

# Important plant areas (IPAs) in the Fergana Valley (Central Asia): The Bozbu-Too-Ungortepa massif

Komiljon Sh. Tojibaev<sup>1</sup>, Farkhod I. Karimov<sup>1</sup>, Hushbaht R. Hoshimov<sup>2</sup>,  
Rustam Gulomov<sup>2</sup>, Georgy A. Lazkov<sup>3</sup>, Chang-Gee Jang<sup>4</sup>, Hee-Young Gil<sup>5</sup>,  
Ju-Eun Jang<sup>5</sup>, Avazbek R. Batoshov<sup>2</sup>, Abdulla Iskandarov<sup>6,7,8</sup>, Hyeok Jae Choi<sup>8</sup>

**1** National Herbarium of Uzbekistan, Institute of Botany of Academy of Sciences of the Republic of Uzbekistan, Durmon yuli str., 32, 100125, Tashkent, Uzbekistan **2** Namangan State University, Uychi str., 316, 160119, Namangan, Uzbekistan **3** Institute for Biology, National Academy of Sciences, Bishkek 720071, Kyrgyzstan **4** Department of Biology Education, Kongju National University, Gongju 32588, Republic of Korea **5** Department of Forest Biodiversity and Herbarium, Korea National Arboretum, Pocheon 11186, Republic of Korea **6** Khorezm Mamun Academy, Markaz-1, 220900, Khiva, Uzbekistan **7** Urgench State University, Kh.Alimdjan str., 14, 220100, Urgench, Uzbekistan **8** Department of Biology and Chemistry, Changwon National University, Changwon 51140, Republic of Korea

Corresponding author: Hyeok Jae Choi ([hjchoi1975@changwon.ac.kr](mailto:hjchoi1975@changwon.ac.kr))

Academic editor: A. Khapugin | Received 5 September 2022 | Accepted 7 December 2022 | Published 30 January 2023

<https://zoobank.org/7ED77F85-94BA-443B-96AD-4784271D1645>

**Citation:** Tojibaev KS, Karimov FI, Hoshimov HR, Gulomov R, Lazkov GA, Jang C-G, Gil H-Y, Jang J-E, Batoshov AR, Iskandarov A, Choi HJ (2023) Important plant areas (IPAs) in the Fergana Valley (Central Asia): The Bozbu-Too-Ungortepa massif. *Nature Conservation* 51: 13–70. <https://doi.org/10.3897/natureconservation.51.94477>

## Abstract

This paper discusses identifying Important Plant Areas (IPAs) in one of the most densely populated regions of Central Asia—the Fergana valley. The recognition of IPA sites is an attempt to introduce new ways of conserving local plant diversity with a high concentration of endemic species in Central Asia, where conservation methods of the former Soviet Union still prevail. The research revealed the current state and geography of many rare species and enriched the flora of Uzbekistan and Kyrgyzstan with several rare species. The second IPA is the transboundary territory of the Fergana valley, uniting the southern spurs of the Chatkal range and the Ungortepa-BozbuToo massif. We documented the distribution of 62 species in the IPAs under the sub-criteria of Plantlife International. Our study aimed at continuing studies on the IPAs in this region, addressing specific conservation challenges, such as conserving national endemics and endangered species that grow outside protected areas and GIS mapping of endemic species.

## Keywords

Central Asia, endemic plants, Fergana Valley, important plant areas

## Introduction

Biodiversity hotspots represent regions with high species richness and centers of endemic species and are generally considered priority conservation regions. They provide a good natural laboratory for conducting studies testing the relationship between extinction risk and evolutionary history (Fu et al. 2022). As a rule, most biodiversity hotspots are covered by a network of protected areas. Globally, protected areas have been increasing significantly over the last few decades. However, the existing global network covers less than 20% of areas important for biodiversity and ecosystem services (Maxwell et al. 2022). It does not offer a sufficient contribution to the representativeness of these areas (Signorello et al. 2018). In many ways, representativeness is not achieved in poorly studied regions of the world.

The Mountains of Central Asia are an important global biodiversity hotspot (Myers et al. 2000) but a botanically poorly-known part of Asia (Manafzadeh et al. 2016; Li et al. 2020). The situation is even worse for the individual regions because dozens of botanical-geographic regions do not have flora lists pertaining to 50–60 years ago. Poor representation is a common problem for Central Asian species, with data often lacking (Wilson et al. 2021). However, many taxonomy, geobotany, and plant ecology studies were carried out (Tojibaev et al. 2020). One such region is the Fergana valley (FV)—the vast depression between the Tian-Shan and Pamir-Alay Mountain systems, mainly in eastern Uzbekistan and partly in Tajikistan and Kyrgyzstan.

In the previous stages of the study, we attempted to identify important plant areas (IPAs) in the FV, one of the most densely human-populated regions in Central Asia with a diverse array of endemic and endangered species. The badlands of the Chust-Pap adyrs (foothills) with a high concentration of endemic species of the western Tian-Shan were chosen as the first IPA of the FV. An overview of international references on IPA research in various countries was given in the first phase of IPA research (Tojibaev et al. 2022).

Identifying species diversity and distribution is key to the protection and prevention of biodiversity loss at both global and local scales, because robust data are paramount for well-informed decisions on policy, conservation, and species management (Dani Sanchez et al. 2021). IPAs consider species distribution and botanical richness and prioritize plants and habitats that are under threat, by identifying a network of key sites for their conservation (<https://www.plantlife.org.uk/international>). The guidelines developed by Plantlife for Europe (Anderson 2002) have been tested and implemented in many countries over the past two decades (<https://www.plantlifeipa.org/about>). Based on this, each new IPA study should comply with accepted standards and subsequently be included in the Plantlife IPA database ([www.plantlifeipa.org/home](http://www.plantlifeipa.org/home)).

This work continues the identification of the IPA sites in FV, Central Asia. The second IPA site in the FV is located between Kyrgyzstan and Uzbekistan, in the southern part of the Chatkal Range. Two areas are clearly distinguished here. These are (a) the Bozbu-Too mountains (Kyrgyzstan) and (b) the lower reaches of the Mailisay river basin and the Ungortepa massif (Kyrgyzstan and Uzbekistan). Based on this, the second IPA site in FV has been named the Bozbu-Too-Ungortepa massif. According to the adminis-

trative zoning, the study area is located in the Chartak district of the Namangan region of Uzbekistan and the Aksy district of the Jalal-Abad region of Kyrgyzstan. Phytogeographically, the IPA site belongs to the South Chatkal district of the Fergana region, Mountainous Central Asian province (Tojibaev et al. 2016, 2017). The core flora of the area, mainly consisting of Mediterranean and Iran-Turanian elements, is heavily influenced by widely distributed species. The South Chatkal district is the southern habitat for some Tian-Shan and western Tian-Shan species, including *Tulipa bifloriformis* Vved., *Fritillaria sewerzowii* Regel, *Ferula tenuisecta* Korovin, and *Ferula prangifolia* Korovin.

The Bozbu-Too-Ungortepa massif and the adjacent Mailisay river basin of the Chatkal Range are poorly studied areas of the FV. The first detailed field studies were carried out in the middle of the last century (1949–1953) when the Institute of Botany of the Academy of Sciences of the Republic of Uzbekistan organized expeditions to study industrial reserves of rubber plants under the local name *tau-sagyz*. In 1949, during a route-geobotanical survey of the FV, large thickets of a rubber-bearing taxonomically unknown representative of the genus *Scorzonera* L. were found (Nabiev 1954). In 1950, this species was described as *Scorzonera uzbekistanica* Czevr. & Bondarenko (Chevrenidi and Bondarenko 1950).

## **A national approach to global conservation priorities**

In Central Asia countries, the realization of IPAs programs, including the identification process, data accumulation, and GIS mapping of species across IPA criteria, is in dynamic development (Tojibaev et al. 2022). In many ways, all countries in Central Asia inherited the Soviet (in some places modernized) system of nature conservation practice. National biodiversity strategies and protected area management are very similar and the main approaches to the development of plants conservation strategies and their implementation remain. The first attempts to identify such IPA sites have been made (Dimeyeva and Vesselova 2015; Tojibaev et al. 2022). The results of the first phase of IPA research created a solid methodological basis. It is already becoming clear that the national IPA programs make it possible to use a pragmatic and proven approach to national plant conservation in local conservation practice. This program can complement other initiatives such as national biodiversity strategies and protected area management. Most importantly, regional data from Central Asia can be integrated into the global IPA network.

