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Endemic plant species richness of Surkhondaryo province, Uzbekistan

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ABSTRACT
Surkhondaryo province is one of the largest and richest in vascular plant species diversity administrative units of Uzbekistan, which also has an extremely high concentration of species endemic to Mountainous Central Asia and Uzbekistan in particular. A characteristic geological feature of this area is the wide spread of variegated outcrops formed during the Cretaceous and partly Paleogene age. Using the botanical-geographical zonation of Uzbekistan and 5x5 km grid cells, we analyzed the distribution of 63 Surkhondaryo province endemics to identify the hotspots of endemic species richness. The Boysun phytogeographic region, located in the southwest spurs of the Hissar ridge, had the largest number of species-rich grid cells. The Surkhon-Sherobod and Bobotog phytogeographic regions, located mainly in the piedmonts, foothills and low mountain belt of the Kugitang and Bobotog mountains, turned out to be poor in endemic species. The extent of occurrence and area of occupancy of 63 provincial endemic species were estimated for the first time. Based on the analysis of available data and long-term field observations, the extinction of one of the narrow endemics of the Surkhondaryo province - *Dipcadi turkestanicum* Vved. appears to be a sad reality.

Key words: Central Asia, endemism, phytogeography, national Red Book

Introduction

Endemism, the geographic restriction of species ranges to a particular area, is a key concept for biodiversity analysis (Kier & Barthlott 2001; Slatyer et al. 2007). Analysis of endemism can provide vital information about taxonomic/floristic groups, and contribute to the identification and conservation of biodiversity hotspots and delimitation of biogeographic regions (Kier et al. 2009; Peruzzi et al. 2015; Baldwin et al. 2017; Peña-Chocarro & De Egea 2018; Darbyshire et al. 2019; El-Khalafy et al. 2021; Kougioumoutzis et al. 2021; Mehrabian et al. 2021). Although endemism studies performed on large scale (e.g. biogeographic zones or large regions) predominate (Beard et al. 2000; Crisp et al. 2001; Linder 2001; Zhang et al. 2009; Salinas-Rodríguez et al. 2017; Noroozi et al. 2019; Tojibaev et al. 2020a), in many relatively small but with a high species diversity and endemics regions this kind of research is necessary due to its ability to identify the most important for conservation areas.

Surkhondaryo province (SP) in the south of Uzbekistan (Central Asia) has long been noted for its unique and diverse flora (Khassanov 1987; Tojibaev et al. 2016) and a high proportion of micro-endemics having exceedingly small distribution areas (Popov 1923; Kamelin 2017).

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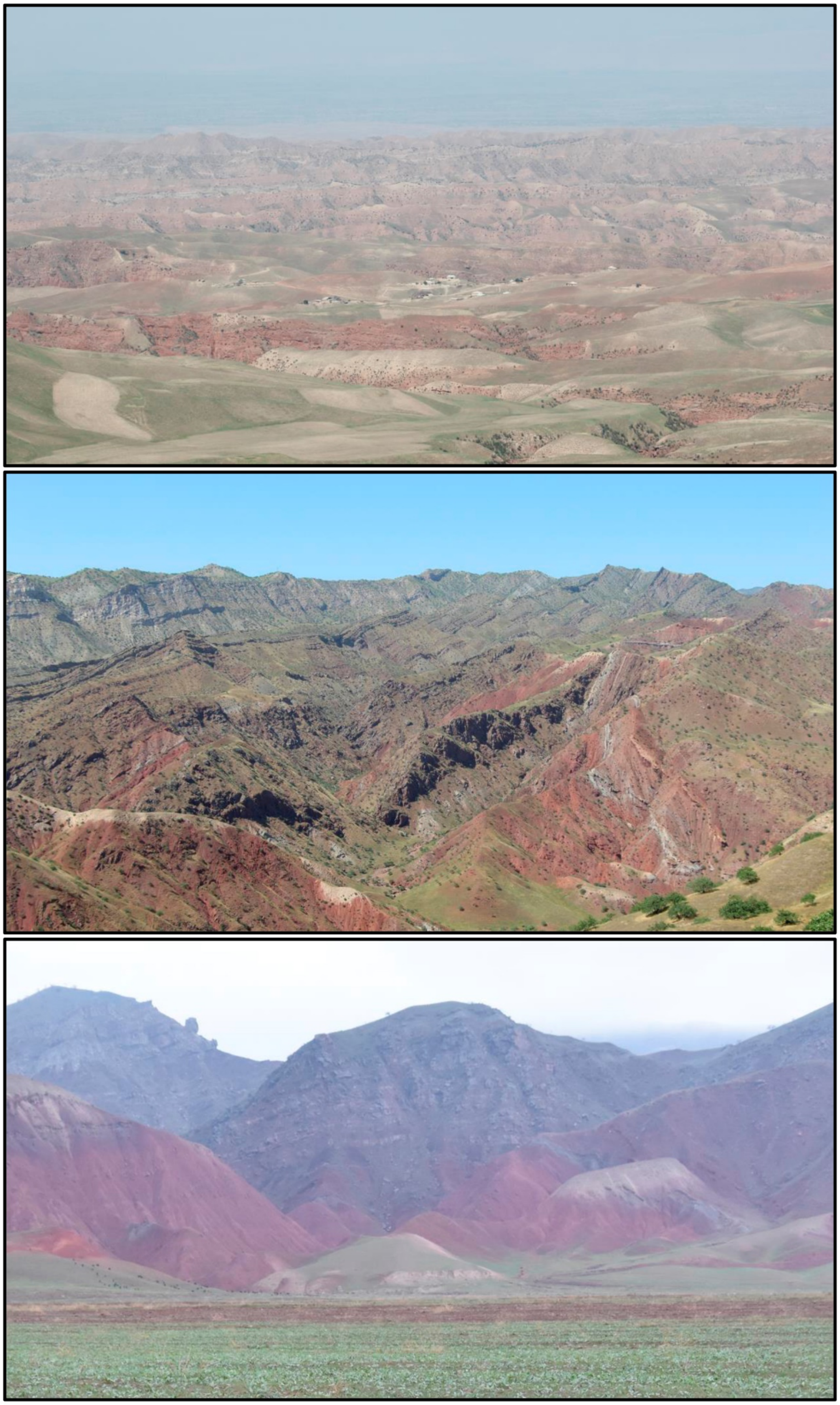

