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СИСТЕМАТИЧЕСКИЕ ОБЗОРЫ И НОВЫЕ ТАКСОНЫ

ASTRAGALUS FERDOWSI-TOOSII (SECT. *DISSITIFLORI*, FABACEAE), A NEW SPECIES FROM NORTHEASTERN IRAN

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Astragalus ferdowsi-toosii is described and illustrated as a new species from Zarnikh Mountain, Khorassan-Kopet Dagh Floristic Province, Iran. Based on a number of morphological features, such as bifurcated hairs, free stipules, imparipinnate leaves, and missing bracteoles, the new species belongs to the *Astragalus* sect. *Dissitiflori*. Notes on its taxonomy, distribution, and ecology as well as evaluation of conservation status are provided.

Keywords: *Astragalus*, new species, sect. *Dissitiflori*, Fabaceae, NE Iran, endemism

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Astragalus L. (1753: 755) (*Gævæn* in Persian), with 3066 accepted species (POWO, 2024), is the largest genus of flowering plants on earth. The Irano-Turanian floristic region is an outstanding area of the natural diversity of the genus globally. It is also the most diverse genus in Iran with about 850 accepted species (Ghahremaninejad et al., 2022). The mega genus *Astragalus* is divided into 136 sections in the Old World (Podlech, Zarre, 2013). The presence of sections, many of which are not monophyletic (Azani et al., 2017, 2019), is practicable for easier identification of its very numerous and diverse species. A group of morphological characters delineates each of these sections, and one of the most notable is undoubtedly that of hair features (Zarre, 2003; Ghahremaninejad, 2004).

Astragalus sect. *Dissitiflori* DC. (1825: 284) is a section comprising bifurcated-hair plants, around 170 species worldwide, with nearly 21 species found in Iran. The section stands as the largest bifurcated-hair section within the genus *Astragalus* on a global scale. The primary centers of diversity for this section are located within the Turkestanian and Armeno-Iranian floristic provinces of the Irano-Turanian region. Its extensive distribution spans from Europe through the former Soviet Union, to China and Mongolia (Maassoumi et al., 2000; Ghahremaninejad et al., 2020).

In this paper, we describe a new species of the genus *Astragalus* discovered during botanical excursions in Khorassan, northeastern Iran. Khorassan, particularly its northern regions, has a significant level of species diversity within the genus *Astragalus* (Ghahremaninejad et al., 2016). Morphological evidence such as bifurcated hairs, free stipules, imparipinnate leaves, and missing bracteoles, support the taxonomic position of our new species within the *Astragalus* sect. *Dissitiflori*. About 200 *Astragalus* species have been recorded, and classified into 45 sections, in the Khorassan provinces of northeastern and eastern Iran (including North Khorassan, Razavi Khorassan, and South Khorassan provinces) (based on Podlech, Zarre, 2013). This accounts for approximately 23% of *Astragalus* species in Iran. The Khorassan-Kopet

Dagh floristic province in northeastern Iran is recognized worldwide for its exceptional plant species diversity, establishing it as a key biodiversity hotspot. Over 2500 vascular plant species have been recorded in this particular area, with nearly 30% of them identified as either endemic or sub-endemic (Memariani et al., 2016a, b; Memariani, 2020). The remarkable levels of plant diversity and endemism in this region highlight its ecological significance and exceptional nature as a floristic province.

MATERIAL AND METHODS

The specimens of the new species were collected from Zarnikh Mount, Razavi Khorassan Province (Iran) during two field trips conducted from May to June 2014 and are kept at FUMH (herbarium acronyms follow Thiers 2023+). We reviewed and consulted the descriptions and identification keys in the relevant literature (Podlech et al., 2010; Podlech, Zarre, 2013). The features of gross morphology of the specimens were examined under a binocular stereomicroscope and compared with those of similar closely related species at FUMH, T, P, W, and virtual herbaria of K and MW. The conservation status of the species was determined based on the IUCN Red List categories and criteria (IUCN, 2019).

DESCRIPTION OF THE NEW SPECIES

Astragalus sect. ***Dissitiflori*** DC., 1825, Prodr. **2**: 284.

