Nova Biologica Reperta 6(3): 326-333 (2019)
Print ISSN: 2423-6330/Online ISSN: 2476-7115
https://nbr.khu.ac.ir; Kharazmi University Press; DOI: 10.29252/nbr.6.3.326

یافته‌های نوین در علوم زیستی
جلد ۶، شماره ۳، صفحات ۳۲۶ الی ۳۳۳ (۱۳۹۸)
انتشارات دانشگاه خوارزمی

استیپا ریکتریانا (تیره گندمیان) و گالیوم سونگاریکوم (تیره روناسیان): دو گزارش جدید از گونه‌های آسیای مرکزی برای فلور ایران

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چکیده. گزارش جدیدی از دو گونه *Stipa richteriana* و *Galium songaricum* برای فلور ایران در این مطالعه ارائه می‌شود. گستره پراکندگی جغرافیایی این گونه‌ها که از کوه‌های بینالود و هزار مسجد در استان خراسان رضوی جمع‌آوری شده‌اند، به طور عمده مربوط به آسیای مرکزی است. ریخت‌شناسی این گونه‌های جدید برای ایران با گونه‌های خویشاوندشان مقایسه و اطلاعاتی درباره آرایه‌شناسی، بوم‌شناسی، جغرافیای گیاهی و وضعیت حفاظتی آنها ارائه می‌شود.

واژه های کلیدی. آرایه شناسی، تنوع زیستی، جغرافیای گیاهی، حفاظت، خراسان-کپه‌داغ

Stipa richteriana (Poaceae) and *Galium songaricum* (Rubiaceae): two new additions of the Central Asian species to the flora of Iran

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Abstract. *Stipa richteriana* and *Galium songaricum* are newly recorded species for the flora of Iran, collected from Binalood and Hezar-Masjed Mountains in Razavi Khorassan Province. The geographical distribution of both species is mainly confined to the Middle Asia. Morphological characters of two newly recorded species are compared with their close relatives. Notes on taxonomy, ecology, phytogeography, and conservation status of both species are provided.

Keywords. biodiversity, conservation, Khorassan-Kopet Dagh, phytogeography, taxonomy

Received 15.06.2018/ Revised 30.05.2019/ Accepted 11.06.2019/ Published 20.10.2019
دریافت: ۱۳۹۷/۰۳/۲۵/ اصلاح: ۱۳۹۸/۰۳/۰۹/ پذیرش: ۱۳۹۸/۰۳/۲۱/ انتشار: ۱۳۹۸/۰۷/۲۸

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INTRODUCTION

The Khorassan-Kopet Dagh floristic province (KK) is situated mostly in the mountains of northeastern Iran and partly extending to the neighboring parts of southern Turkmenistan. The area encompasses very diverse flora and vegetation types. As a transitional zone, KK is a corridor connecting different phytogeographical units of the Irano-Turanian region such as Central Iranian, Afghan, Aralo-Caspian, and the Middle/Central Asian, as well as the Hyrcanian province of the Euro-Siberian region. Moreover, the presence of a local center of plant endemism has made the area a unique and separate biogeographical entity (Memariani *et al.*, 2016a). A comprehensive analysis of the plant diversity showed that the level of endemism in KK is about %14 (Memariani *et al.*, 2016b), which is higher than the average in neighboring Central Asia (Sennikov, 2016). The KK is a part of the Irano-Anatolian mountain system, which is recognized to be amongst the thirty-five so-called hotspots of biodiversity in the World (Mittermeier *et al*., 2011).

In growing seasons of 2017-2018, during ecological studies on selected endemic plants in Khorassan- Kopet Dagh, we recorded and collected some unknown plant specimens, in phytosociological releves, belonging to the genera *Stipa* and *Galium*. Using the identification keys in the relevant Floras, they were determined as two new species not previously recorded from Iran.

Stipa L. is one of the largest genera in the family Poaceae. Based on the narrow taxonomic concept, it comprises over 150 species in temperate regions of the Old World (Barkworth & Everett, 1987; Nobis, 2014). Central Asia is an important center of diversity of *Stipa* with ca. 70 species (Nobis *et al.*, 2013, 2017). According to Bor (1970), in Flora Iranica, this genus is represented by 18 species in Iran. In the monograph of *Stipa* in the southwest and south Asia, Freitag (1985) recorded 22 species from Iran. Based on published works, 13 species of *Stipa* are recognized for the flora of Khorassan in northeastern Iran (Freitag, 1985; Joharchi *et al.*, 2007; Ghahremaninejad *et al.*, 2012; Memariani *et al.*, 2016c).