Fig. 1. A general view of variegated outcrops in the study area.

The SP and its surrounding areas have long attracted the interest of phytogeographers studying not only species diversity (Korovin 1961; Kamelin & Khasanov 1987), but also origin, evolution, and distribution pattern of narrow specialists of the variegated outcrops (Popov 1923; Kamelin 2017) which are widespread in SP (Kamelin 2017). This typical for Central Asia type of vegetation (Oreogypsophyta), according to Kamelin (2017) is mountainous by origin (Fig. 1).

This vegetation is found in the territory of the Kopetdag-Khorasan and mountainous Central Asia, the Inner Tian Shan, at the periphery of the Northern Tian Shan, in the Turkestan deserts from Ustyurt to Turgai and Pribalkhashye and also in the central lowland massifs of the Kyzylkum. It grows on a variety of soil substrates: red sandstone, alabaster, gypsum limestone and variegated clay, which are widespread and form characteristic landscapes of variegated outcrops. This flora was called «flora of variegated outcrops» by Popov (1923). Of the 1,400 plant species recorded in this territory, 682–685 are associated mainly with variegated outcrops. Of these, 540 species are endemic (Kamelin 2017). According to Kamelin (2017), the majority of vascular plant species of variegated outcrops in Mountainous Central Asia, including SP, settled over the Cretaceous and partly Paleogene age. A variety of factors, namely predominance of gypsum and calcareous rocks, friability, poor resistance of substrates to water and wind erosion, extreme dryness of habitats, strong insolation and unique chemistry of soils of variegated outcrops gave rise to the narrow habitat specialization (Popov 1923; Kamelin 2017).

The previous studies of the endemic flora of the West Hissar region (part of SP) were limited to either creation of the species checklists (Kamelin 1973; Vasilchenko & Vasilieva 1985; Kamelin & Khasanov 1987; Khassanov 1991; Turginov 2017) or analysis of the species distribution and their phylogenetic relationships (Butkov 1938; Popova 1951; Ibragimov 2010; Turginov 2017). Current data on endemic species composition of SP, including the Red Data Book of the Republic of Uzbekistan (Khassanov 2016) is significantly outdated. The aim of this study was the analysis of distribution of all known SP strict (narrow) endemics in five SP phytogeographic regions, and the creation of endemism richness regional map. The results of this study are supposed to provide information important for identification of priority areas for conservation.

Materials and methods

Study area

SP is an administrative unit of Uzbekistan, located in the south-east of the country (Fig. 2). It borders with the Kashkadarya region of Uzbekistan within the country and with Turkmenistan, Afghanistan and Tajikistan outside it. The territory covers 20,100 km². The altitude ranges from 270 m to 3920 m (Piryax peak) (Ergashev 1994). Variegated outcrops and sands cover 8777 and 1582 km^2, respectively, of the natural landscape. In our study, we used administrative division for analysis, since in Uzbekistan, as in many other countries, environmental decisions and actions are taken at the administrative level. In addition, the National Red Book, as well as procedures for collecting cadastral data on flora and fauna, are also carried out at the provincial level.

Phytogeographically, SP represents three transboundary phytogeographic districts of Mountain Middle Asia province (Kamelin 1973; Tojibaev et al. 2016), extending into Tajikistan - Hissar-Darvaz (Sangardak-Tupalang region) and Bobotog (Bobotog region), and into Afghanistan, Tajikistan and Turkmenistan - West Hissar (Surkhon-Sherobod and Kugitang regions) (Fig. 2).