=*Pedina* Steven, 1856, Bull. Soc. Imp. Naturalistes Moscou, 29: 144. ≡*A.* sect. *Pedina* (Steven) Bunge, 1868, Mém. Acad. Imp. Sci. Saint Pétersbourg, 11(16): 96.

=*A.* sect. *Xiphidium* Bunge, 1868, Mém. Acad. Imp. Sci. Saint Pétersbourg, 11(16): 123.

=*A.* sect. *Cystodes* Bunge, 1868, Mém. Acad. Imp. Sci. Saint Pétersbourg, 11(16): 133.

=*A.* sect. *Tricholobos* Freyn, 1905, Bull. Herb. Boiss., sér. 2, 5: 560.

Astragalus ferdowsi-toosii F. Ghahrem., Joharchi & Memariani ***sp. nova*** (sect. *Dissitiflori*) (Fig. 1–3).

Type: IRAN. Razavi Khorassan Province: Kashmar, Kuh-Sorkh, SW Chalpo, N slope of Zarnikh Mount, 2020 m, 35°35′58.1″ N, 58°30′45.2″ E, 25 05 2014, *Joharchi 45225* (holotype FUMH!; isotypes FUMH!, T!).

Plants up to 37 cm tall, subshrubby, often ligneous only at the base. Hairs at stems and leaves medifixed, appressed, at bracts and calyx mostly sub-basifixed to basifixed. Stems several, up to 20 cm, ascending, parts of the year up to 15 cm, very densely hairy. Stipules 2.75–4.5 mm long, 1–2 mm broad, greenish, triangular, free from the petiole, densely white hairy or together with few black hairs or with dense black hairs at the lower part and the node. Leaves imparipinnate, 2.5–6 cm; petiole 0.3–2 cm, like the rachis slender and densely white hairy. Leaflets in 5–12 pairs, 5–12 × 1–4 mm, elliptic to oblong, obtuse to subacute, on both sides mostly densely white hairy. Peduncles 4–15 cm, covered with white, just below the raceme also with few black hairs. Racemes densely 5–22-flowered, capitate to shortly ovate or wider than long, roughly elongated at fruiting time. Bracts mostly greenish, lanceolate-triangular to lanceolate-

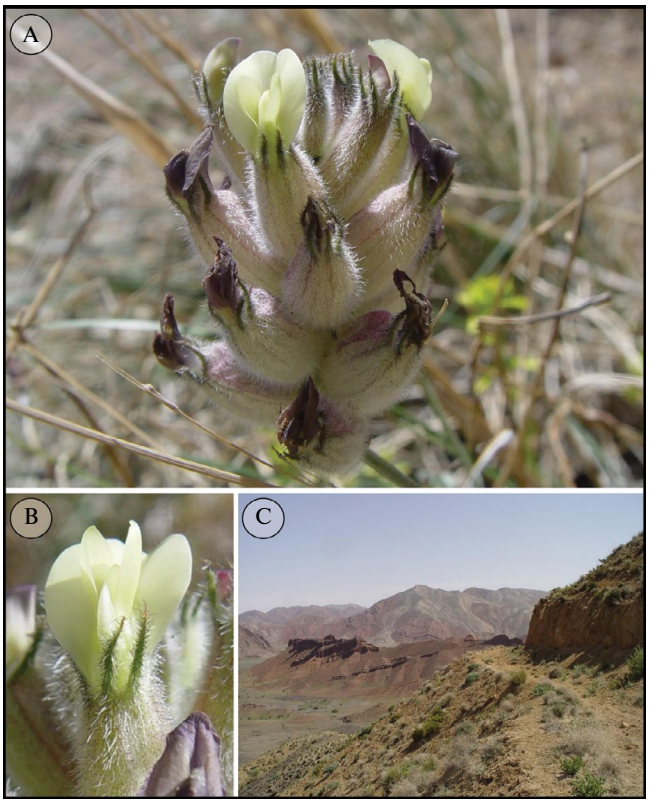

Fig. 1. *Astragalus ferdowsi-toosii* in its natural habitat. A – inflorescence; B – close-up view of a flower; C – Zarnikh Mount where very few populations of *A. ferdowsi-toosii* are found in the montane steppe vegetation.