Galium L., with about 667 species distributed worldwide, is the largest genus of the tribe Rubieae in the family Rubiaceae (Yang *et al.*, 2018). It is a taxonomically problematic genus and its species groups are often poorly differentiated morphologically and geographically. In the Flora Iranica, 45 *Galium* species are recorded for Iran (Ehrendorfer *et al.*, 2005). Based on current data, 12 *Galium* species occur in Khorassan provinces (Joharchi *et al.*, 2007; Ghahremaninejad *et al.*. 2010).

In this paper, we aim to document the new records of *Stipa* and *Galium* species for the flora of Iran as well as revised descriptions of both species based on collected specimens from Binalood and Hezar-Masjed mountains in Razavi Khorassan Province. We also provide additional notes on their taxonomy, ecology, and biogeography.

MATERIALS AND METHODS

The plant specimens were collected during 2017-2018 field excursions in Khorassan-Kopet Dagh Mountains and vegetation data were recorded in phytosociological releves. The herbarium specimens were examined using identification keys and species descriptions in relevant Floras and monographs (Tzvelev, 1976; Freitag, 1985; Pobedimova, 2000; Ehrendorfer *et al.*, 2005). We consulted the images of the type and representative specimens of newly recorded species and their close relatives in B, MW, and W herbaria in order to confirm their identity (herbarium codes based on Thiers, 2018). The plant specimens are preserved in the Herbarium of Ferdowsi University of Mashhad (FUMH). We produced a distribution map for both species using collection data of the herbarium specimens in ArcGIS 10.3 software. The threat status of the species was determined based on the IUCN Red List categories and criteria (IUCN, 2016).

RESULTS AND DISCUSSION

New records

***Stipa richteriana* Kar. & Kir.,** Bull. Soc. Imp. Nat. Moscow 14 (4): 862 (1841). (Fig. 1, 2 A-D)
Type: E. Kazakhstan, in lapidosis mont. Arganaty, 1840, Karelin 907 (LE).

Perennial, caespitose, densely tufted, basal branching intravaginal, with few culms and many vegetative shoots; culms 59-60 (-70) cm, 3-noded, densely pubescent below the nodes; leaf-sheaths densely pubescent, outer margin hairy, at the junction with the blades densely bearded; ligules obscure, up to 0.2 mm long, ciliate at the margin; blades at the culm leaves up to 7 (-8) cm long, at the vegetative shoots up to 15 (-20) cm long, usually involute, 0.3-0.5 mm diam., upper surface densely pubescent, beneath pubescent at the base; panicle (15-) 20-25 × (1-) 2 cm, open, linear, exserted or embraced at base by subtending leaf, the branches ascending with 1-5 spikelets; spikelets 10-15 mm long, glumes persistent, subequal, acuminate, margins and tip hyaline, setulose along the primary vein, the lower 3-5-nerved, the upper 7-nerved; anthecium 6-7 mm long; callus 0.6-0.8 mm long, densely bearded; lemma lanceolate, coriaceous,

Fig. 1. Herbarium specimen of *Stipa richteriana* (Memariani & Behroozian 46440, FUMH).