Extensive field surveys covering all altitudinal zones (from 270 to 3900 m) were conducted during the natural growing season from mid-March to August from 2015 to 2021. We referred to SP endemics those species whose ranges were limited only to this province. Distributional data were obtained from more than 7000 field records made in 2020–2021 and from 1847 herbarium specimens deposited in the TASH, MW, LE as well as from electronic resources such as

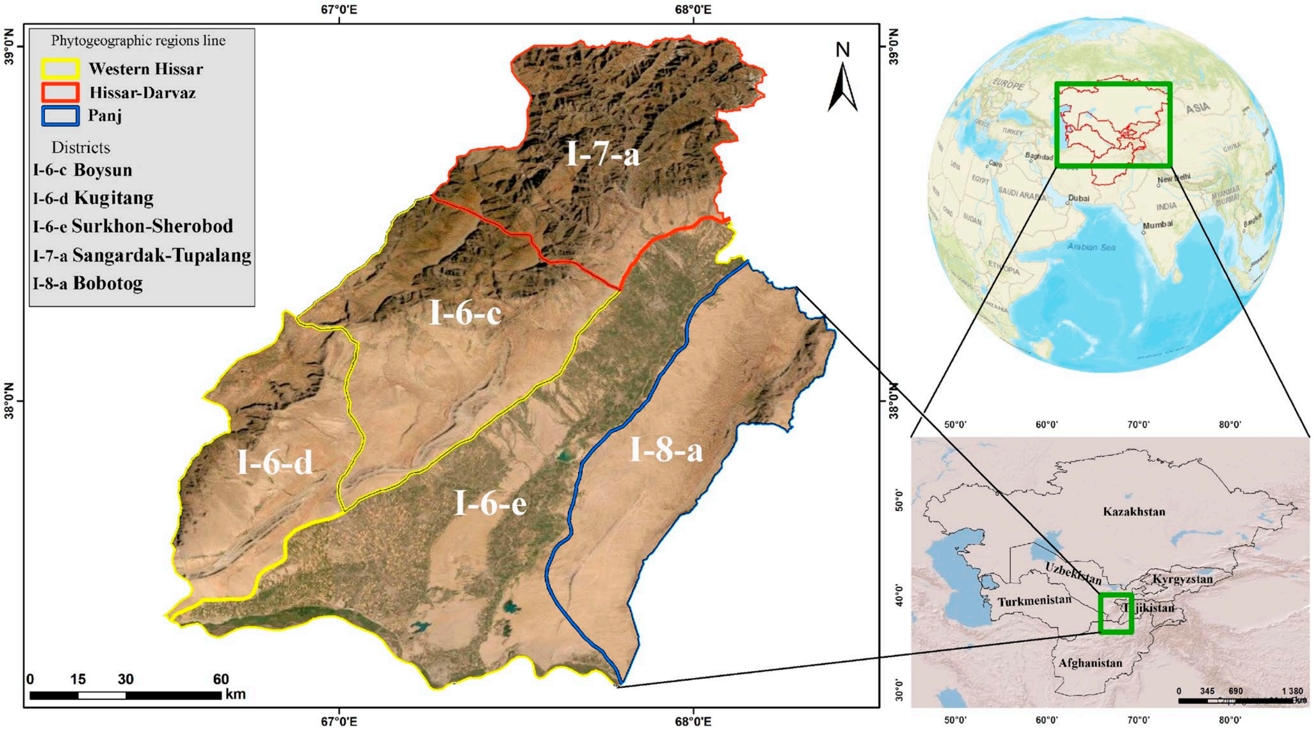

Fig. 2. Geographic location of Surkhondaryo province and its phytogeographic subdivision.

Plantarium (www.plantarium.ru) and GBIF (www.gbif.org). Besides, relevant floristic and taxonomy literature was examined (Merkulovich 1936; Nevskiy 1937; Popova 1951; Khassanov 1987; Ibragimov 2010; Turginov 2017). As a result, 293 occurrence records for 63 species were collected (Table 1). We defined species richness and collection density as the number of endemic species and occurrence records per grid cell, respectively.

Taxonomic identification was based on Flora of Uzbekistan (1941–1963), published first three volumes of the new Flora of Uzbekistan (Sennikov 2016, 2017, 2019), and recently published data on Apiaceae (Tojibaev et al. 2020a), *Tulipa* (Tojibaev & Beshko 2015), *Elwendia* (Kljuykov et al. 2018), *Plocama* (Khassanov et al. 2019) and *Scrophularia* (Tojibaev et al. 2020b). The nomenclature of each taxon followed Plants of the World Online (POWO)(http://www.plantsoftheworldonline.org, accessed on 12 January 2022), and International Plant Name Index (www.ipni.org, accessed on on 12 January 2022).