Рис. 1. *Astragalus ferdowsi-toosii* в естественном местообитании. A – соцветие; B – цветок крупным планом; C – гора Зарних, где среди горной степной растительности встречается очень малое число популяций *A. ferdowsi-toosii*.

acuminate, acute, 3–5 mm long, densely black hairy. Pedicels ca. 0.5 mm, white and black hairy. Calyx 15–16 mm, at first tubular, during the flowering and fruiting stage somewhat swollen, nearly elliptically inflated (up to ca. 8 mm broad), densely villous with spreading, basifixed white and few black mixed hairs, black hairs usually shorter, very asymmetrically bifurcate to nearly basifixed; teeth subulate-setaceous, 4–6 mm, densely black hairy together with fewer white hairs. Petals light yellow, later turning blue to dark blue. Standard 20–22.5 mm; blade 8 × 10 mm wide, obovate to slightly panduriform, round to very slightly emarginated. Wings 20–21.5 mm; blades narrowly oblong to elliptic, 6.5–7 × 2.5–3 mm, rounded; auricle ca. 0.5 mm, claw 14–14.5 mm. Keel 17.5–18.5 mm; blades obliquely elliptic-triangular, acute, ca. 6.5 × 3.5 mm; claw 11–12 mm. Stamen-tube nearly truncate at the mouth, 18–19 mm long. Ovary nearly sessile, white hairy with fewer black hairs; style glabrous, at lower part with few hairs. Unripen legumes erect, nearly subsessile, oblong, densely villous.

Additional specimens examined (Paratypes): IRAN. Razavi Khorassan Province: Kashmar, Kuh-Sorkh, SW Chalpo, N slope of Zarnikh Mount, 2020 m, 35°35′58.1″ N, 58°30′45.2″ E, 17 06 2014, *Joharchi & Zangooei 45264* (FUMH!); Razavi Khorassan Province: Kashmar, NE Khezr Beig, Zarnikh Mount, 2020 m, 35°35′51″ N, 58°27′59″ E, 25 05 2014, *Joharchi 45215* (FUMH!).

Eponymy: The specific epithet honors Hakim Abolghasem Ferdowsi Toosi (940–1020 AD), one of the greatest Iranian poets and an everlasting pillar of Persian literature. His famous book is one of the most revered epics in the world, and has succeeded in reviving and preserving the Persian Language over time. It is worth noting that many of plants mentioned in the book such as *Indigofera tinctoria* L. (*Neel* in Persian), *Cercis griffithii* L. (*Arghavan* in Persian), and *Alhagi* sp. (*Moghilan* in Persian), belong to the family Fabaceae (*Baghela'iyan* in Persian), like our new species. Ferdowsi was born, lived, and died in the Khorassan province. Previously, four other plant taxa, i. e., *Silene ferdowsii* (Nejati Edalatiyan et al., 2011), *Euphorbia ferdowsiana* (Pahlevani et al., 2015), *Iris ferdowsii* (Memariani, Joharchi, 2017), and *Schlerorhachis ferdowsii* (Hassanpour et al., 2023) have been named in his honor.

Taxonomic relationships: *Astragalus ferdowsi-toosii* is related to the species of the *Astragalus* sect. *Dissitiflori* by its more or less inflated calyx. Previously, al-

Fig. 2. Holotype specimen of *Astragalus ferdowsi-toosii* (*Joharchi 45225-FUMH*) collected from Zarnikh Mount, NE Iran.

Рис. 2. Голотип *Astragalus ferdowsi-toosii* (*Joharchi 45225-FUMH*), собранный на горе Зарних, СВ Иран.

most all of these species were placed in the *Astragalus* sect. *Cystodes* Bunge (1868: 133), now included in the *A.* sect. *Dissitiflori*. Based on this fact, the relatives of the new species could be *A. medius* Schrenk (native to East European Russia, Kazakhstan – POWO, 2024), *A. albicaulis* DC. (native to Europe to north Caucasus – POWO, 2024), and *A. vesicarius* L. (native to Europe – POWO, 2024). When using certain identification keys, it somewhat resembles *A. alamliensis* Rech. f. (1941: 255) from *A.* sect. *Erioceras* Bunge (1868: 109) due to inflated calyx.

