183 m, 28 July 2017, *A. Neemati* 2017217 (HSBU!); 1 km of Baladeh to Royan village, 2524 m, 28 July 2017, *A. Neemati* 2017218 (HSBU!); 1 km of Baladeh to Royan village, 2722 m, 28 July 2017, *A. Neemati* 2017219 (HSBU!); Baladeh to Royan village, 2950 m, 28 July 2017, *A. Neemati* 2017220 (HSBU!); Kojur District, Kodir village, 1503 m, 28 July 2017, *A. Neemati* 2017221 (HSBU!); Kelardasht, Rudbarak, 1709 m, 14 July 2018, *A. Neemati* 2017222 (HSBU!); Kelardasht, Vandarbon, 1907 m, 14 July 2018, *A. Neemati* 2017223 (HSBU!); Polur to Rineh, 2334 m, 14 July 2018, *A. Neemati* 2017224 (HSBU!); Firuzkuh, Veresk, 2334 m, 14 July 2018, *A. Neemati* 2017225 (HSBU!); Firuzkuh road, Pol-e Sefid, 1257 m, 15 July 2018, *A. Neemati* 2017226 (HSBU!); Firuzkuh road, Gadok-pass, 2111 m, 15 July 2018, *A. Neemati* 2017227 (HSBU!); Semnan: Naudeh et Shahrud, 1000–2000 m, 15 June 1956, *F. Schmid* 6117 (W!); 57 Km of SE. Shahpasand, 1250 m, 10 May 1966, *H. Pabot* 25618 (TARI!); Between Shahpasand and Shahrud, Khoshyeylagh, 1600–1800 m, 18 May 1978, *P. Wendelbo & M. Assadi* 29626 (TARI!); Shahrud, Khosh yeylagh, 2000 m, 26 June 1972, *M. Riazi* 3718 (TARI!); Shahrud, Khoshyeylagh, 27 June 1952, *A. Zargani* 2761 (IRAN!); 45–52 Km Shahmirzad, Fulad mahalleh, 2200–2300 m, 9 July 1974, *M. Renz & A. Zargani* 2753 (IRAN); Semnan, Parvar protected area, 2200 m, 30 May 1975, *K. H. Rechinger* 13433 (W!); Shahrud, Khosh yeylagh, 2030 m, *H. Foroughi* 10414 (TARI!); 69 Km Shahrud from Azadshahr, Gardane-Khosh yeylagh, 2000 m, 3 August 1982, *M. Assadi & V. Mozaffarian* 40969 (TARI!); Shahrud, Kuh-e Ghatry, 2310 m, 8 June 1984, *H. Foroughi* 8986 (TARI!); ca. 50 Km N of Semnan, between Sheli to Hikuh villages, 2400 m, 28 July 1971, *M. Assadi & V. Mozaffarian* 40621 (TARI!); AFGHANISTAN. Nozi, 9000 ft, 21 June 1937, *W. N. Koelz* 11987 (W!); Faizabad, 1100–1900 m, 11 July 1948, *L. Edelberg* 1397 (W!); Badghiz, Kush Asia, Khaleqdad, 900 m, May 1969, *Janata* 33 (W!); Kouh-Tchehel Dokhteran, 1 July 1959, *L. Edelberg* 7229 (W!); Khash-Dt, 8000 ft, 8 August 1937, *W. N. Koelz* 12915 (W!); Polat, 9000 ft, 10 September 1939, *W. N. Koelz* 13949 (W!); Jaji, inter Ahmad Khel et Ali Khel, 2200 m, 2400 m, 9 July 1965, 32195 (W!); Khost, Jugi Sata Kandao inter Gardez, 2200–2800 m, 8 July 1965, 32145 (W!); Paghman, 7000 ft, 12 May 1937, *W. N. Koelz* 11389 (W!); Mazar-I Sharif, Balkh supra Aq Kupruk, 700–800 m, 6–7 June 1962, 16309 (W!); Armenia. Syunik province, c.4 Km NW of Sisian, 1785 m, 4 July 2003, 030752 (W!); Vayots Dzor province, area SSE of Vayk, 2010 m, 15 June 2009, *Tamanian* 03487 (W!); Georgia. Dedoplistskaro District, Iori plateau, Environs of village Kasristskali, on road from village to Vashlovani reserve, 555 m, 14 May 2006, *N. Lachashvili* 340 (W!); Caucasus. distr. Razdan, clivi montis Ketandag in vicinitate pagi Charencavan, 1700–2100 m, 7 July 1975, *Vasak* 02228 (W!); TURKMENISTAN. Regio transcaspica Aschabad, in glareosis montium supra pagum Nephton, 4 May 1990, *s.c.* 212 (W!).