Field surveys were carried out within the framework of the "Grid mapping of the flora of Uzbekistan" project. The project has high importance as the first step towards mapping flora of the entire Central Asian region and broader in Eurasia.

The phytogeographic analysis used the scheme of phytogeographical division of Uzbekistan (PDU) (Sennikov et al. 2016; Tojibaev et al. 2016). The PDU was generated digitally, so the distributional data of SP endemic plant taxa can be analyzed with ArcGIS 10.6 software (Esri Inc.). The extent of occurrence (EOO) and the area of occupancy (AOO) were estimated using the GeoCAT tool (Bachman et al. 2011).

Spatial distribution and grid mapping patterns

The territory of Uzbekistan is divided into 19,240 cells of a 5 × 5 km grid. Of these, 882 grids make up the study area. The species richness of SP endemics in the grid cells was calculated simply as the total number of species in each grid cell. Maps of the geographical distribution of each endemic species were processed in ArcView GIS (ESRI 1999).

Results

In this study, we updated, utilizing the results of present and previous studies (Merkulovich 1936; Nevskiy 1937; Popova 1951; Vasilchenko & Vasilieva 1985; Khassanov 1987, 1991) the checklist of endemic plants of SP region, which now comprises in total 63 species from 35 genera and 20 families.

Checklist and taxonomic diversity

As shown in Fig. 3, Asteraceae and Fabaceae had the highest number of species (13 and 11, respectively), followed by Lamiaceae (8), Amaryllidaceae (4), Apiaceae (4) and Plumbaginaceae (3). The remaining 14 families were represented by one to three species. Among the genera, the species richest were *Astragalus* L. (7 species), *Cousinia* Cass. (6), *Scutellaria* L. (5), *Jurinea* Cass. (4), *Allium* L. (4), *Iris* L. (3), *Acantholimon* Boiss. (3), and *Oxytropis* DC. (2). The other genera were represented by a single species.

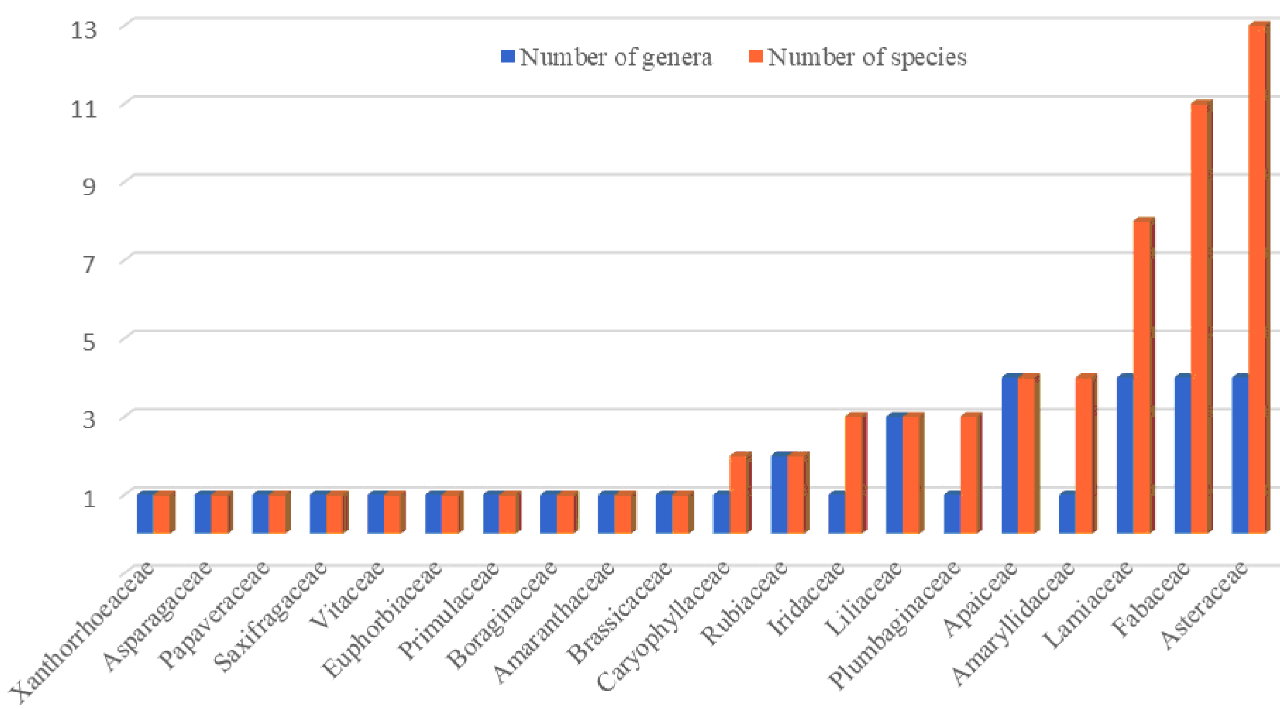

Fig. 3. Number of endemic species and genera per family

Table 1. List of endemic plant species of Surkhondaryo province with number of preserved herbarium specimens, range assessments, threat level and phytogeographical regional distribution. Phytogeographical regions: Sangardak-Tupalang (ST), Boysun(B), Surkhon-Sherobod (SSh), Kugitang (K), Bobotog (Bb). Other abbreviations: EOO-extent of occurrence; AOO-area of occupancy; EX-Extinct; CR-critically endangered; EN- endangered; VU-vulnerable;