Our new species differs from its three relative species in several character states in stipules, leaflet pairs, number of flowers, bract color, calyx, petals, etc. These differences, and at the same time similarities, can be clearly seen in Table 1. It is clear that these four species are geographically separated and distant,

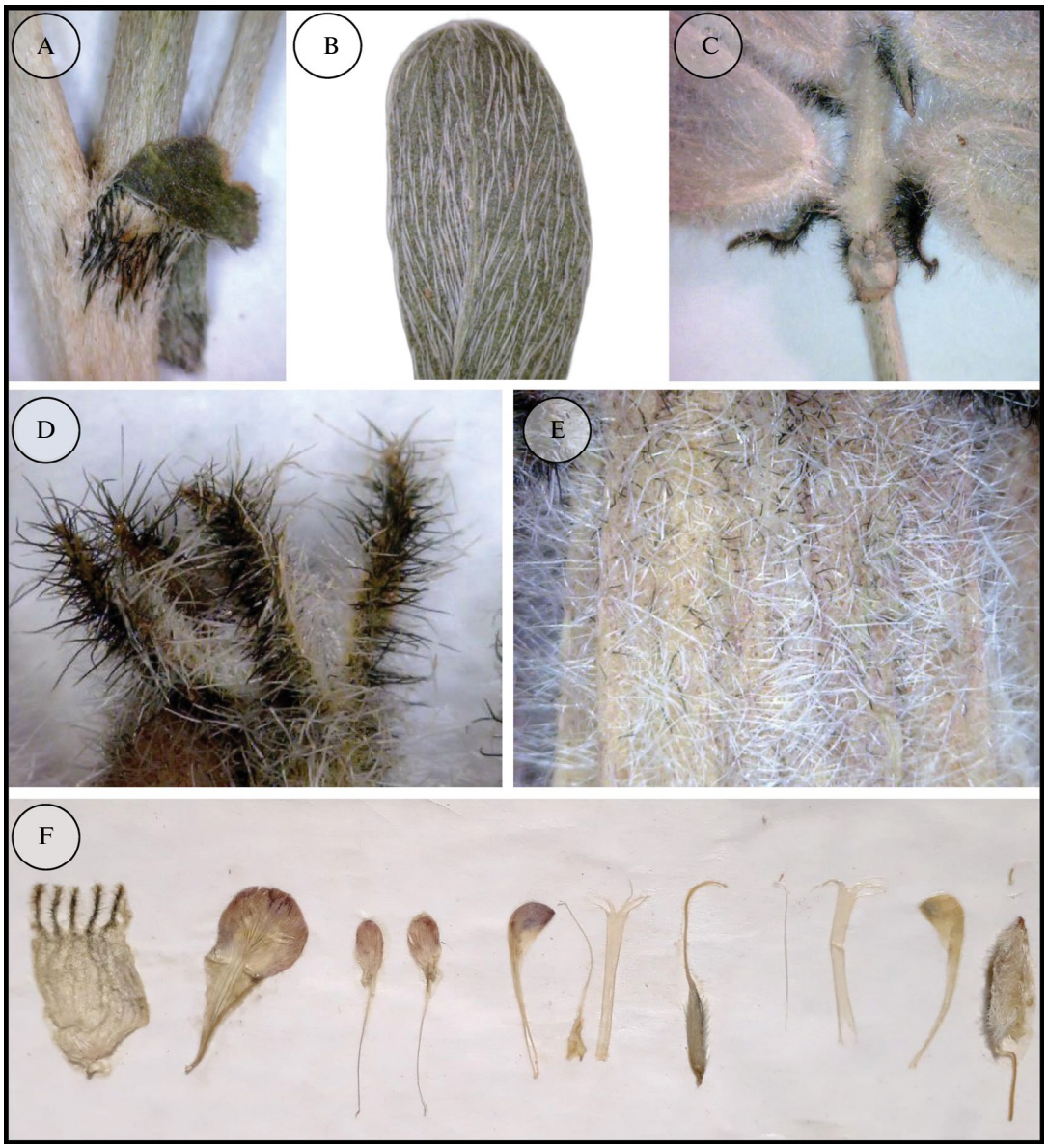

Fig. 3. Some details of morphological characters in *Astragalus ferdowsi-toosii*. A – stipules and their black hairs; B – a leaflet with white dense bifurcate hairs; C – black densely hairy floral bracts; D – calyx teeth with dense black hairs; E – calyx tube with spreading, basifixed white and few black mixed hairs; F – dissected floral parts.