## **Materials and methods**

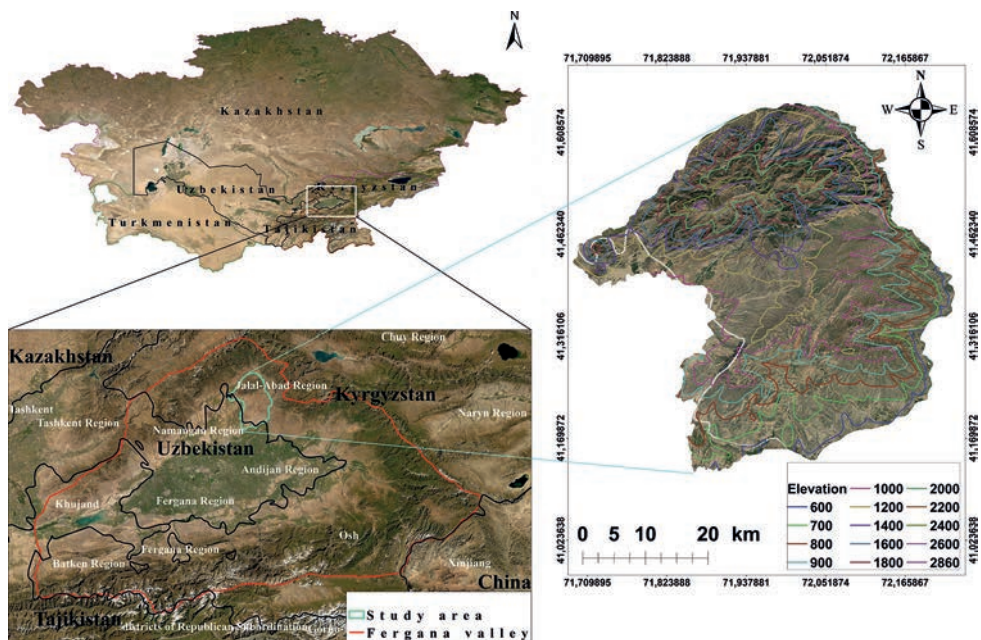
### **Study area**

The FV is an intermountain trough covering an area of about 22 000 km<sup>2</sup>. Including the surrounding mountains, it covers up to 80 000 km<sup>2</sup> and is located

in Uzbekistan, Kyrgyzstan, and Tajikistan (Tojibaev et al. 2018a). The length of the valley is about 250–300 km. The width of the FV reaches 130 km and narrows to 5–10 km in the west. In the east, the valley is bordered by the Fergana Range (Kyrgyzstan), by the Alay (Kyrgyzstan and Uzbekistan) and Turkestan ranges (Kyrgyzstan, Tajikistan, and Uzbekistan) in the south, and the Chatkal (Kyrgyzstan and Uzbekistan) and Kurama ranges (Tajikistan and Uzbekistan) in the north. Quaternary deposits (pebble, crushed stone, sand, loam, sandy loam, and clay) compose the plains and fill intermontane, post-, and inter-adyr depressions. The surface of the FV, especially in its central part, is flat and represents the ancient terraces of the Syr Darya River (up to four terraces) and numerous alluvial cones (Naumenko and Zubov 2021).

The botanical significance of Central Asia in terms of global plant diversity and the use of this phrase concerning a specific geographical area were discussed in a previous publication (Tojibaev et al. 2022).

The study area is north of the Syr Darya River on the southern slopes of Chatkal Range. Tashkumyr town (Kyrgyzstan) is the eastern, and Kerben town (Kyrgyzstan) the western border. The southern border runs along the meridian of Yangikurgan and Uchkurgan towns (Uzbekistan), and further north along Avletim (Kyrgyzstan). The IPA site was located between  $41^{\circ}25'9.44''\text{N}$ ,  $71^{\circ}41'31.76''\text{E}$  and  $41^{\circ}27'23.85''\text{N}$ ,  $72^{\circ}10'53.88''\text{E}$ , with an altitude range from 550 to 2860 m above sea level. The site is 48–56 km long and 30–42 km wide (Fig. 1).



**Figure 1.** Study area. The Bozbu-Too-Ungortepa massif.

## Climate and geomorphology

The climate of the IPA site and its surroundings is dry and warm. As no precise climatic data are available for this IPA site, extrapolations have been made based upon the average data for Namangan weather stations and using the environmental lapse rate (6 °C/1000 m). The annual rainfall in the lower zone (500–800 m) varies from 170–280 mm, and from 350–400 mm in the upper zone (1200–1500 m). The average temperature is 2–5 °C in January, and 27–28 °C and 7–10 °C in the upper part in July. The average annual temperature is 13.2 °C, and the lowest is 4 °C. The absolute minimum fluctuates around -20 °C. Rainfall occurs in spring and autumn-winter. There are two contrasting periods: spring (until the end of May) with green vegetation and summer when most of the vegetation burns out and the vegetation is a shade of yellow (Nabiev 1954).

The study area occupies two lower geomorphological stages—the foothills and the low mountains of South Chatkal. The variegated geological structure of the surface and the intense runoff characteristic of the region, causing erosion of slopes, have a significant effect on soil formation and the soil cover structure. For this reason, the predominant part of the site is devoid of a characteristic soil cover due to the vigorous erosion of the surface. This is one of the main factors affecting the formation of vegetation cover (Nabiev 1954).

## Data collection

In the Uzbekistan part, the first field studies to identify the IPA were in 2013–2014 by Tojibaev's team but were stopped due to lack of funding. In Kyrgyzstan, the first field studies of the authors (G.A. Lazkov) began in the 1990s. However, targeted research under the IPA program was carried out only in 2020–2022. From the IPA surveys both in Kyrgyzstan and Uzbekistan, Lazkov's and Tojibaev's team field records, literature data from Nabiev (1954), Vernik and Rakhimova (1982), and herbarium collections data (mainly in TASH, FRU, LE, MW; Thiers 2022), a total of 1275 vascular plant species have been recorded in the IPA site.

## Taxonomy

Taxonomic identification was based on Flora of Uzbekistan (1941–1963), Flora of Kyrgyzstan (1952–1965), *Conspectus Florae Asiae Media* (1969–1993), a taxonomic revision of some families of the flora of Kyrgyzstan (Pimenov and Kljuykov 2002; Lazkov 2006a), the newly published first four volumes of the new Flora of Uzbekistan (Sennikov 2016, 2017, 2019, 2022), the recently published data on Apiaceae (Tojibaev et al. 2020), *Tulipa* (Tojibaev and Beshko 2014), and the checklist of the Flora of Tian-Shan mountains (Tojibaev et al. 2020). The nomenclature of each taxon followed Plants of the World Online (POWO) <http://www.plantsoftheworldonline.org>, and International Plant Name Index (IPNI) [www.ipni.org](http://www.ipni.org).

## Site selection

Species and habitats were selected according to the proposed IPA criteria. The IPA site selection methodology fits the European IPA criteria set out in the IPA site selection manual and their modifications published in authoritative publications (Anderson 2002; Blasi et al. 2011; Darbyshire et al. 2017), the main of which are:

1. The IPA site satisfies either criterion A, B, C, or any combination of these.
2. Previously tested approaches in the conditions of mountainous Central Asia were applied, which makes it possible to ensure the creation of a regional network.
3. The IPA site contains those conditions necessary to ensure the long-term viability of the species or intraspecific taxa. Also, the selected IPA site contains multiple qualifying species to focus conservation action at the national and trans-boundary levels.

We used only selected vascular plants and habitats and existing data on their distribution on a national and regional scale. This is because, as in Kyrgyzstan, there is currently no classification of habitats, especially critical habitats, in Uzbekistan. Moreover, the studied area is typical for the south of mountainous Central Asia.

The boundaries of the Bozbu-Too-Ungortepa IPA site are broadly in line with the regional assessment of KBAs (Key Biodiversity Areas) in Central Asia (CEPF 2017). Biodiversity hotspots N°11 (Karatag Mountains), N°12 (Ungortepa), and N°05 of the contours (Aflatun-Padshaata) from the final report “Biodiversity hotspots in the mountainous region of Central Asia” are included in the Bozbu-Too-Ungortepa IPA.

Existing conservation threats were estimated based on field observations and analysis of the available literature data (Davletkeldiev 2006; Khassanov 2019; Eastwood et al. 2009).

## Results

### Criterion A (threatened species)

According to the generally accepted formulation, IPA sites with criterion A should hold significant populations of one or more species of global or regional conservation concern (Anderson 2002). After modifying IPA methodology as proposed by the authors in the previous stages of the IPA research in Central Asia (Tojibaev et al. 2022), 62 vascular plant species were recognized as belonging to criterion A. Following the national requirements, we also listed national and regional species of interest (Table 1).

**Table 1.** The list of selected species including the criterion A of the Bozbu-Too-Ungortepa massif with IPA sub-criteria, IUCN Conservation status, general distribution and preserved herbaria.