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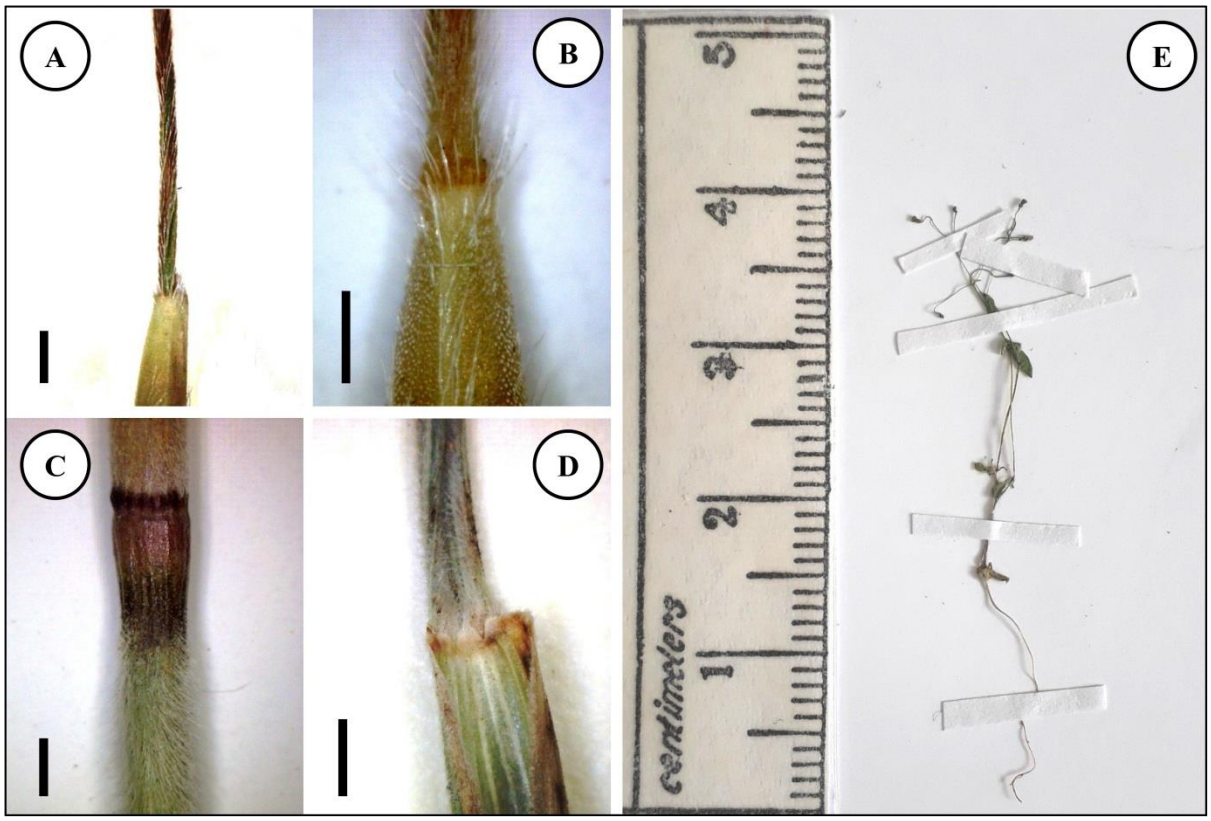

Fig. 2. A-D. Some details of morphological characters in *Stipa richteriana* (Memariani & Behroozian 46440, FUMH), scale bars = 1 mm. **A.** the minutely pubescent awn with twisted columna. **B.** the entire lemma apex with a crown of hairs. **C.** the densely pubescent culm below the nodes. **D.** the collar showing the short membranous and ciliolate ligule with densely pubescent leaves on upper surface. **E.** the dwarf *Galium songaricum* plant (Joharchi & Behroozian 46259, FUMH).

without keel, with 0.5 mm long ascending hairs, only the marginal hairs almost reaching the top, the top with a crown of 0.5-1.5 mm long hairs; awn bigeniculate, (5-) 6-7 cm long, minutely pubescent throughout, columna densely twisted, with 0.2 mm long hairs, seta falcate with 0.5 mm long hairs; palea equalling lemma in length, glabrous, with a tuft of a few hairs at the apex; lodicules 3, 1.5 mm long, glabrous; anthers 3, 3-4 mm long, yellow; ovary glabrous, with 2 stigmas; caryopsis fusiform.

Specimen seen: Razavi Khorassan province: NW Neyshabur, Bargish (Baharkish), above Oghbaei garden, 2210 m, 36° 41′ 41.9″N, 58° 40′ 6.9″E, Memariani & Behroozian 46440 (FUMH).

General distribution: Central Asiatic, mainly in Kazakhstan, Uzbekistan, Western China, and Eastern Afghanistan, and also in NE Iran (in the present work).

Taxonomy: *Stipa richteriana* belongs to section *Stipa*, species group of "*Eriostipa*" (Freitag, 1985). *S. bungeana* Trin. is another Central Asiatic species which is known as one of the close relatives of *S. richteriana*. Freitag (1985) recorded *S. richteriana* from Afghanistan on the basis of a specimen from higher mountains of Hindukush in Ghazni Province, which was misidentified by Bor (1970) as *S. bungeana*. The latter species can be distinguished from *S. richteriana* by some morphological characters such as its shorter anthecium, glabrous awn, and different leaf and lemma indumentum (Table 1). *S. richteriana* can be confused with *S. haussknechtii* Boiss. (sect. *Lasiagrostis* (Link) Hackel), which is an endemic feather grass to Iran. However, it clearly differs from the latter by its contracted linear vs. very loose ovate panicle, among other characters (Table 1). The Central Asiatic *S. breviflora* Griseb. is separated from *S. richteriana* by its longer awns (over 9 cm long) and longer hairs on seta (1-2 mm long) (Nobis *et al*., 2016).