3.2. *O. nervosa* Complex Group

A total of 13 specimens of the complex group of *O. nervosa* were investigated. The main diagnostic characters included large (up to 25 cm) and lanceolate rosette leaves, prominent reticulate veins, glabrous nectary, setae with glabrous tubercles as well as very short and sparse rays and golden yellow corolla.

3.2.1. Taxonomic Treatment

***Onosma nervosa* Riedl** (1962: 234). Type:—IRAQ. Kajan Mountain, nr. Penjwin, 1590 m, 21 June 1957, *A. Rawi in Nat. Herb. Iraq* 22705 (holotype: K [K000852615 digital image!]).

= *O. maculata* Ranjbar & Almasi (2015: 522–525). Type:—IRAN. Lorestan, Khorramabad to Sefid Dasht, Dareh Ashkaft, 1300 m a.s.l., 28 May 2012, *Ranjbar & Almasi* 30194 (holotype: BASU [digital image!]). *syn. nov.*

Notes:—*O. maculata* shows great similarity to *O. nervosa* having large rosette lanceolate leaves, reticulate veins, and middle and upper stem leaves oblong to linear-lanceolate; both of them also include 2 terminal or 1–2 lateral cymes, elongated fruit, and lanceolate bracts. In addition, they are similar in calyx and corolla (size, shape of lobes and color) and glabrous nectaries. The two mentioned taxa are also similar in the lengths of leaf, calyx, bract, pedicel, corolla, and anther. However, some weak characters (e.g., tubercle color, spots of stems and peduncle, hair density variations in different parts) cannot be the main basis for the differentiation and separation of different species in the genus *Onosma* and other genera of Boraginaceae [20] (Figures 4 and 5).

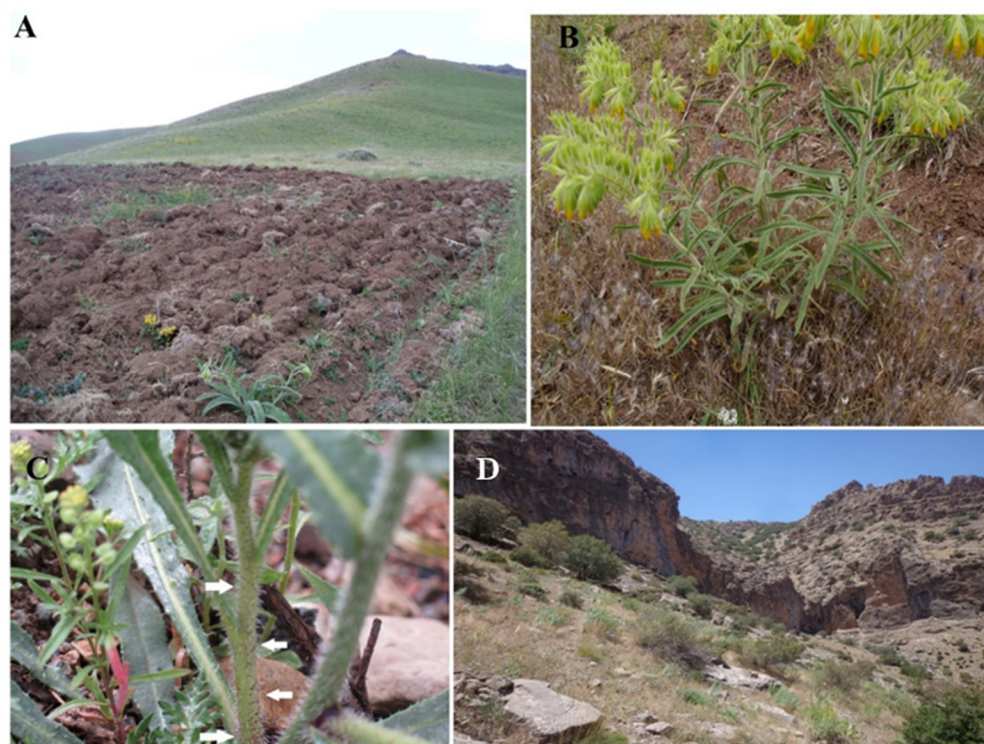


Figure 4. (A) Habitat of *Onosma nervosa* Riedl in Divandarreh (B) *O. nervosa* Riedl, (C) *Anchusa azurea* Mill. with purplish to black spots in stem (D) Habitat of *Onosma nervosa* Riedl in Shaho, Ravansar.