№	Accepted Taxa	Number of records	EOO km^2	AOO km^2	Grid cells	IUCN (2019)	UZ RDB status	Phytogeographical regions
1.	*Acantholimon annae* Lincz.	1	-	4	1	CR	2	ST
2.	*Acantholimon gontscharovii* Czerniak.	10	635	36	7	EN		ST
3.	*Acantholimon vvedenskyi* Lincz.	2	-	8	2	CR		B, ST
4.	*Allium decoratum* Turginov & Tojibaev	1	-	4	1	CR		B
5.	*Allium fritschii* F.O. Khass. & Yengalycheva	2	-	8	1	CR		K
6.	*Allium nikolai* F.O. Khass. & Achilova	2	-	8	1	CR		B
7.	*Allium rhodanthum* Vved.	9	6020	28	7	VU + EN		SSh, B, Bb
8.	*Ampelopsis chondisensis* (Vassilcz. & V.N. Vassil.) Tuljag.	1	-	4	1	CR		ST
9.	*Astragalus alexeji* Gontsch.	2	-	8	2	CR	0	B, ST
10.	*Astragalus juniperetorum* Gontsch.	4	476	12	4	EN		B
11.	*Astragalus kamelinii* Podlech.	1	-	4	1	CR		ST
12.	*Astragalus nigrocarpus* F.O. Khass. & I.I. Malzev	1	-	4	1	CR		ST
13.	*Astragalus pseudanthylloides* Gontsch.	10	664	36	8	EN	2	B
14.	*Astragalus pseuidoquisqualis* Podlech	1	-	4	1	CR		ST
15.	*Astragalus rotundus* Gontsch.	1	-	4	1	CR		B
16.	*Bergenia hissarica* Boriss.	4	279	12	4	EN	2	ST
17.	*Calispepla aegacanthoides* Vved.	11	6	16	2	CR + EN	1	B
18.	*Calophaca reticulata* Sumnev.	4	37	12	3	CR + EN	1	B
19.	*Cephalopodum hissaricum* Pimenov	1	-	4	1	CR	1	ST
20.	*Climacoptera oxyphylla* U.P. Pratov	1	-	4	1	CR	2	SSh
21.	*Corydalis sangardanica* Mikhailova	3	15	12	3	CR + EN		ST
22.	*Cousinia glaphyrocephala* Jux. ex Tscherneva	1	-	4	1	CR	1	K
23.	*Cousinia hoplophilla* Tscherneva	2	-	8	2	CR	2	B

24.	*Cousinia platystegia* Tscherneva	2	-	8	2	CR		K, SSh
25.	*Cousinia rhodantha* Kult.	6	1178	20	5	EN	1	B
26.	*Cousinia stricta* Tscherneva	1	-	4	1	CR		Bb
27.	*Cousinia vvedenskyi* Tscherneva	3	84	12	3	CR + EN	2	B, ST
28.	*Primula hissarica* (Lipsky) Bornm.	29	746	60	14	EN	2	B, ST
29.	*Dipcadi turkestanicum* Vved.	4	-	-	1	Extinct	0	SSh
30.	*Elwendia bucharica* Kljuykov & Lyskov	1	-	4	1	CR		ST
31.	*Eremurus iae* Vved.	7	106	20	5	EN	2	B, ST
32.	*Euphorbia triodonta* Prokh.	2	-	8	2	CR	1	SSh
33.	*Fritillaria baisunensis* Ruksans	5	148	12	2	EN		B
34.	*Gagea takhtajanii* Levichev	1	-	4	1	CR		ST
35.	*Galium irinae* Pachom.	1	-	4	1	CR		ST
36.	*Iris petri* F.O. Khass., Rakhimova & Achilova	1	-	4	1	CR		B
37.	*Iris rudolphii* F.O. Khass.	9	455	16	4	EN		SSh
38.	*Iris victoris* F.O. Khass., Khuzhan. & Rakhimova	1	-	8	3	CR		SSh
39.	*Jurinea nevskii* F.O. Khass.	1	-	4	1	CR		B
40.	*Jurinea tscherneviae* Tojibaev & Turginov	2	-	8	2	CR		B
41.	*Jurinea pjataevae* Iljin	3	2	12		CR + EN		ST
42.	*Jurinea sangardensis* Iljin	4	212	16		EN	1	ST
43.	*Lagochilus botschantzevii* Kamelin & Tzukerv.	7	177	20	3	EN		Bb
44.	*Moluccella bucharica* (B.Fedtsch.) Ryding	25	3	12	2	CR + EN		B
45.	*Oxytropis tyttantha* Gontsch.	7	312	16	2	EN	3	B, ST
46.	*Oxytropis vvedenskyi* Filim.	10	3	8	2	CR	3	B
47.	*Parrya pjataevae* (Pachom.) D.A. German & Al-Shehbaz	5	6	12	2	CR + EN		ST
48.	*Phlomoides baburii* (Adylov) Adylov, Kamelin & Makhm.	1	-	4	1	CR	1	SSh
49.	*Plocama alshehbazii* F.O. Khass., D. Khamr., U. Khuzh. & Achilova	1	-	4	1	CR		SSh, B