No	Accepted species name	IPA category	Conservation status (IUCN)			Red Data Book	Preserved Herbaria
			EOO km <sup>2</sup>	AOO km <sup>2</sup>	Category		
1	<i>Malus sieversii</i> (Ledeb.) M.Roem.	Ai	Not evaluated		VU A2acde	KG	TASH, FRU, TAD, MW, AA
2	<i>Acanthophyllum pungens</i> (Bunge) Boiss.	Aii	1,685,141.644	248	LC+EN	UZ	TASH, FRU, TAD, MW, AA
3	<i>Allium dodecadontum</i> Vved.	Aii	19,569.468	92	VU+EN	KG	TASH, FRU
4	<i>Allium viridiflorum</i> Pobed.	Aii	133.707	16	EN	UZ	TASH, FRU
5	<i>Anthochlamys tjanschanica</i> Iljin ex Aellen	Aii	21,576.049	136	NT+EN	UZ	TASH, FRU, MW
6	<i>Crataegus knorringiana</i> Pojark.	Aii	19,859.660	52	EN	KG	TASH, FRU
7	<i>Delphinium knorringianum</i> B.Fedtsch.	Aii	23,231.587	24	NT+EN	KG, UZ	TASH, FRU
8	<i>Dorema microcarpum</i> Korovin	Aii	21,800.193	46	NT+EN	KG, UZ	TASH, FRU, MW
9	<i>Eminium regelii</i> Vved.	Aii	95,605.497	80	LC+EN	KG	TASH, FRU, TAD, MW, AA
10	<i>Gamanthus ferganicus</i> Iljin	Aii	15,513.182	136	VU+EN	UZ	TASH, FRU, MW
11	<i>Iris kolpakowskiana</i> Regel	Aii	126,385.582	96	LC+EN	KG	TASH, FRU, MW, AA
12	<i>Hedlundia persica</i> (Hedl.) Mezhen'skyj	Aii	851,107.371	144	LC+EN	KG	TASH, FRU, TAD, MW, AA
13	<i>Lamyropappus schakaptaricus</i> (B. Fedtsch.) Knorring & Tamamsch.	Aii	4,166.438	108	EN	KG	TASH, FRU, MW
14	<i>Oreosalsola drobovii</i> (Botsch.) Akhani	Aii	34,390.040	80	NT+EN	TJ, UZ	TASH, FRU, TAD, MW, AA, FRU, MW
15	<i>Seseli eryngioides</i> (Korovin) Pimenov et V.N.Tikhom.	Aii	1,190.623	20	EN	KG	FRU, MW
16	<i>Tulipa ferganica</i> Vved	Aii	36,709.666	156	NT+EN	UZ	TASH, FRU, MW
17	<i>Allium tatyanae</i> F.O.Khass. & F.Karimov	Aiii	13,360	8	CR	-	TASH
18	<i>Astragalus allotricholobus</i> Nabiev	Aiii	316,899	24	EN	-	TASH, FRU, MW
19	<i>Corydalis bosbutooënsis</i> Lazkov	Aiii	3,040	8	CR	-	TASH, FRU
20	<i>Gagea spelaea</i> Levicev et Lazkov	Aiii	3,786	8	CR	-	FRU
21	<i>Iris austrotschatkalica</i> Tojibaev, F. Karim. et Turgunov	Aiii	0	8	CR	-	TASH
22	<i>Acantholimon nabievii</i> Lincz.	Aiii	2,039.723	48	EN	-	TASH, FRU, MW
23	<i>Allium arkitense</i> R.M. Fritsch	Aiii	1 124,205	20	EN	-	TASH, FRU
24	<i>Allium gracillimum</i> Vved	Aiii	9 463,085	28	VU+EN	-	TASH, FRU, TAD MW
25	<i>Allium haneltii</i> F.O. Khass. & R.M. Fritsch	Aiii	865,233	36	EN	-	TASH
26	<i>Allium oreoscordum</i> Vved.	Aiii	19 763,085	36	VU+EN	-	TASH, FRU, MW
27	<i>Allium pseudopskemense</i> ined.	Aiii	2523	16	EN	-	FRU
28	<i>Astragalus bosbutooënsis</i> Nikitina et Sudn.	Aiii	356,940	20	EN	-	TASH, FRU
29	<i>Astragalus melanocomus</i> Popov	Aiii	827,190	12	EN	-	LE, MW
30	<i>Astragalus pseudodianthus</i> Nabiev	Aiii	1169,459	32	EN	-	TASH, FRU
31	<i>Astragalus spryginii</i> Popov	Aiii	4442,536	20	EN	-	TASH, FRU, MW
32	<i>Cousinia knorringiae</i> Bornmuller	Aiii	775,616	32	EN	-	TASH, FRU
33	<i>Cousinia krauseana</i> Regel & Schmalh.	Aiii	37 072,599	36	NT+EN	-	TASH, FRU, MW
34	<i>Echinops knorringianus</i> Iljin	Aiii	8,933.847	40	VU+EN	-	TASH, FRU, MW
35	<i>Eremurus czatkalicus</i> Lazkov	Aiii	3,153,563	32	EN	-	TASH, FRU, MW
36	<i>Ferula incisoserata</i> Pimenov et J. Baranova	Aiii	749,070	16	EN	-	TASH, FRU, MW
37	<i>Fritillaria rugillosa</i> Naumenko & Zubov	Aiii	4,885,728	32	EN	-	TASH, FRU
38	<i>Hedysarum gypsaceum</i> Korotkova	Aiii	1,956.487	28	EN	-	TASH, FRU, MW
39	<i>Hedysarum turkestanicum</i> Regel et Schmalh.	Aiii	15 611,335	32	VU+EN	-	TASH, FRU, MW
40	<i>Hyalolaena intermedia</i> Pimenov & Kljuykov	Aiii	2,969,10	24	EN	-	TASH, FRU
41	<i>Iris narynensis</i> O. Fedtsch.	Aiii	2 735,900	28	EN	-	TASH, FRU, MW
42	<i>Limonium ferganense</i> Ilkonn.-Gal.	Aiii	5 203,680	12	VU+EN	-	TASH, FRU, MW
43	<i>Oxytropis gymnogyne</i> Bunge	Aiii	14,138.749	120	VU+EN	-	TASH, FRU, TAD MW

No	Accepted species name	IPA category	Conservation status (IUCN)			Red Data Book	Preserved Herbaria
			EOO km <sup>2</sup>	AOO km <sup>2</sup>	Category		
44	<i>Phlomis adylovii</i> Lazkov	Aiii	1,810.229	24	EN	–	FRU
45	<i>Phlomis kirghisorum</i> Adylov, Kamelin & Makhm.	Aiii	2,605.687	40	EN	–	TASH, FRU
46	<i>Phlomis alaiica</i> (Popov) Adylov, Kamelin & Makhm.	Aiii	43,650.470	24	NT	–	TASH, FRU, MW
47	<i>Phlomis urodonta</i> (Popov) Adylov et al.	Aiii	176.445	32	EN	–	TASH, FRU
48	<i>Scutellaria xanthosiphon</i> Juz.	Aiii	1,810,209	24	EN	–	FRU, MW
49	<i>Silene fetissovii</i> Lazkov	Aiii	2948,074	28	EN	–	FRU, MW
50	<i>Seseli giganteum</i> Lipsky	Aiii	893.356	20	EN	–	LE, MW, AA, TASH, FRU, TAD
51	<i>Seseli unicaule</i> (Korovin) Pimenov	Aiii	16 472,343	32	VU+EN	–	LE, TASH, FRU, WILR, MW
52	<i>Tanacetopsis ferganensis</i> (Kovalevsk.) Kovalevsk.	Aiii	5,310.020	24	VU+EN	–	FRU, MW
53	<i>Allium minutum</i> Vved.	Aiv	10,420.306	20	VU+EN	TJ	LE, TASH, FRU, TAD
54	<i>Astragalus syreitschikovii</i> Pavlov	Aiv	95,139.963	68	LC+EN	–	MW, AA, TASH, FRU
55	<i>Fritillaria sewerzowii</i> Regel	Aiv	39,522.829	116	NT+EN	–	TASH, FRU, AA, MW
56	<i>Jurinea winkleri</i> Iljin	Aiv	6,661.322	108	VU+EN	–	TASH, MW
57	<i>Leibnitzia knorringiana</i> (B. Fedtsch.) Pobed.	Aiv	8,443.694	40	VU+EN	–	FRU, MW
58	<i>Lagochilus knorringianus</i> var. <i>drobovii</i> (Kamelin & Tzukerv.) Lazkov	Aiv	32,447.798	60	NT+EN	–	TASH, FRU, AA, MW
59	<i>Polycnemum perenne</i> Litv.	Aiv	32,249.538	152	NT+EN	–	TASH, FRU, AA, MW
60	<i>Pseudosedum ferganense</i> Boriss.	Aiv	27,595.830	100	NT+EN	–	LE, MW, TASH, FRU
61	<i>Tulipa bifloriformis</i> Vved.	Aiv	15,621.720	164	VU+EN	TJ	TASH, FRU, MW, TAD
62	<i>Takhtajianantha tau-saghyz</i> (Lipsch. & G.G.Bosse) Zaika, Sukhor. & N.Kilian.	Aiv	28,713.924	28	NT+EN	–	TASH, FRU, AA, MW

## Category *Ai*

This category includes globally threatened species. In the Bozbu-Too-Ungortepa IPA site, only one species was described as category *Ai*.