***Galium songaricum* Schrenk ex Fisch. & C.A.Mey.**, Enum. Pl. Nov. 1: 57 (1840) (Fig. 2E).

Annual; roots thin, thread-like, reddish or brown; stems fragile, prostrate, thin, branched, (3-) 5-20 cm long, glabrous, rarely with scattered, long hairs, quadrangular; leaves 2, arranged in a whorl with two smaller leaf-like stipules, (2.5-) 5-15 (-23) mm long, (1.5-) 2.5-5 (-8) mm wide, lowest leaves obovate to

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Table 1. Morphological and chorological comparison of *Stipa richteriana* with its closely relates species.

Character	*Stipa bungeana*	*Stipa haussknechtii*	*Stipa richteriana*
Ligule	Eciliate	Eciliate	ciliolate
Leaf-blade state	conduplicate	involute	involute
Leaf-blade width	0.76-1.3 mm	2-3 mm	0.3- 0.5 mm
Leaf-blade surface	glabrous	glabrous	pubescent
Panicle shape	lanceolate	ovate	linear
Upper glume	3-5-veined	3-veined	7-veined
Anthecium	4.5-5 mm long	7 mm long	6-7 mm long
Column of lemma awn	scabrous	puberulous	puberulous
Lemma surface hairy	below	all along	all along
Lemma apex shape	entire	Dentate	entire
Palea apex	undifferentiated	undifferentiated	ciliate
Geographical distribution	Middle/Central Asia	Endemic to Iran (C, SW, S)	Middle/Central Asia, E Afghanistan, NE Iran (new record)

spatulate, other leaves elliptic to lanceolate-elliptic, obtuse to slightly acute, 1-nerved, thin, glabrous on both sides, less commonly covered with scattered, upright hairs, petiole 0.5-1.5 mm long; inflorescence as axillary cymes, 1-2(-3)-flowered; pedicels glabrous, thin, (3-) 12-20 (-40) mm long, longer than leaves, often with a pair of small bracts somewhat above the middle of the pedicel, rarely 2-3 flowers on short pedicel, usually horizontally directed, corolla white, sometimes with purplish lobes, rotate, (0.2-) 0.5-1 mm in diameter, lobes 4 (rarely 3), wide, ovate-triangular, acute; stamens 4 (-5)-lobed, anthers yellow; style two-parted almost from the middle; ovary glabrous to rarely hispid; Mericarps 2, globular to reniform, less commonly with one mericarp, 0.2-2 × 0.2-2.5 mm, glabrous or covered with long, hooked-curved, white hairs.

Specimen seen: Razavi Khorassan province: N Mashhad, SW Balghour, 2150 m, 36° 49′ 58.3″N, 59° 35′ 54.7″E, Joharchi & Behroozian 46259 (FUMH).

General distribution: Central Asia, Western Siberia, Western Himalaya, Turkmenistan (Central Kopet Dagh), and NE Iran (in the present work).

Taxonomy: *Galium songaricum* belongs to sect. *Depauperata* Pobed. subsect. *Quadrifolia* Pobed., which includes only annual taxa having two leaves with usually two smaller leaf-like stipules, resembling four-leaf whorls. *Galium* sect. *Depauperata* includes few closely related species such as the North American *G. bifolium* S.Watson and the Himalayan *G. exile* Hook.f. (= *G. handelii* Cufod.) (Ehrendorfer *et al.* 2005; Chen & Ehrendorfer, 2011). There are several morphological characters which differentiate *G. songaricum* from the closely related species *G. exile* and another similar perennial species i.e. *G. triflorum* Michx. (Table 2).

Table 2. Morphological comparison between *Galium songaricum* and its closely related species.