Figure 5. *Onosma nervosa* with purplish to black spots.

These characteristics have been frequently observed in different populations of both species in various herbaria (Figure 6). Accordingly, we suggest that *O. maculata* is synonymous with *O. nervosa*.

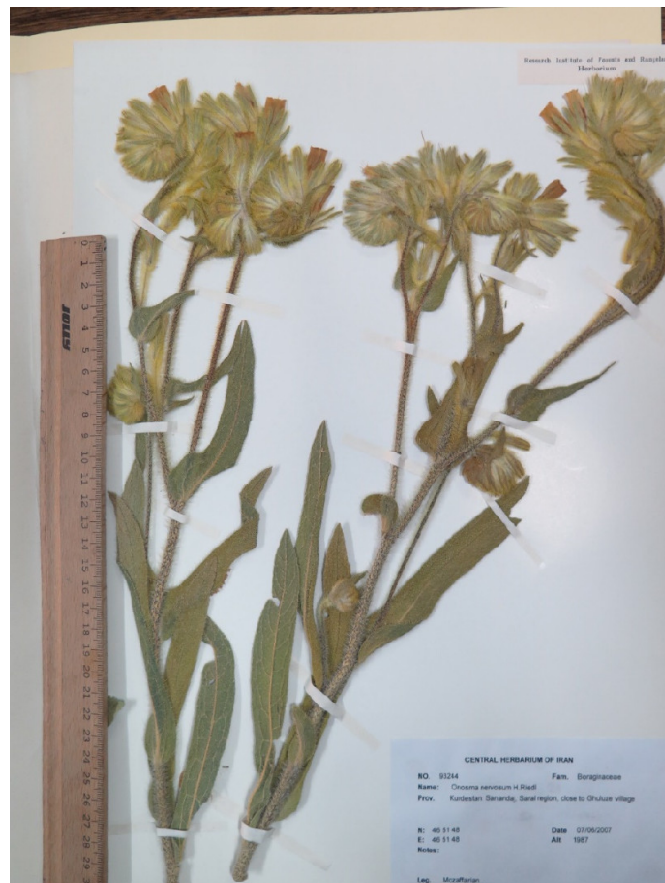


Figure 6. *Onosma nervosa* Riedl with purplish to black spots on stem.

- **Phenology:**—Flowering from mid-June to mid-July, fruiting from June to early August.
- **Distribution:**—Iran, Iraq.
- **Specimens examined**—IRAN:—Lorestan: Hamedan: Nahavand, Gamasiab, 2119 m, 21 July 2017, *M. J. Nikjouan 20178602* (HSBU!) Kermanshah: Malavi to Eslamabad, 1200 m, 7 June 2007, *V. Mozaffarian 64384* (TARI!), Ravansar, Shaho, 1801 m, 20 June 2017, *M. J. Nikjouan 20178603* (HSBU!) Kurdistan: Sannandaj to Divandareh, 9 June 2016, *M. Arabameri 20169851* (HSBU!); 15 Km Marivan to Sannandaj, 1000–1850 m, 8 July 1995, *V. Mozaffarian 74656* (TARI!); 11 Km Kamyaran to Kermanshah, 1800–2000 m, 15 June 1987, *M. Assadi 60660* (TARI!); Kamyaran to Sonqor, 1970 m, 3 June 2001, *B. Hamzei & Y. Asri 87747* (TARI!); Kamyaran to Sonqor, Tang-Gharal, 1700 m, 3 June 2001, *B. Hamzei & Y. Asri 87744* (TARI!); Isfahan, Kuh-e Venizan, 2500 m, 8 July 1996, *V. Mozaffarian 77244* (TARI!); Baneh, 2200 m, *K. H. Rechinger, 05718* (W!); Sanandaj, Saral region, close to Ghuluze village, 1987 m, 7 June 2007, *V. Mozaffarian 93244* (TARI!) Lorestan: Khorramabad to Borujerd, Zagheh, 1944 m, 15 June 2017, *M. J. Nikjouan 20178579* (HSBU!); Borujerd to Khorramabad, 2174 m, 15 June 2017, *M. J. Nikjouan 20178601* (HSBU!); Borujerd, Kuh-e Garin, 2103 m, 9 July 2017, *M. J. Nikjouan 20178601* (HSBU!); Khorramabad to Sefid Dasht, Dareh Ashkaft, 1320 m, 15 June 2017, *M. J. Nikjouan 20178605* (HSBU!); 25 Km Khorramabad to Sefid Dasht, 1600 m, 30 May 2005, *M. Assadi & I. Mehregan 88935* (TARI!).