### *Malus sieversii* (Ledeb.) M.Roem., Fam. Nat. Syn. Monogr. 3: 216 (1847)

= *Malus kirghisorum* Al.Fed. & Fed., Trudy Yuzhno-Kirgizsk. Eksped. 1: 220 (1949).

**Note.** *Malus sieversii* is grown and consumed worldwide, and there is increasing interest in the crop's evolutionary history and in variety improvement for traits such as fruit characteristics, disease resistance, and stress tolerance (Gross et al. 2012). The species is still found in the fragmented fruit and nut forests of Central Asia and is threatened by habitat degradation, mainly from agricultural development and overgrazing (Eastwood et al. 2009). In Central Asia, this species is considered vulnerable, meaning it is threatened with extinction in the wild according to the IUCN Red List categories and criteria (IUCN 2021). Threats include loss and degradation of habitat because of agricultural expansion and development, genetic erosion (grafting of commercial varieties and hybridization), and over-grazing.



**Existing Conservation Threats.** Over-collection for firewood.

**General distribution.** Afghanistan, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan, Uzbekistan, Xinjiang.

**Distribution in FV.** All mountain ranges of the FV.

### Category *Aii*

Fifteen species were described in category *Aii*.

All species listed in sub-criterion *Aii* are included as threatened species in the Red Data Books of Kyrgyzstan (Davletkeldiev 2006) and Uzbekistan (Khassanov 2019). Our definition of sub-criterion *Aii* agrees with the formulation by Darbyshire et al. (2017), according to which the site must consist of species of IUCN Regional Red List or another regionally approved peer-reviewed threat list.

***Acanthophyllum pungens* (Bunge) Boiss., Fl. Orient. 1: 561 (1867)**  
Figs 2A, 3A

= *Acanthophyllum albidum* Schischk., V.L. Komarov (ed.), Fl. URSS 6: 893 (1936).

**Note.** This polymorphic species is widespread in Central Asia (Lazkov 2006a). Several species were described based on variations of this species, which were later recognized as synonyms of *A. pungens* (Bondarenko 1972; Lazkov 2006a; Lazkov and Sultanova 2014). These “small species” which were later recognized as synonyms, including *A. albidum* Schischk., are of conservation interest. The last taxa were described by Schischkin (1936) from Central FV (Margelan, Kosch-Karchi). These plants are distinguished by white tepals and small inflorescences (up to 15 mm) and, as a rare endemic of FV, were listed in the Red Data Book of Uzbekistan (Khassanov 2019).

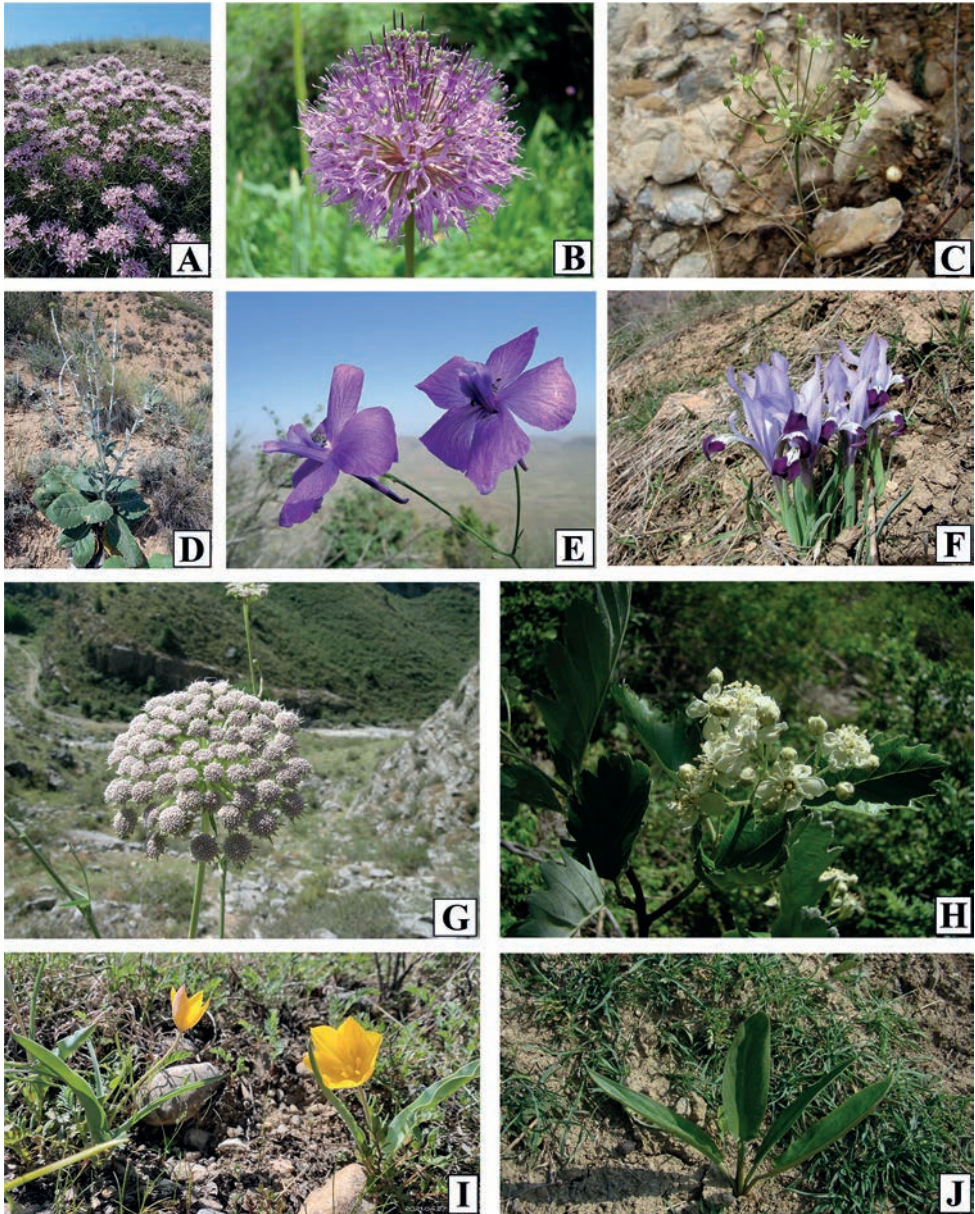
**Existing Conservation Threats.** Habitat fragmentation.

**General distribution.** Kazakhstan, Kyrgyzstan, Mongolia, North Caucasus, Tajikistan, Transcaucasus, Uzbekistan, Xinjiang.

**Distribution in FV.** Foothills and lower mountains of FV.

***Allium dodecadontum* Vved. in Opred. Rast. Sred. Azii 2: 316 (1971)**  
Figs 2B, 3B

**Note.** The species is a member of a small cluster (Alay-Fergana Geographical clade sect. *Acropetala* sensu Fritsch et al. 2010) and comprises five species occurring in western Tian-Shan: partly in Kyrgyzstan, partly in Uzbekistan (Fritsch et al. 2010; Fritsch and Khassanov 2008). Together with *A. schachimardanicum* Vved. (endemic of the middle and upper belts of the Alay Range), *A. dodecadontum* is rec-