50.	*Rindera kuhitangica* Raenko	1	-	4	1	CR		K
51.	*Scutellaria fedtschenkoi* Bornm.	13	499	40	5	EN	3	B, K
52.	*Scutellaria guttata* Nevski ex Juz.	16	2554	56	11	EN	2	B, ST
53.	*Scutellaria holosericea* Gontsch. ex Juz.	13	88	48	6	CR + EN	1	ST
54.	*Scutellaria heterotricha* Juz. & Vved.	2	-	8	2	CR		ST, K
55.	*Scutellaria villosissima* Gontsch. ex Juz.	11	42	40	4	CR + EN	2	ST
56.	*Seseli merculowiczii* (Korovin) Pimenov & Sdobnina	11	770	36	9	EN		ST
57.	*Silene nataliae* F.O. Khass. & I.I. Malzev	1	-	4	1	CR	1	K
58.	*Silene michelsonii* Preobr.	7	153	24	6	EN		ST
59.	*Sphaerosciadium denaense* (Schischk.) Pimenov & Kljuykov	2	-	8	2	CR	1	ST
60.	*Taraxacum butkovii* Kovalevsk.	1	-	4	1	CR		B
61.	*Tulipa bactriana* J. de Groot & Tojibaev	1	-	4	1	CR		SSh
62.	*Vicoa discoidea* (Nabiev) Kamelin	1	-	4	2	CR		ST
63.	*Vicoa rupicola* Krasch.	2	-	8	2	CR		B

Species richness and collection density

Of 882 grid cells that make up the SP territory, only 115 cells contained endemic species. The majority (78) had only one such species, and 22, 10 and 4 cells had two, three and four endemic species, respectively. Only one cell had seven endemic species, which is located in the Sangardak-Tupalang region (AI207). The majority of cells having endemic species are located in the mid-mountain zone of the eastern and north-eastern part of SP (Fig. 4). Many species are known from a single herbarium specimen (Table 1). Almost the same pattern shows the number of herbarium collections per cell: 1–2 herbarium specimens were collected in 85 grid cells (74% of all grid cells). 3 to 4 - in 20 grid cells and 5–6 - in three grid cells (Fig. 4b). This means that in field surveys collectors were mostly attracted by «interesting» species, many of which are endemics.