Рис. 3. Некоторые детали морфологии *Astragalus ferdowsi-toosii*. A – прилистники с черными волосками; B – листочек с белыми густыми двуконечными волосками; C – черно-густоволосистые прицветники; D – зубцы чашечки с густыми черными волосками; E – трубка чашечки с отстоящими неветвистыми белыми волосками с примесью немногочисленных черных; F – препарированные части цветка.

namely from France to Kazakhstan and from there to the northeast of Iran. Perhaps this is geographical remoteness that makes their relationship with each other doubtful at first glance. However, morphologically, their similarity with each other is undeniable. Especially by looking at the virtual herbaria, e. g. JACQ virtual herbarium (https://www.jacq.org/#database) this similarity can be confirmed. In order not to make this article unnecessarily long, we refrained from bringing pictures of the herbarium specimens of these three relatives here; anyway, readers can easily visit this virtual herbarium. However, Table 1 shows the close relationship of these four species. Perhaps we can consider these species as four vicariant ones that had a common origin; and over time, speciation has occurred for them.

Table 1. Comparison of morphological characters of *Astragal*us *ferdowsi-toosii* with related species in *Astragalus* sect. *Dissitiflori*

Table 1. Сравнение морфологических признаков *Astragalus ferdowsi-toosii* с родственными видами *Astragalus* из секции *Dissitiflori*

Character	Species			
	A. ferdowsi-toosii	*A. albicaulis*	*A. vesicarius*	*A. medius*
Plant height, cm	up to 37	20–40(–50)	up to 35	(18–)25–50
Stipule length, mm	2.75–4.5	3–6	2–3	2.5–4
Leaf length, cm	2.5–6	3–8	4–6	(1.5–)2.5–5
Petiole length, cm	0.3–2	0.6–2.5	1.5–3.5	0.5–0.8
Number of leaflet pairs	5–12	3–5(–6)	(3–) 5–10	2–4
Leaflet length × width, mm	5–12 × 1–4	6–25 × 1–6(–10)	4–12 × 1.1–3	(5–)8–15(–20) × 1.5–5
Peduncle length, cm	4–15	10–25	3–19	4–12
Number of flowers in raceme	5–22	7–18	3–20	5–10
Bract length, mm	3–5	3–5	2.5–5	4–7
Bract color	Mostly greenish	Whitish	Whitish	Whitish
Pedicel length, mm	c. 0.5	c. 0.5	c. 0.5	c. 2
Calyx length, mm	15–16	10–12	8–12	12–15(–20)
Calyx teeth length, mm	4–6	2–4	2–4	3–5
Calyx teeth shape	Subulate-setaceous	Subulate	Subulate	Subulate or triangular
Petal color	Pale yellow, blue to dark blue	Whitish to yellow	Purplish to violet	Pale yellow
Standard dimension	20–22.5 × 8–10 mm	(18–)20–27 × 7–9	17–23 × 6–10	20–26 × 8–9
Standard blade shape	Round to very slightly emarginate	Emarginate to bilobed	Emarginate	Widely emarginate
Wing length, mm	20–21.5	17–20	15.5–20(–21.5)	19–24
Wing blade length × width, mm	6.5–7 × 2.5–3	7–8 × 2.2–3.5	6.5–7 × 2.5–3.5	5–9 × 3–5
Wing claw length, mm	14–14.5	c. 12	10–11	14
Keel length, mm	17.5–18.5	15–17	13–16(–18)	18–20
Keel blade length × width, mm	6.5 × 3.5	5–6 × 2.4–3.5	c. 6 × 3	6–8 × 3.5–4
Keel claw length, mm	11–12	c. 11	8–11	12–13