3.2.2. Emended Description

Perennial, 40–50 cm high, long woody rhizome. **Stems** several, erect to ascending, distinctly spotted with dark purplish to black tubercles. **Setae** appressed, glabrous tubercles, with semi-dense white to yellow. **Rosette leaves** lanceolate, 120–230 × 20–30 mm, reticulate venation, attenuate at the base, acute at the apex to a long petiole up to 60 mm. **Middle and upper cauline leaves** linear-lanceolate, sessile, 40–120 × 10–35 mm. **Inflorescence** paniculate, 10–15 cm, white pubescent, elongated in fruit. Pedicel 3–15 mm. **Bracts** lanceolate, 3–20 mm, **Calyx** divided to base, 10–12 mm, elongated up to 16 mm in fruit; lobes lanceolate, 1–2 mm wide, white-yellow bristles outside. **Corolla**, campanulate or clavate-campanulate, 12–22 mm, golden yellow; lobes triangular, obtuse, 1.5 × 2–3 mm, densely pubescent outside. **Annulus** glabrous. **Anthers** connate at base, 6–10 mm long. **Style** filiform, little out of corolla; stigma bilobed. **Nutlets** 7–8 mm, ovoid, keeled above, glabrous, light brown.

4. Conclusions

The species *O. dichroantha* and *O. sharifii* are regarded as synonyms of *O. setosa*, and *O. maculata* is reduced to synonymy with *O. nervosa*. In addition, the typification of accepted names and relevant synonyms, detailed morphological descriptions and brief comments on the relationships of species are provided. Moreover, we emphasize that the introduction of any new species should be based on complete evidence to avoid systematic complexity. The results of this study play an important role in solving the problems of plant diversity and in the conservation of plant diversity. The accurate delimitation and identification of species is the first step to determining priorities for conservation. Species are one of the main conservation units, and identifying accurate scientific names of them is therefore crucial to gathering reliable information in conservation biology.

Author Contributions: F.K.N. and A.R.M. designed the study and wrote the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The present study is primarily based on the consultation of the relevant literature, 71 field surveys, and examination of specimens from the following herbaria: HSBU, IRAN, 72 TARI, and W, WU. In addition, high-resolution digital images of specimens were obtained 73 from 22 other international herbaria including JE, MPU, B, BM, C, E, G, GH, HAL, K, LD, 74 LINN, M, MA, MEL, MO, P, PRC, S, TU, US, UPS, and WAG.