Character	*Galium songaricum*	*Galium exile*	*Galium triflorum*
Growth form	annual	annual	perennial
Stem height	(3-)5-30 cm	4-20 cm	(15-)25-80(-120) cm
Stem state	branched	somewhat branched	somewhat branched
Leaf number in a whorl	4	4	4 to 6(-8)
Leaf shape	elliptic	ovate or oblanceolate to linear-elliptic	narrowly ovate to broadly oblong-lanceolate
Leaf size	(7-)12-15(-23) × (2-)5(-8) mm	(2-)3.5-10(-12) × 1-3.5(-5) mm	(15-)20-25(-45) × (6-)7-8(-15) mm
Petiole size (in fruit)	short or elongate	short	short or subsessile
Cymes	1 or 2(-3)-flowered	1-flowered	3 to several-flowered
Corolla lobes number	4	3(4)	4

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Notes on ecology and biogeography of the newly recorded species

Stipa richteriana is widely distributed in Aralo-Caspian lowlands to the montane and subalpine steppes and shrublands of Pamir-Alai and Eastern Tianshan Mountains (Freitag, 1985; Nobis *et al.*, 2016). It grows on stony and clay slopes, rarely on sands and pebbles (Tzvelev, 1976). Based on the data collected from the habitats in NE Iran, it grows in high montane steppes of the western parts of Binalood mountain range, on northwest-faced slopes at the elevations around 2200 m a.s.l., which is dominated by dwarf shrubs and thorn-cushion plants such as *Astragalus verus* Olivier and *Acantholimon erinaceum* (Jaub. & Spach.) Lincz., respectively. The habitats of *S. richteriana* in the area are also co-dominated by *Dianthus polylepis* Bien. ex Boiss. subsp. *binaludensis* (Rech.f.) Vaezi & Behrooz. which is known as a vulnerable plant and endemic to Khorassan-Kopet Dagh (Farsi *et al.* 2013, Memariani *et al.*, 2016b).

The distribution range of *Gailum songaricum* is mainly confined to the Central Asian spruce and juniper forests. The closest habitat to the Iranian recorded locality is the high mountains of Kopet Dagh in southern Turkmenistan (Pobedimova, 2000). Based on our recorded locality in NE Iran, it occurs on northwest-faced slopes at the elevations above 2100 m a.s.l. in Hezar-Masjed Mountains. The habitat is a montane steppe which is mainly dominated by thorn-cushion *Onobrychis cornuta* (L.) Desv. and inhabited by another endemic taxon, i.e. *Dianthus polylepis* subsp. *polylepis*.

The new records of *Stipa rechteriana* and *Galium songaricum* extend the distribution range of these Eastern Irano-Turanian species more south-westward to NE Iran (Fig. 3), which belongs to Khorassan- Kopet Dagh (KK) floristic province. In KK, about 100 plant species (*ca.* 3.7% of the flora) have a distribution pattern such as that of the newly recorded species, which is well known as Khorassan- Kopet Dagh/Eastern Irano-Turanian chorotype (IT $^{KK-E}$).