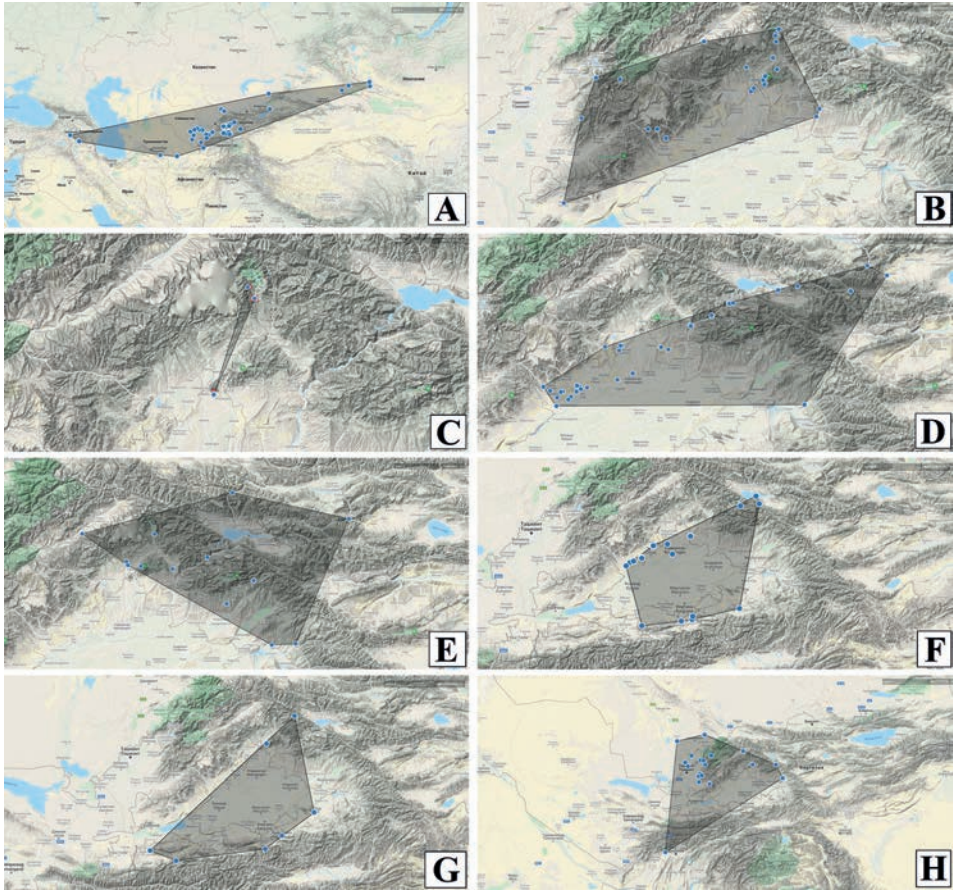
**Figure 2.** The wild habitat of some plants in FV **A** *Acanthophyllum pungens* **B** *Allium dodecadontum* **C** *Allium viridiflorum* **D** *Lamyropappus schakaptaricus* **E** *Delphinium knorringianum* **F** *Iris kolpakowskiana* **G** *Seseli eryngioides* **H** *Hedlundia persica* **I** *Tulipa ferganica* **J** *Eminium regelii*.

ognized as the most basal species of the cluster and is considered strictly endemic to Chatkal Range.

**Existing Conservation Threats.** Habitat fragmentation.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Mid-mountain belt of the Chatkal Range.



**Figure 3.** Distribution map of the species of sub-criterion *Aii*, based on GeoCAT **A** *Acanthophyllum pungens* **B** *Allium dodecadontum* **C** *Allium viridiflorum* **D** *Anthochlamys tjanschanica* **E** *Crataegus knorringiana* **F** *Dorema microcarpum* **G** *Delphinium knorringianum* **H** *Eminium regelii*.

*Allium viridiflorum* Pobed. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 11: 64 (1949)

Figs 2C, 3C

**Note.** This species is a representative of the bi-type *Allium* ser. *Verticillata* Tzag., which have whorled leaves (Fritsch 2016). *A. viridiflorum* differs from *A. verticillatum* Regel, the type species of the section, by the greenish color of tepals that are nine times longer than the pedicels, short stamens, ecological preference, and geographical distribution (Tojibaev et al. 2014b). *A. viridiflorum* was previously considered a local endemic of Arkit, Chatkal range, Kyrgyzstan (Lazkov and Sultanova 2014). A new species population was found in the Uzbekistan part of this IPA site (Tojibaev et al. 2014b).

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Low and mid-mountain belt of the Chatkal Range.

***Anthochlamys tjanschanica* Iljin ex Aellen in Verh. Naturf. Ges. Basel 61: 170 (1950)**  
Fig. 3D

**Note.** The genus *Anthochlamys* comprises five species (POWO, 2022) and is distributed in the Iran-Turanian floristic region (Sukhorukov and Konstantinova 2012). Except for *A. tjanschanica*, almost all the taxa can be found in Iran and western Afghanistan, which differs from other species by its distribution in the Tian-Shan Mountains (Sidorenko et al. 1968; Prатов 1972a).

The species belongs to the rare endemic species of FV with a very narrow distribution range. It inhabits gravelly and loessal slopes of foothills and does not grow in protected areas (Tojibaev et al. 2022).

**Existing Conservation Threats.** Habitat fragmentation, dry-farming, overgrazing.

**General distribution.** Kyrgyzstan, Tajikistan, Uzbekistan.

**Distribution in FV.** Foothills of FV.

***Crataegus knorringiana* Pojark. in Ref. Nauchno-Issl. Rabot, Otdelenie Biol. Nauk 1945: 7 (1947)**

Fig. 3E

**Note.** FV, the Chatkal Range, and the surrounding area, in particular, are important areas in the conservation of wild species of hawthorns (Pachomova 1976). Species known to be widely distributed throughout Central Asia, including *C. songorica* C.Koch., *C. turkestanica* Pojark., and *C. pontica* C.Koch, and some endemic species with narrow distribution both grow in these areas. The distribution of narrow-range species is bounded by the Chatkal river basin and the adjacent mountain ranges of the FV. This group includes *C. rematilibata* (Chatkal, Turkestan and Alay ranges), *C. tianschanica* Pojark. (Chatkal Range), *C. ferganensis* Pojark. (Chatkal, Fergana, Alay ranges), and *C. knorringiana* with distribution in the Chatkal and Alay ranges (Pachomova 1976). The last species were recorded in Bozbu-Too during the IPA surveys.

**Existing Conservation Threats.** Habitat fragmentation, human disturbance, over-grazing, and cutting threaten the species (Eastwood et al. 2009).

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Mid-mountain belt of Chatkal and Alay ranges.

***Delphinium knorringianum* B.Fedtsch. in J. Roy. Hort. Soc. 61: 196 (1936)**

Figs 2E, 3G

**Note.** This rare ornamental plant is a relic species with a disjunctive area and is endemic to FV, where it was found on the northern slopes of the Atoynok Mountain Range and in the northern spurs of Turkestan and Alay ranges.

**Existing Conservation Threats.** Habitat fragmentation.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Mid-mountain belt of the Atoynok Mountain Range and in the northern spurs of the Turkestan and Alay ranges.

***Dorema microcarpum* Korovin in Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbeksk. S.S.R. 8: 6 (1947)**

Fig. 3F

**Note.** As mentioned by M.G. Pimenov (1988), it is difficult not to use the epithet “marvelous” for the Iran-Turanian genus *Dorema* D. Don because, compared to other genera of the Umbeliferae family, it has simple umbel located along the axis of the common inflorescence. This is the most striking feature of the genus *Dorema*, truly unique within the Umbelliferae. The hotspot of the genus is in the Kopet Dag Range (Turkmenistan and Iran) and the surrounding lowlands and plains (Pimenov 1983a, 1988).

*Dorema microcarpum* is the type species of the sect. *Microcarpa* Pimenov, and is considered the most eastern species of the genus. The mountain surrounding FV limits the distributed area (Pimenov 1988). The species is on the verge of extinction, caused mainly by habitat fragmentation. It is included in the Red Data Books of Kyrgyzstan (Davletkeldiev 2006) and Uzbekistan (Khassanov 2019).

**Existing Conservation Threats.** Habitat fragmentation, dry-farming, overgrazing.

**General distribution.** Fergana, South Chatkal, Kurama, and Alay ranges (Kyrgyzstan, Uzbekistan).

**Distribution in FV.** Foothills of FV.

***Eminium regelii* Vved. in Schreder (ed.), Fl. Uzbekistan. 1: 540 (1941)**

Figs 2J, 3H

**Note.** The species is listed as a rare endangered species in the Red Data Book of Kyrgyzstan (Davletkeldiev 2006) and is sporadically distributed in western Tian-Shan and northern Pamir-Alay (Pazij 1972). In the IPA site, the species occurs as single individuals in silty soil and loess slopes in piedmonts and low-montane zones.

**Existing Conservation Threats.** Habitat fragmentation, dry-farming, overgrazing in early spring.

**General distribution.** Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan.

**Distribution in FV.** Foothills of FV.

***Gamanthus ferganicus* Iljin in Trudy Bot. Inst. Akad. Nauk S.S.S.R., Ser. 1, Fl. Sist. Vyssh. Rast. 2: 131 (1936)**

Fig. 4A

≡ *Halimocnemis ferganica* (Iljin) Akhani, Int. J. Pl. Sci. 168: 948 (2007).