Acknowledgments: We are grateful to Lorenzo Cecchi for his sincere and helpful support in typification and for his valuable comments on an earlier draft of this paper. We thank the curators, directors, and collection managers of the herbaria cited in the text for permission to examine or borrow the specimens or the digital images in their care, especially Irina Illarionova and Larisa Raenko (LE), Alexey P. Seregin (MW), Jörn Hentschel (JE), Mats Hjertson (UPS), Ülle Reier (TU), Caroline Loup (MPU), Olof Ryding (C), Susan Lutz (US), Roxali Bijmoer (WAG), Hajo Esser (M), Patrik Mráz (PRC), Mark A. Spencer F.L.S. (LINN), Eva García Ibáñez (MA), Arne Anderberg (S), Norbert Holstein (BM), Michaela Schull (GE), Jim Solomon (MO), Arne Thell (LD), Marcus Lehnert (HAL), Aaron McArdle (MEL), Ernst Vitek (W), Bitá Askari (IRAN) and Ziba Jamzad (TARI). We are profoundly thankful to Mohammad Javad Nikjouyan, Mahnaz Arabameri, Akbar Nemati, Elham Hatami and Alireza Mokhtari for their help in the fieldwork and in providing the specimens and images.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. He, Y.; Xu, X.M.; Zhou, Y.; Liu, Q.R. *Onosma fuyunensis* (Boraginaceae), a new species from Xinjiang, China. *PhytoKeys* **2020**, *144*, 11–22. [[CrossRef](#)] [[PubMed](#)]
2. Cecchi, L.; Coppi, A.; Selvi, F. *Onosma juliae* (Boraginaceae), a new species from southern Turkey, with remarks on the systematics of *Onosma* in the Irano-Turanian region. *Phytotaxa* **2016**, *288*, 201–213. [[CrossRef](#)]
3. Mehrabian, A.; Amini Rad, M. *Onosma moussavi* sp. nov. (Boraginaceae) from Zagros Mountain(s), Iran. *Feddes Repert.* **2018**, *129*, 304–311. [[CrossRef](#)]
4. Moradi Zeinab, H.; Mehrabian, A.R.; Naghizadeh, S.; Mostafavi, H.; Khajoei Nasab, F. Distribution patterns, diversity and conservation priorities of *Onosma* L. (Boraginaceae Juss) in some sections of the northwestern geomorphologic unit of Iran. *Environ. Sci.* **2019**, *17*, 73–94. (In Persian) [[CrossRef](#)]
5. Naghizadeh, S.; Mehrabian, A.; Moradi Zeinab, H.; Mostafavi, H.; Khajoei Nasab, F. Distribution patterns, diversity and conservation Priorities of *Onosma* L. (Boraginaceae Juss) in part of Armeno-Iranian Province of Iran. *J. Plant Res. (Iran. J. Biol.)* **2021**, *34*, 451–463. (In Persian)
6. Davis, P.H.; Mill, R.R.; Tan, K. *Flora of Turkey and the East Aegean Islands*; Edinburg University Press: Edinburg, UK, 1988; Volume 10, (Suppl. S1), pp. 184–185.
7. Riedl, H.; Binzet, R.; Orcan, N. A new species of *Onosma* (Boraginaceae-Lithospermeae) from southern Turkey. *Edinb. J. Bot.* **2005**, *61*, 127–130. [[CrossRef](#)]
8. Binzet, R.; Orcan, N. A new species of *Onosma* (Boraginaceae) from Southern Turkey. *Novon* **2007**, *17*, 8–10.
9. Kandemir, A.; Türkmen, Z. A new species of *Onosma* (Boraginaceae) from eastern Turkey. *Turk. J. Bot.* **2010**, *34*, 277–282. [[CrossRef](#)]
10. Aytaç, Z.; Türkmen, Z. A new *Onosma* L. (Boraginaceae) species from southern Anatolia, Turkey. *Turk. J. Bot.* **2011**, *35*, 269–274. [[CrossRef](#)]
11. Mehrabian, M. Distribution patterns and diversity of *Onosma* in Iran: With emphasis on endemism conservation and distribution pattern in SW Asia. *Rostaniha* **2015**, *16*, 36–60. (In Persian)
12. Binzet, R. A new species of *Onosma* L. (Boraginaceae) from Anatolia. *Turk. J. Bot.* **2016**, *40*, 194–200. [[CrossRef](#)]
13. Binzet, R. *Onosma anatolica*, a new species of Boraginaceae from Turkey. *PhytoKeys* **2016**, *69*, 39–49. [[CrossRef](#)] [[PubMed](#)]
14. Binzet, R.; Eren, Ö. *Onosma erzincanica* (Boraginaceae: Lithospermeae), a new scree species from Turkey. *Phytotaxa* **2018**, *356*, 117–130. [[CrossRef](#)]
15. Firat, M.; Binzet, R. *Onosma satensis* sp. nov. (Boraginaceae: Lithospermeae), a new species from Hakkari (eastern Anatolia, Turkey). *Adansonia* **2021**, *43*, 185–195. [[CrossRef](#)]
16. Mehrabian, A.R.; Naghizadeh, S.; Khajoei Nasab, F.; Moradi Zeinab, H.; Mozaffarian, V. Two new species and a new record for *Onosma* L. (Boraginaceae) from northwestern Iran. *Feddes Repert.* **2022**. [[CrossRef](#)]
17. Teppner, H. Blüten und Blütenbesucher bei *Onosma* (Boraginaceae–Lithospermeae). *Feddes Repert.* **1996**, *106*, 525–532. [[CrossRef](#)]
18. Kolarčík, V.; Zozomova-Lihova, P.; Martonfi, V.J.J. Systematics and evolutionary history of the Asterotricha group of the genus *Onosma* (Boraginaceae) in central and southern Europe inferred from AFLP and nrDNA ITS data. *Plant Syst. Evol.* **2010**, *290*, 21–45. [[CrossRef](#)]
19. Mehrabian, A.; Mozaffarian, V. Seven New Species of *Onosma* L. (Boraginaceae) with emphasis on their habitats in Iran. *Taiwania* **2018**, *4*, 366–388. [[CrossRef](#)]
20. Khajoei Nasab, F.; Mehrabian, A.R.; Nemati, A. Taxonomic revision of the *Onosma gaubae* *Sensu lato* (Boraginaceae) based on morphological and ecological analysis. *Plant Biosyst.* **2020**, *155*, 1019–1031. [[CrossRef](#)]
21. Schur, P.J.F. *Enumeratio Plantarum Transsilvaniae, Exhibens Stirpes Phanerogamas Sponte Crescentes atque Frequentius cultas, cryptogamas vasculares, charceas, etiam muscos hepaticasque*; G. Braumüller: Vindobona, Austria, 1866; Volume xviii, p. 984.
22. Boissier, P.E. *Plantarum orientalium Novarum Decas Secunda ex Florae Orientalis Volumine Tertio mox Exituro Excerpta*; H. Georg: Geneva, Switzerland, 1875; p. 9.