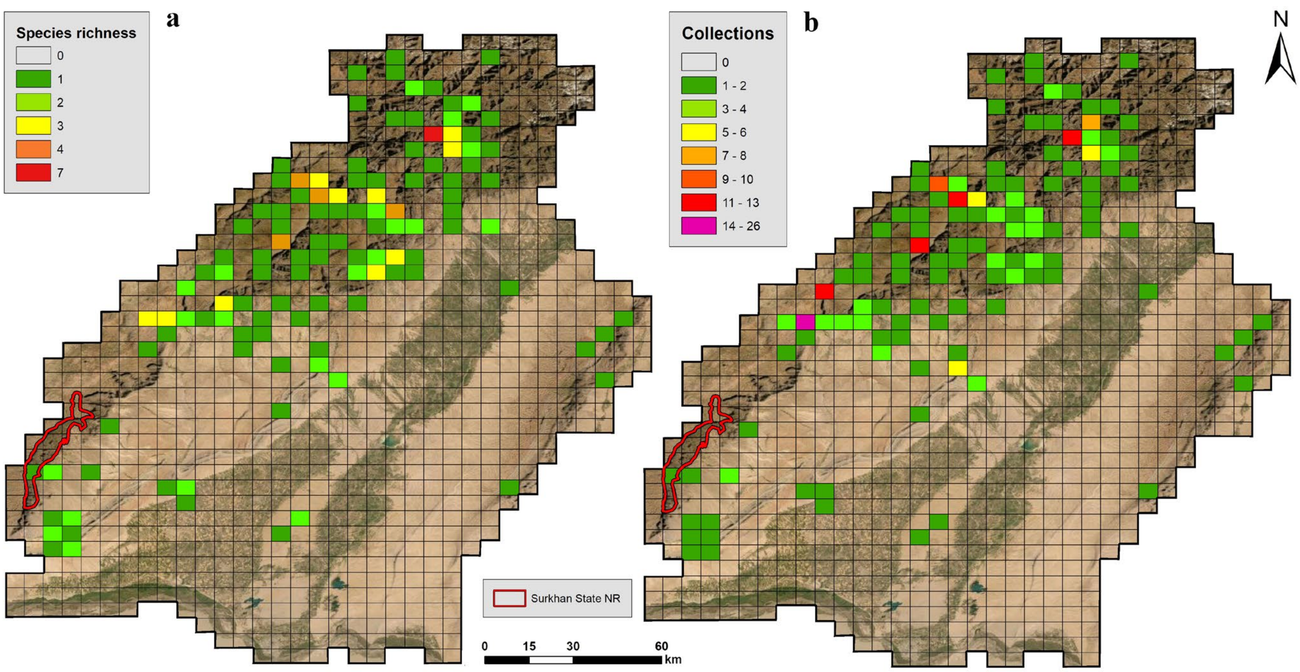

Fig. 4. Centers of endemism in the study area identified by endemic species richness (a) and the number of collections (b). Blanc cells indicate no records of endemic species and lack of collections.

Species richness across the phytogeographic regions

The largest number of grid cells having ≥ 3 species were in Sangardak-Tupalang, followed by Boysun and Kugitang (Table 2), all in mid and high mountains of Hissar ridge. The Sangardak-Tupalang region, which belongs to Hissar-Darvaz phytogeographic district, contained 50 (out of 115) grid-cells with at least one species, and was a home for 29 species in total. The Boysun phytogeographic region, located in southwest spurs of Hissar ridge, contained 42 grid cells with at least one species, and was a home for 28 species in total.

Table 2. Number of endemic species across the botanical-geographical regions in the study area.

Botanical-geographical region	Species	Grid cells	High scored grid cells (≥ 3 species)
Sangardak-Tupalang (ST)	29	50	9
Boysun (B)	28	42	5
Surkhon-Sherobod (SSh)	9	4	-
Kugitang (K)	6	14	2
Bobotog (Bb)	3	5	-

Discussion

Since the earliest phytogeographical studies of Central Asia (Fedchenko 1915; Popov 1923; Korovin 1962), within floristically diverse and harboring large number of both paleo- and neo-endemics mountainous Central Asia, foothills and mountains of southern Uzbekistan stand out by their unique biodiversity (Merkulovich 1936; Popova 1951).

Dividing the geographical space into relatively-homogeneous units is one of the most traditional approaches in biogeography (Fattorini 2016). Furthermore, biogeographical regionalization is needed in order to provide reference areas for large-scale ecological analyses, as well as conservation and management practices (Cervellini et al. 2020).

The grid mapping of the distribution of endemic species in SP confirms the opinion that this region is an important refugium of the unique flora of variegated outcrops whose core comprise the autochthonous ancient Mediterranean types (Kamelin 2017). It has been suggested by several authors such as Popov (1923) and Kamelin (2017) that the small patches of this habitat, having very special soil chemistry and spatially isolated position, were the sites of intensive parapatric speciation. Within SP province, the richest in endemics regions were Sangardak-Tupalang, Boysun and Kugitang, all in the mid and high mountains of the Hissar ridge. These results corroborate findings from the earlier studies (Vasilchenko & Vasilieva 1985; Khassanov 1991).

On the other hand, grid-based mapping shows deficiencies in in studying vascular plant diversity. Most of the grid cells in Surkhon-Sherobod and Bobotog regions, and more than half of the cells in Kugitang and Boysun regions have zero collecting density values. However, this does not mean that these grid cells have never been surveyed for endemic species. They were, although less frequently than the other regions, and endemic species untill now have not been found there. The main reason why these areas are visited much less often than others is the very strong anthropogenic pressure there, and species poor and depressed by continous overgrazing local vegetation. Nevertheless, this also indicates that this part of mountainous Middle Asia remains a poorly studied region (Li et al. 2020).

Notes on populations of selected genera

The first SP endemic checklist with the distribution of species in the comprising SP phytogeographic regions was made by Tojibaev et al. (2016). In the present study, we critically reviewed all endemic SP taxa based on herbarium, literature and long-term field observations, and provided the distribution grid maps at a spatial scale of 5x5 km for 63 taxa. Comparison of the new data obtained from our field studies with the previous data, including data from the National Red Data Books (Khassanov & Pratov 2009; Khassanov 2016) revealed significant new findings for several taxa. These taxa include two endemic monotypic genera *Calispepla* Vved. (*C. aegacanthoides* Vved.) and *Sphaerosciadium* Pimenov &

Kljuykov (*S. denaense* (Schischk.) and *Dipcadi turkestanicum* (Asparagaceae Juss.) described by Vvedensky (1941) from Khaudak desert.