Distribution, habitat, and conservation: According to current information, *A. ferdowsi-toosii* is a rare local endemic species in the southern zone of the Khorassan-Kopet Dagh floristic province (Fig. 4A). It is restricted to the middle montane steppes (around 2000 m a. s. l.) of Mount Zarnikh (the Persian word for Orpiment). The area has an average temperature of 17.8 °C and an average annual precipitation of about 180 mm. On the mountain slopes, it is covered with deep yellow-orange colored soils composed of silt and clay, resulted from the erosion of ophiolitic rocks. These soils are highly rich in Arsenic and Sulfur especially in the form of orpiment (As_2S_3) mineral (Parvaresh et al., 2017; Mirtadzadini, Joharchi, 2017). The unique ecological features of the area have led to the establishment of xeromorphic vegetation with several edaphic endemic and heavy-metal resistant taxa, some of which have recently been recognized and introduced as new species, e. g., *Jurinea khorassanica* Joharchi & Mirtadz. (Mirtadzadini, Joharchi, 2017).

Astragalus ferdowsi-toosii can be considered critically endangered (CR: B1 + B2ab(iii)) based on its highly restricted populations and the extent of occurrence in Zarnikh Mount (Fig. 4B). This may face the

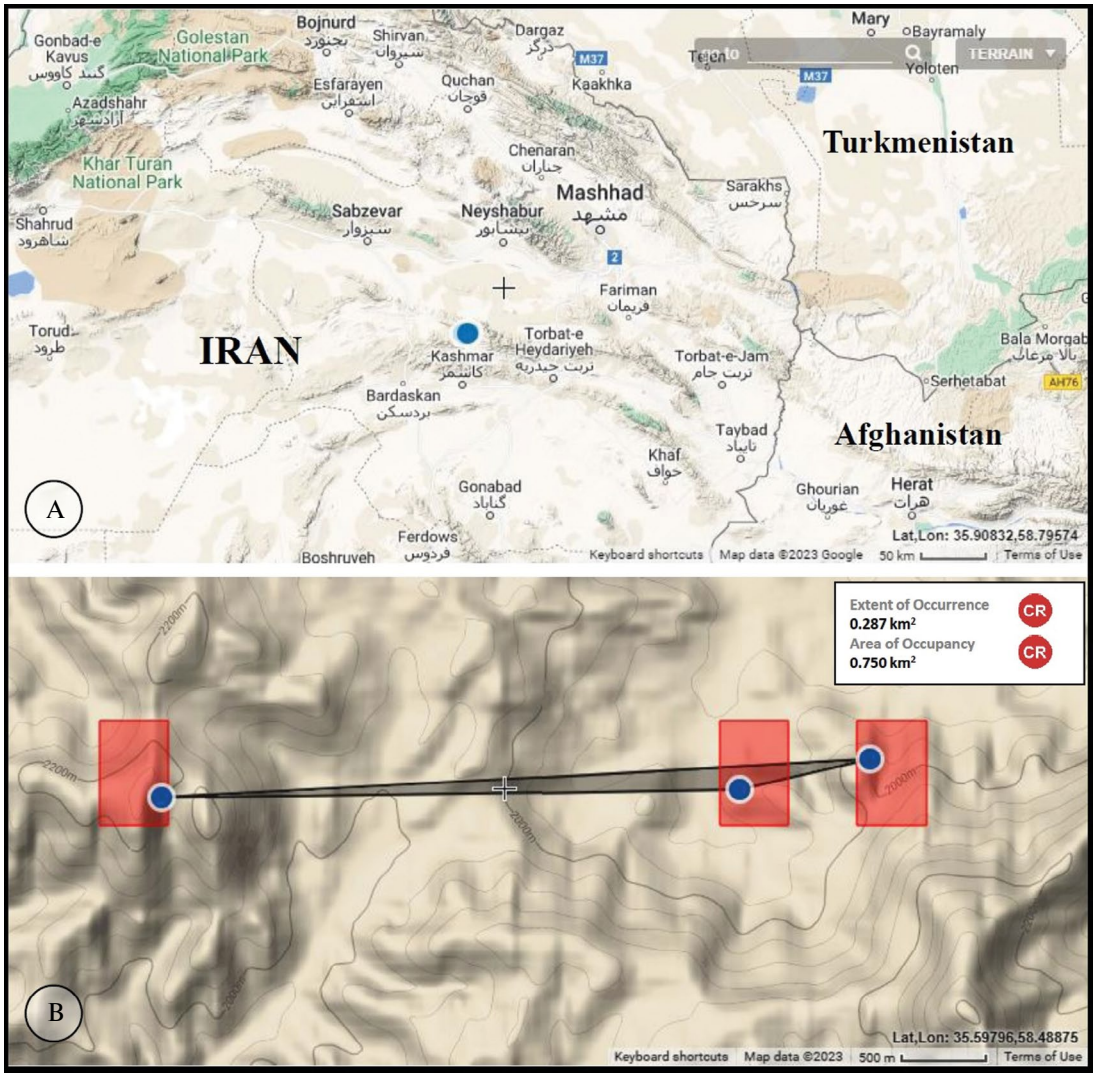

Fig. 4. Distribution maps of *Astragalus ferdowsi-toosii*. A – Geographical position of the study area and location of *A. ferdowsi-toosii* populations (blue circles) in Kashmar-Torbat mountain range, southern part of Khorassan-Kopet Dagh floristic province, NE Iran; B – GeoCAT distribution map of the species, and estimation of Extent of Occurrence (EOO) and Area of Occupancy (AOO), with maximum distance of 4.5 km between pairs of points, based on IUCN Red List Criteria.

Рис. 4. Карты распространения *Astragalus ferdowsi-toosii*. А – географическое положение исследуемой территории и расположение популяций *A. ferdowsi-toosii* (синие кружки) на горном хребте Кашмар-Торбат, южная часть Хорасан-Копетдагской флористической провинции, СВ Иран; В – карта распространения вида GeoCAT и оценка области распространения (EOO) и области обитания (AOO) с максимальным расстоянием между парами точек 4.5 км на основе критериев Красного списка МСОП.