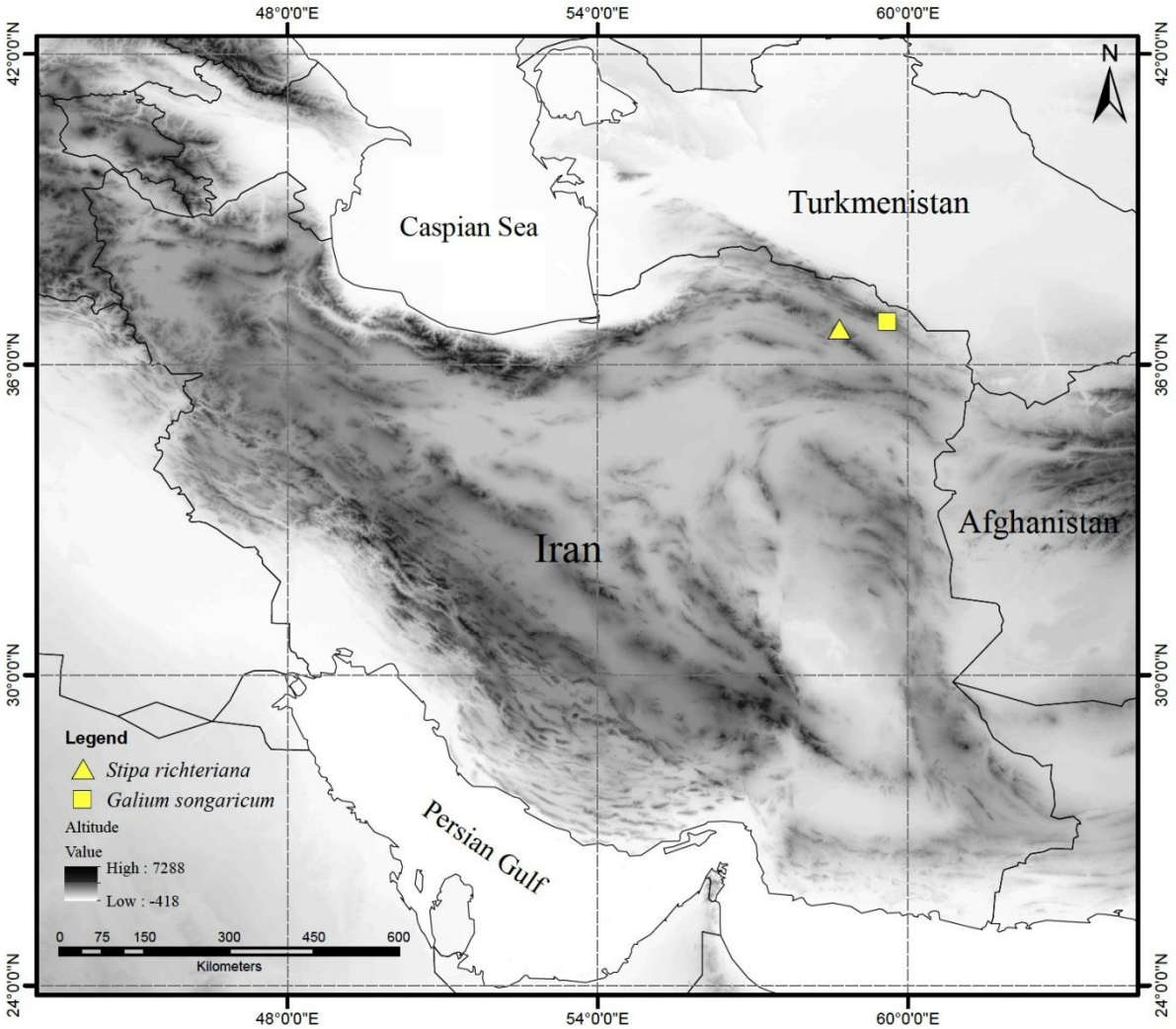

Fig. 3. Distribution map of the newly recorded species *Stipa richteriana* and *Galium songaricum* in Iran.

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Their distribution ranges are restricted mainly to the lowlands and/or mountains of the Middle/Central Asia with a disjunction in KK and some of them are connected to KK through the north of Afghanistan (Memariani *et al.*, 2016a). A number of these plant species have been discovered and recorded for the flora of Iran during the last 15 years, such as *Galatella litvinovii* Novopokr. (Aydani *et al.*, 2006), *Anemone tschernjaewii* Regel (Joharchi & Akhani, 2006), *Allium barsczewskii* Lipsky and *A. tenuicaule* Regel (Memariani *et al.*, 2007), *Allium turcomanicum* Regel (Fritsch & Maroofi, 2010), *Festuca karatavica* (Bunge) B.Fedtsch. (Memariani & Arjmandi, 2013), *Primula fedtschenkoi* Regel (Joharchi & Nejati, 2015), *Piptatherum latifolium* (Roshev.) Nevski (Memariani *et al.* 2016c), and *Rosa kokanica* (Regel) Regel ex Juz. (Arjmandi *et al.*, 2016).

According to the dwarf habit of *G. songaricum* and difficultly distinguishable specimens of *S. richteriana* in their habitats, it is highly probable that these plants have been overlooked by the Iranian field botanists. Therefore, searching more for them may result in finding additional habitats and a wider distribution range in Iran. Concerning the insufficient information on their distribution, and in order to avoid placing more taxa in DD (Data Deficient) category, we refer to the criterion D2 of the IUCN Red List categories and criteria which deals with very small or restricted populations for some taxa with few numbers of known locations (IUCN, 2016). Based on this criterion, the conservation status of *S. richteriana* and *G. songaricum* is provisionally evaluated as VU (Vulnerable) in Iran.

ACKNOWLEDGEMENT

This paper is a part of the results of the Ph.D. thesis of the first author supported by Grant No. 3/42756, Vice President for Research and Technology of Ferdowsi University of Mashhad. The authors would like to thank the Faculty of Science of Ferdowsi University of Mashhad and the stuff assistance of FUMH for their support.

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How to cite this article:

Behroozian, M., Ejtehadi, H. Memariani, F., Joharchi, M.R. and Mesdaghi, M. 2019. *Stipa richteriana* (Poaceae) and *Galium songaricum* (Rubiaceae): two new additions of the Central Asian species to the flora of Iran. – Nova Biol. Reperta 6: 326-333.

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[DOR: 20.1001.1.24236330.1398.6.3.9.8]

[DOI: 10.29252/nbr.6.3.326]