**Note.** The genus *Gamanthus* Bunge is predominantly a desert and foothill genus, growing on sands and variegated outcrops. The genus is represented by five species (POWO 2022), mainly in Central Asia, with a disjunction into the Caucasus and Iran and the environs (*Gamanthus pilosus* (Pall.) Bunge). Of these, two species, *G. ferganicus* Iljin and *G. leucophyllus* Botsch., are endemic to Mountainous Central Asia. The first species is bound to the FV, occurring in saline crushed stone slopes of the foothills (Pratov 1972b). It differs from other species of the genus by having opposite leaves covered throughout with crisp, closely appressed hairs.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Tajikistan, Uzbekistan.

**Distribution in FV.** Endemic; low mountains of Chatkal Range (Ungortepa).

***Iris kolpakowskiana* Regel in Trudy Imp. S.-Peterburgsk. Bot. Sada 5: 263 (1877)**  
Figs 2F, 4B

= *Iridodictyum kolpakowskianum* (Regel) Rodion., Rod Iris: 202 (1961).

**Note.** This is an ornamental and early flowering species with a reducing area. The distribution area includes piedmont plains, foothills, and low mountains (up to 1500 m) in western and northern Tian-Shan. The species populates silty-soil, loess, and stony slopes. Such landscapes predominate in FV and are places of intensive human activity. For this reason, the number of individuals is limited and declining. The species is included in the Red Book of Kyrgyzstan (Davletkeldiev 2006).

**Existing Conservation Threats.** Habitat fragmentation, dry-farming, overgrazing in early spring.

**General distribution.** Western and northern Tian-Shan (Kazakhstan, Kyrgyzstan, Uzbekistan).

**Distribution in FV.** Foothills of FV.

***Hedlundia persica* (Hedl.) Mezhenkyj, NULESU Coll. Fruit Ornament. Pl.: 32 (2018)**

Figs 2H, 4C

≡ *Sorbus persica* Hedl., Kongl. Svenska Vetensk. Acad. Handl., n.s., 35(1): 70 (1901).

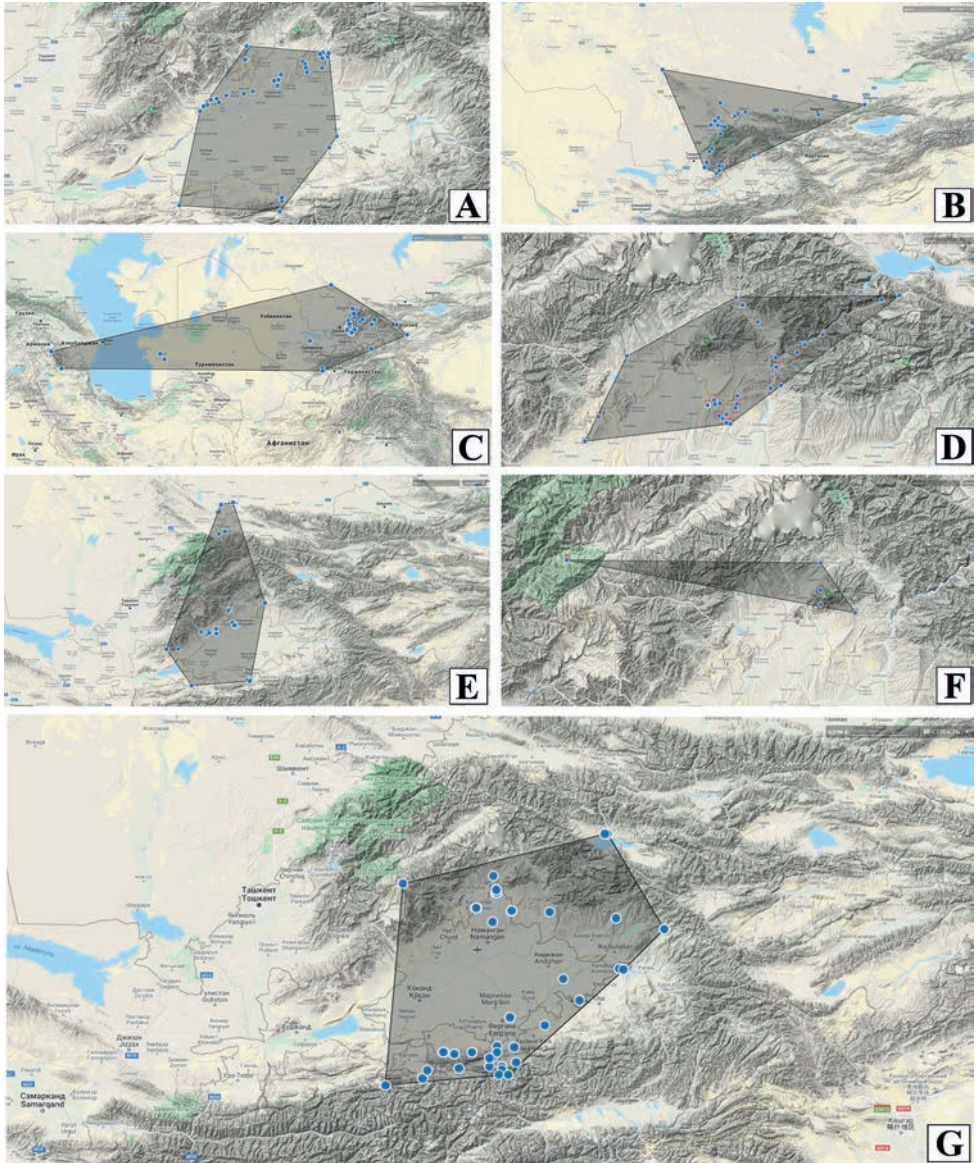
≡ *Pyrus persica* (Hedl.) M.F.Fay & Christenh., Global Fl. 4: 115 (2018).

**Note.** Although the species is rare and red-listed in Kyrgyzstan (Davletkeldiev 2006) and has a restricted distribution in Central Asia, Iran, Caucasus and Afghanistan, there are no immediate threats. Most of the Central Asian populations are in protected areas (Chatkal, Besh-Aral, Sary-Chelek, and Aksu-Djabagli reserves).

**Existing Conservation Threats.** Over-collection for firewood.

**General distribution.** Iran, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan, Uzbekistan

**Distribution in FV.** Mid-mountain belt of Chatkal, Fergana, Alay and Turkestan ranges.



**Figure 4.** Distribution map of the species of sub-criterion *Aii*, based on GeoCAT **A** *Gamanthus ferganicus* **B** *Iris kolpakowskiana* **C** *Hedlundia persica* **D** *Lamyropappus schakaptaricus* **E** *Oreosalsola drobovii* **F** *Seseli eryngioides* **G** *Tulipa ferganica*.

***Lamyropappus schakaptaricus* (B.Fedtsch.) Knorring & Tamamsch. in Bot. Zhurn. S.S.S.R. 38: 909 (1954)**

≡ *Cirsium schakaptaricum* O.Fedtsch. & B.Fedtsch., Consp. Fl. Turkest. 4: 287 (1912).

**Note.** The monotypic genus *Lamyropappus* Knorring & Tamamsch. belongs to the relicts of the flora of Central Asia (Kamelin 1973; Tojibaev et al. 2019). The unique species of the genus has been described as a species of *Cirsium* L. (as *C. schakaptaricum* O.Fedtsch. & B.Fedtsch.) (Fedtschenko and Fedtschenko 1912). Based on the results of taxonomical revisions of the genus, this species was allocated as a monotypic genus *Lamyropappus* in 1954 (Neustrueva-Knorring and Tamamschian 1954). The species has been described in the vicinity of the village of Shekaftar (Central Asia, FV, Kyrgyzstan). Locus classicus is located in boundary areas with Uzbekistan. According to published data (Tamamschian 1963; Tulaganova 1993a), the species' distribution area includes the Pribalkhash District, with deserts and mountains in the middle section of the Naryn river basin (Chatkal and Fergana ranges).

The species has been included in the first three editions of the Red Data Book of Uzbekistan (Pratov 2009). In the 1960s, all cited habitats became farmlands or inhabited settlements. Accordingly, the species' local population in Uzbekistan has disappeared. Tojibaev (2002), within the inventory of flora of southern slopes of the Kurama range in FV, studied boundary areas of Uzbekistan and a Shakaftar village in detail. However, populations of the species have not been found. The northern foothills of FV, in particular the vicinity of the village Shekaftar, are used as farmland. The species has not been found in fragmented natural landscapes. Following the results of these studies, the species has been excluded from the last edition of the Red Data Book (Pratov 2009). However, during field surveys of 2018–2019, a fragmented population of the species was found in the vicinity of Arbagish village in Uzbekistan.

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Pribalkhash Deserts, western Tian-Shan (Kazakhstan, Kyrgyzstan, Uzbekistan).