new species at extremely high risk of extinction. Unfortunately, based on our field observations during 2023, its populations have been negatively affected by the prolonged drought in recent years. The type location is also inhabited by a number of endemic and/or threatened species, such as *Jurinea khorassanica* Joharchi & Mirtadz., *Astragalus neyshabourensis* Podlech, *Cousinia bienertii* Bunge, and *Asparagus khorassanensis* Hamdi & Assadi. Several less-explored sites in the Khorassan-Kopet Dagh harbor the edaphic endemic species on calcareous, serpentine, and gypsum soils, most of which are rare and endangered plants on the verge of extinction (Memariani, 2018, 2020; Amiri et al., 2022). Therefore, urgent *in situ* and *ex situ* conservation efforts for rare and threatened species as well as continuous monitoring of the vegetation in dramatically changing environments are recommended.

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ASTRAGALUS FERDOWSI-TOOSII (СЕКЦИЯ *DISSITIFLORI*, FABACEAE) – НОВЫЙ ВИД ИЗ СЕВЕРО-ВОСТОЧНОГО ИРАНА

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Описан новый вид астрагала из провинции Хорасан-Резави (Северо-Восточный Иран), *A. ferdowsi-toosii*, названный в честь персидского поэта Абулькасима Фирдоуси (ок. 940–1020). Новый вид является локальным эндемиком высокогорий Zarnikh Mount близ города Кашмер. Характерный признак *A. ferdowsi-toosii* – сильно вздувающаяся чашечка – свидетельствует о формальной принадлежности к секции *Cystodes* Bunge, в настоящее время вошедшей в секцию *Dissiti flori* DC. Авторы сравнивают признаки близких видов *A. vesicarius*, *A. medius*, *A. albicaulis* в сводной таблице. Популяция *A. ferdowsi-toosii* требует охраны, по наблюдениям 2023 г. на нее негативно влияет продолжительная засуха последних лет.

Ключевые слова: *Astragalus*, новый вид, sect. *Dissiti flori*, Fabaceae, Северо-Восточный Иран, эндемизм

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