23. Riedl, H. Boraginaceae. In *Flora iranica, Flora des Iranischen Hochlandes und der Umrahmenden Gebirge*; Rechinger, K.H., Ed.; University Press: Edinburgh, UK, 1967; Volume 48, pp. 1–28.
24. Mehrabian, A.R.; Sheidai, M.; Mozaffarian, V. Micromorphology of leaf trichomes in *Onosma* (Boraginaceae) and their systematic relevance in Iran. *Phytol. Balc.* **2014**, *20*, 33–48.
25. Binzet, R. *Onosma*. In *Türkiye bitkileri Listesi (Damarlı Bitkiler)*; Güner, A., Aslan, A., Ekim, T., Vural, M., Babaç, T., Eds.; Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını: İstanbul, Turkey, 2012; pp. 234–240.
26. Teppner, H. Die *Onosma alboroseum*-Gruppe (Boraginaceae). *Phyton* **1980**, *20*, 135–157.
27. Ghahreman, A.; Attar, F. A new species of the genus *Onosma* from W. Iran. *Iran. J. Bot.* **1996**, *7*, 51–55.
28. Attar, F.; Hamzeh'ee, B. *Onosma bisotunensis* (Boraginaceae), a new species from western Iran. *Novon* **2007**, *17*, 279–281.
29. Dehshiri, M.M. *Onosma zagrica* (Boraginaceae), a new species from Iran. *Phytotaxa* **2018**, *367*, 284–290. [[CrossRef](#)]
30. Boissier, P.E. *Diagnoses Plantarum orientalium Novarum*; B. Herrmann: Lipsia, Germany, 1849; Volume 11, p. 107.
31. Boissier, P.E. *Flora orientalis, sive enumeratio plantarum in Oriente a Graecia et Aegypto ad Indiae fines hucusque observatarum*; Georg, H.: Geneva, Switzerland; Basel, Switzerland; Leiden, Switzerland, 1879; Volume 4, p. 181.
32. Popov, M.G. Family CXXXVIII. Boraginaceae G. Don. In *Flora URSS [In Russian]* 19; Shishkin, B.K., Ed.; Akademia Nauk: Moscow, Russia, 1953; pp. 97–690. (In Russian) [pp. 73–507 of the English translation]
33. Khatamsaz, M. *Flora of Iran*; Assadi, M., Maassoumi, A.A., Khatamsaz, M., Eds.; Research Institute of Forests and Rangelands: Tehran, Iran, 2002; Volume 39, pp. 114–167.
34. Riedl, H. Beiträge zur Kenntnis der Gattung *Onosma* in Asien (Vorarbeiten zu K. H. Rechinger, Flora Iranica III). *Oesterreichische Bot. Z.* **1962**, *109*, 213–249. [[CrossRef](#)]
35. Almasi, M.; Ranjbar, M. *Onosma maculata* sp.nov. (Boraginaceae) from Iran. *Nord. J. Bot.* **2015**, *33*, 522–525. [[CrossRef](#)]
36. Thiers, B.M. (Continuosly Updated): Index Herbariorum. 2020. Available online: <http://sweetgum.nybg.org/science/ih/> (accessed on 23 August 2020).
37. Ledebour, C.F. *Plantae novae Rossiae meridionalis ex Asperifoliarum familia*. In *Beiträge zur Naturkunde aus den Ostseeprovinzen Russlands*; Pander, H.C., Ed.; Schünmann, J.C.: Dorpa, Estonia, 1820; Volume 1, pp. 70–72.