**Distribution in FV.** Foothills and low mountains in Naryn River Valley, Chatkal, and Fergana ranges.

***Oreosalsola drobovii* (Botsch.) Akhani in Phytotaxa 249: 162 (2016)**

Fig. 4E

≡ *Salsola drobovii* Botsch. in Bot. Mater. Gerb. Bot. Inst. Uzbekistansk. Fil. Akad. Nauk S.S.S.R. 3: 3 (1941).

**Note.** The genus *Oreosalsola* Akhani, a non-C4 lineage, was described as a new genus segregated from *Salsola* s.l. Morphologically and phylogenetically, *Oreosalsola* is very similar to *Salsola arbusculiformis* Drobow, i.e., the “Collinosalsola” group. The main differences are the relatively long inflorescences, glaucous annual branches, and deep



bifid divergent stigmas in *Oreosalsola* in contrast to dark green annual branches, shorter inflorescences, and less divided stigmas in “*Collinosalsola*” (Akhani et al. 2016). The genus comprises nine species, mostly distributed in Central Asia and Iran (POWO 2022).

*Oreosalsola drobovii* (Botsch.) Akhani is distributed in the central and western Tian-Shan area. The FV is the southern border of the species distribution. It is found as solitary plants, inhabiting dry gravelly and stony slopes of the foothills and the lower belt of mountains. In the dry and waterless slopes of the Kurama ridge, the population is vulnerable, but the semi-shrub life form allows it to survive the “waterless” periods. But, this biomorph is the limiting factor in the context of various external impacts, such as cutting and fragmentation of habitats. This species is not protected in the Fergana part of the range.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low mountains of Kurama and Chatkal ranges.

***Seseli eryngioides* (Korovin) Pimenov & V.N.Tikhom., in S.K.Cherepanov, Sosud. Rast. SSSR: 30 (1981)**

Figs 2G, 4F

**Note.** This is one of the subendemic species of the Bozbu-Too-Ungortep IPA site with a few numbers of individuals. The distribution area is limited by the Chatkal range (Pimenov 1983b). Part of a known population inhabits protected areas in the Besh-Aral Nature Reserve (Davletkeldiev 2006).

**Existing Conservation Threats.** Unstudied.

**General distribution.** Western and northern Tian-Shan (Kyrgyzstan).

**Distribution in FV.** Foothills of FV.

***Tulipa ferganica* Vved. in Byull. Sredne-Aziatsk. Gosud. Univ. 21: 148 (1935)**

Figs 2I, 4G

**Note.** This is a subendemic species of FV and also grows on the southern macroslope of the Susamyr Range. All populations are located in the eastern part of the valley within the Chatkal and Alay ranges. Despite its wide distribution in this part of FV, there is a decrease in habitats and individuals in populations, especially around large settlements. Populations in the vicinity of Yangikurgan, Andijan, and Namangan are most threatened, with observed declines of over 25–30% in the last 20–25 years. Therefore, the presence of this species in the protected areas of the FV is important. Currently, the FV presents 11 protected areas with four types (including natural monuments). In terms of preserving wild tulip populations, the most significant protected area is the Sary-Chelek Reserve and other reserves located in Kyrgyzstan (Dekhkonoov et al. 2021). *T. ferganica* has been found in almost all protected areas within Kyrgyzstan. However, further efforts are needed to document the presence of species in many protected areas across the region. According to Wilson et al. (2021), climate-changing models using *T. ferganica* and

*T. korolkowii* underline the restricted representation of these taxa in protected areas. The species is threatened by agricultural expansion, habitat fragmentation, and over-grazing.

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Western Tian-Shan and northern Pamir-Alay (Kyrgyzstan, Tajikistan, Uzbekistan).

**Distribution in FV.** Foothills and low mountains of FV.

### Category *Aiii*

Thirty six species were described in category *Aiii*.

In this study, following Darbyshire et al. (2017), sub-criteria *Aiii* and *Aiv* we defined differently from those used within Europe (Anderson 2002). As noted in Anderson (2002) and analogical publications (Blasi et al. 2011; Marignani and Blasi 2012), European IPA sub-criteria focus on threatened national endemics and national near-endemics, using political boundaries. For sub-criteria *Aiii* and *Aiv* we focused on FV and the Afghan-Turkestan province, areas that are larger than the political boundaries of some European countries.

Species of sub-criteria *Aiii* were divided into two groups: “Highly Restricted Endemics” (HRE), which consist of species with a total range of less than 100 km<sup>2</sup>; and “Range Restricted Endemic” (RRE) with a total range of no more than 5000 km<sup>2</sup>, but more than 100 km<sup>2</sup> (Darbyshire et al. 2017).

### Highly Restricted Endemics of FV

#### *Allium tatyanae* F.O.Khass. & F.Karimov in *Stapfia* 99: 211 (2013)

Figs 6A, 8A

**Note.** This species was previously described at this IPA site (Khassanov et al. 2013). Since 2013, only five herbarium specimens have been collected, including two type specimens kept at TASH (TASH000469, TASH000470). Research in recent years, including within the framework of this study, shows that the species is extremely rare and is not found in the adjacent territories of Uzbekistan and Kyrgyzstan.

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Uzbekistan.

**Distribution in FV.** Subendemic; foothills of FV.

#### *Astragalus allotricholobus* Nabiev in *Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. S.S.R.* 14: 17 (1954)

Fig. 8B

**Note.** This is one of the lesser-known species of *Astragalus* sect. *Chaetodon* Bunge. It was described by M.M. Nabiev at the IPA site area during his inventory study of the

flora of Maylisay river basin (1954). The species in the herbaria of Central Asia (Tashkent, Bishkek) is represented by only a few specimens. A possible reason for this is the natural rarity of populations and the narrow range of distribution areas.

The species is well distinguished from other representatives of the sect. *Chaetodon*, primarily from *Astragalus rumpens* Meffert allians, by the pubescence of the calyx (long, spaced, and shortly appressed) and beans (short, appressed hairs). This feature was the reason for the specific epithet, which in Latin means “beans otherwise hairy”.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic (Chatkal, Kurama); foothills of southern Chatkal.

***Corydalis bosbutooënsis* Lazkov in Bot. Zhurn. (Moscow & Leningrad) 91: 954 (2006)**

Figs 6B, 8C

**Note.** This interesting species (sect. *Strictae*, subsect. *Flabellatae* Fedde), with a narrow range, was previously described at this IPA site (Lazkov 2006b). The author of the species limited the distribution area to the Bozbu-Too Mount massif. The species was considered a narrow endemic of Bozbu-Too, Kyrgyzstan in all publications (Lazkov and Sultanova 2014). During IPA field research in 2019–2020, we found local populations of this species in Uzbekistan on the rocky outcrops of Ungortepa. The discovered population in Uzbekistan occupied approximately 400 × 500 m and was represented by single and grouped plants of 5–10 individuals.

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills and low mountains of FV.

***Gagea spelaea* Levichev & Lazkov in J. Asia-Pacific Biodivers. 12: 343 (2019)**

Figs 6C, 8D

**Note.** The genus *Gagea* Salisb. is one of the largest genera in Liliaceae. Numerous studies have estimated that the number of species in the genus ranges from about 100 (Dahlgren et al. 1985; Xinqi and Turland 2000) to more than 320 (Levichev 2013; Peterson et al. 2016), which is largely due to the incomplete taxonomic revision of *Gagea* (Levichev 1999). Several new species from Iran (Zarrei et al. 2010a, 2010b), Western Europe (Peruzzi et al. 2007), and Turkey, and surrounds (Kayikçi et al. 2014) were described in the last decade. Central Asia is considered a territory with many newly described species of *Gagea*. According to current data, 34 species of *Gagea* are known in the FV (Tojibaev et al. 2018a), and, more recently, 36 in Kyrgyzstan (Levichev et al. 2019). However, this number is incomplete, since several undescribed taxa are present in Central Asia, including the mountains surrounding of the FV.

Described from FV, *Gagea spelaea* belongs to the group of white-flowered *Gagea* species. Until recently, this species was only known from the Chatkal Range's Sary-Chelek Nature Reserve, Kyrgyzstan (Levichev et al. 2019). New field surveys under the IPA FV project found two localities of the species in the Bozbu-Too area.

**Existing Conservation Threats.** Habitat fragmentation, farmlands.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Endemic; Chatkal Range (Bozbu-Too, Sary-Chelek).

***Iris austrotschatkalica* Tojibaev, F.Karim. & Turgunov in Turczaninowia 17(4): 12 (2014)**

Figs 6D, 8E

**Note.** The species also was previously described at this IPA site (southern Chatkal ridge, Ungortepa) in 2014 (Tojibaev et al. 2014c). *Iris austrotschatkalica*, with a narrow range of edaphic tolerance, i.e., a stenobiont, grows only on dry, well-warmed stony soils. The vertical interval is also very narrow, from 1200–1300 m only. Despite a careful study of adjacent territories, the species remains known only from the locus classicus in Uzbekistan.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Uzbekistan.