Calispepla Vved. (Leguminosae)

Genus *Calispepla* includes the only species *C. aegacanthoides* Vved. having a single location in the Boysun Mountains. The genus was described by Vvedensky (1955) in the middle of the 20th century. This relic taxon is most closely related to the Mediterranean genera *Genista* L. and *Ulex* L., distributed more than 3000 km away. Since 1952, only one population has been known from the *locus classicus* in Boysun (valley of the Machai River, Sary-Shato), which occupies around 0.5–0.6 hectares. The species was included in the Red Data Book of Uzbekistan (Khassanov 2019). In 2019, a new large population occupying an area of approximately 100–120 hectares, was discovered 20 km south from the *locus classicus*.

Sphaerosciadium Pimenov (Apiaceae)

Another endemic relic monotypic genus *Sphaerosciadium* is also included in the Red Data Book of Uzbekistan (Khassanov 2019). The only species of this genus *S. denaense* (Schischk.) Pimenov & Kljuykov was described in 1950 by Schischkin (1950) as *Danaa denaensis* Schischk. in the valley of the Sangardak river on the rocks near village Nillu. It is rather close to the Mediterranean genus *Physospermum* Cusson. Previously, it was known from a single population. We have discovered 4 new populations with approximately 500 individuals in total.

Dipcadi Medik. (Asparagaceae)

The genus *Dipcadi*, comprising 41 species, is mainly distributed in the Mediterranean region, Africa and South-West Asia (Mabberley 1997). South Africa and India are considered as the primary centers of the genus diversity, with 13 and 10 species, respectively (Ghazanfar 1996; Rawat & Chandra 2014). Central Asian flora has a single genus representative, namely *D. turkestanicum* Vved. (Pazij 1971), which was described by (Vvedensky 1941) from a specimen collected by himself in 1937. *D. turkestanicum* is a desert species most closely related to the species of arid regions *D. serotinum* (L.) Medik. and *D. erythraeum* Webb & Berthel. Since the type collection in Khaudak Desert (total area less than 266 km²), the species was collected only once in 1958 and stored in TASH (16.04.1958, №233, Vvedensky & al., TASH).

This species has always attracted the attention of famous botanists of Central Asia, who periodically made attempts to find the species in the Khaudak sands and adjacent areas. The last attempts were repeatedly made by F. Khassanov and O. Turginov in the last decade, but were unsuccessful. Our field surveys in March-April of 2019–2021 aslo were unseccesful. For these reasons, the current status of this species in the Red Data Book of Uzbekistan (2019), which is «probably disappeared», appears to be true. Thus, *D. turkestanicum* should be added to the recently published list of extinct species, including those from the genus *Dipcadi* (Humphreys et al. 2019).

Proposed expansions of the protected area network

Strict endemics of SP, which are narrow endemics of variegated outcrops, have the high priority for conservation in Uzbekistan (Tojibaev et al. 2019). All the known populations of these species experience strong anthropogenic pressure, are declining and many exhibit depressed natural reproduction (e.g. *Moluccella bucharica*) (Tojibaev et al. 2019; Achilova 2021). This group of species requires urgent efforts to prevent their extinction, but the available options are limited. Since cultivation *ex situ* in a botanical garden turned out to be unsuccessful (Belolipov 1980; Tojibaev et al. 2019), the only alternative for these species is *in situ* conservation (Tojibaev et al. 2019). The majority of these species are not protected and their natural habitat (variegated outcrops) is disappearing. To prevent the extinction of these species, there is no alternative to the creation of new protected areas. Surkhon reserve, which is the only nature reserve in the SP, protects 39 of 50 species of the Red Data Book of Uzbekistan inhabiting the Kugitang Ridge, but covers a negligible fraction of the SP endemics. Only two provincial endemics (*Silene nataliae* and *Scutellaria heterotricha*), one population per species, grow in the reserve. Earlier, recommendations concerning the existing in Uzbekistan protected areas system (Beshko et al. 2013) suggested the expansion of Surkhon reserve and the creation of three new protected areas in SP: South-West Hissar, Kelif-Sherobod and Bobotog Reserves. Similarly, Volis and Tojibaev (2021) also recommended, after analyzing the predicted ranges of critically endangered plant species of Uzbekistan, the creation of new protected areas in SP. These new protected areas must necessarily have suitable for variegated outcrops endemics edaphic conditions. If the new protected areas having suitable for these species (under both current and expected in the future climate) set of conditions are not established in SP, then endemics of variegated strata with a narrow distribution, including *Moluccella bucharica*, *Tulipa bactriana*, and other species having CR category are doomed to extinction, and will follow the notorious *Dipcadi turkestanicum*.

Conclusions

The provided in this paper list of endemic species is the most comprehensive for SP to date and can serve as a guide for provincial conservation plans. The two kinds of grid cells having occurrence records of endemic species are especially important for formulating these plans. Grid cells with high values of endemic species richness (considered as hotspots) are important because the protection of these spatial units will simultaneously protect many species. And grid cells that represent a single known location of a species are important because such species do not occur anywhere outside these cells.

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No potential conflict of interest was reported by the authors.

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