**Distribution in FV.** Endemic; low mountains of Chatkal Range (Ungortepa).

**Range Restricted Endemics**

***Acantholimon nabievii* Lincz. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 21: 495 (1961)**

Figs 6E, 8F

**Note.** This species has a limited distribution in the form of a narrow strip along the northern foothills of the FV (Tojibaev et al. 2022). The main part of the population grows close to a large settlement (Chust, Kosonsoy towns).

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; northern foothills of FV.

***Allium arkitense* R.M.Fritsch in Stapfia 80: 385 (2002)**

Figs 6F, 8G

**Note.** The species, one of the rare species of the FV, was described over the past two decades (Fritsch et al. 2002). Prior to our research, the species was known only from the locus classicus (Fritsch 2016). New populations of the species were found during field surveys in Kyrgyzstan (Lazkov) and Uzbekistan (Tojibaev, Karimov, Hoshimov). Thus, the species has a transboundary range.

**Existing Conservation Threats.** Habitat fragmentation, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; northern foothills of FV.

***Allium gracillimum* Vved. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 9: 243 (1946)**

Figs 6G, 8H

**Note.** Originally, the species was described as a narrow endemic of the Mogoltau Mountains, Tajikistan (Vvedensky 1971). Later, it was found in the southern part of the Kurama range, Tajikistan (Tojibaev's oral communication), and the Chatkal range (Lazkov and Turdumatova 2010). According to current data, the species distribution area covers Mogoltau, the southern slopes of Kurama (both in Tajikistan), and the Atoynak and Chatkal ranges (Kyrgyzstan).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Tajikistan.

**Distribution in FV.** Endemic; low mountains of Mogoltau, Atoynak, Chatkal and Kurama ranges.

***Allium haneltii* F.O. Khass. & R.M. Fritsch in Linzer Biol. Beitr. 30: 282 (1998)**

Figs 6I, 8I

**Note.** This is a morphologically and geographically interesting species of *Allium* sect. *Brevidentia* F.O.Khass. & Yengalycheva (Fritsch et al. 1998). The species is widely separated from its closest relatives, i.e., the Afghan species *A. miserabile* Wendelbo and *A. circumflexum* Wendelbo (Fritsch et al. 1998). All relatives are distinguished by simple inner filaments, coriaceous outer bulb tunics, and boat-shaped bulblets.

The distribution area is limited by the foothills of Kurama and Chatkal ranges (Tojibaev et al. 2020). The main part of the population grows close to a large settlement and is threatened by habitat fragmentation.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Uzbekistan.

**Distribution in FV.** Endemic; northern foothills of FV.

***Allium oreoscordum* Vved. in Bot. Mater. Gerb. Glavn. Bot. Sada R.S.F.S.R. 5: 95 (1924)**

Figs 6H, 8J

**Note.** This is one of the primitive *Allium* species in the flora of Central Asia. Characterized by the peculiar structure of the bulb, i.e., bulbs are attached to an ascending rhizome, they are narrowly conical, and bulb tunics are reticulate. The species was

described from Ungortepa, i.e., in the IPA area. Currently, the area is limited to the Chatkal and Uzun-Akhmat ranges (FV) and the species is known in 10–12 locations; most of them are found in the Bozbu-Too-Ungortepa IPA.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; northern foothills and mid-mountains of FV.

***Allium pseudopskemense* ined. (sect. *Cepa*)**

Figs 6J, 8K

**Note.** *Allium* sect. *Cepa* (Mill.) Prokh. is a small group within the genus *Allium* that includes 12 wild and cultivated species. Two of them, *Allium cepa* L. (common or bulb onion) and *A. fistulosum* L. (bunching onion) are economically important (Yusupov et al. 2021). In «Flora of the Kirghiz SSR» (Nikitina, 1951), three wild (*A. galanthum* Kar. & Kir., *A. oschaninii* O.Fedtsch., *A. pskemense* B.Fedtsch.) and one cultivated species (*A. cepa*) representatives of sect. *Cepa* have been recorded. The same number of species of sect. *Cepa* (*A. cepa*, *A. oschaninii*, *A. praemixtum* Vved., *A. pskemense*) was recorded in Uzbekistan (Sennikov 2017).

During field research at the IPA site in 2012–2013, Lazkov collected specimens distinctive from *A. pskemense*. A subsequent revision of all herbarium specimens in FRU and TASH with similar morphological features shows that recently collected specimens differed from *A. pskemense* due to important characteristics such as filament structure and distribution areas. Prior to that point, all collectors in Kyrgyzstan wrongly identified it as the closely related *A. pskemense*. The difference between the newly collected plants and *A. pskemense* is justified morphologically, genetically, and geographically. The plant from this IPA site has been named *Allium pseudopskemense* ined.

**Existing Conservation Threats.** Habitat fragmentation.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Foothills of FV.

***Astragalus bosbutooënsis* Nikitina & Sudn. in Izv. Akad. Nauk Kirgizsk. S.S.R., Ser. Biol. Nauk 1: 68 (1974)**

Figs 6K, 8L

**Note.** The species was described in the Bozbu-Too Range and was considered endemic to Kyrgyzstan (Kamelin 1981; Lazkov and Sultanova 2014). It belongs to the sect. *Xiphidium* Bunge (subsect. *Microtropidia* Kamelin), and is a loose, non turf-forming plant with elongated pink-purple inflorescences. All known locations were in the Bozbu-Too. However, in 1950 and 1972, very similar plants were collected from Uzbekistan, between the Pap and Charkesar foothills and Chatkal reserve, re-

spectively. Because of the rarity of this species in the Uzbekistan part of the Chatkal Range, it remained overlooked by subsequent researchers (Krasovskaya and Levichev 1986; Tojibaev 2010). The new records significantly expanded the distribution area of this rare plant species (Tojibaev et al. 2014b). According to the latest data, the species is a narrow endemic of the FV, with distribution in the Atoynak and Chatkal ranges (Tojibaev et al. 2020).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills and low mountains of FV.

***Astragalus melanocomus* Popov in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 10: 24 (1947)**

Fig. 9A

= *Astragalus isophytus* Nabiev in Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. S.S.R. 14: 20 (1954).

**Note.** The species belongs to sect. *Chaetodon* Bunge (Puchkova 1967, 1981; Podlech and Zarre 2013). In Central Asia, the sect. *Chaetodon* is represented by a large number of species endemic to mountainous Central Asia, including rare and threatened ones (Tojibaev et al. 2015). *A. melanocomus* is endemic to the mountain ranges surrounding the FV (Puchkova 1967, 1981; Tojibaev et al. 2015). From the study area, it is known only from two herbarium collections from 1912 and 1933, kept in LE (Ungor-Tepa Mountains, O. Knorring, sn, 1912; Environs of the village of Kassansay, Drobow and Sakhobutdinov, sn, 1933). Subsequent studies in both Uzbekistan and Kyrgyzstan did not reveal the presence of *A. melanocomus* in this IPA site and surrounding areas.

**Existing Conservation Threats.** Unknown.

**General distribution.** Uzbekistan.

**Distribution in FV.** Endemic; middle mountain belt of FV.

***Astragalus pseudodianthus* Nabiev in Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. S.S.R. 14: 21 (1954)**

Fig. 9B

**Note.** The species was described by Nabiev (1954) from the gypsum slopes of the northern foothills of the FV, bordering the IPA site. Other closely related species differ in the large size of the flower, calyx, and beans, and legumes 1–2 mm long. According to Vinogradova (1981) the species belongs to sect. *Aureophora* Kamelin, consisting of four species, and are narrow endemics to the foothills and low mountains of western Tian-Shan and western Pamir-Alay. Podlech and Zarre (2013) classified the species into sect. *Dissitiflora* with more than 1954 species worldwide.

Nabiev (1954) also described several *Astragalus* species, which are still considered narrow endemics of foothills and low mountains of southern Chatkal, bordering the Bozbu-Too-Ungortepa IPA site, namely *A. allotricholobus* (see above), *A. isophysus* (syn. of *A. melanocomus* Popov), both belong to the sect. *Chaetodon*, and *A. caudicosus* Galkina & Nabiev (sect. *Ornithopodium*, sensu Podlech and Zarre 2013: 1782–1797).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills and low mountains of Kurama and Chatkal ranges.

***Astragalus spryginii* Popov in Dimo, Soil Invest. Exped. Rivers Syr-daria & Amudaria 1: 51 (1915)**

Fig. 9C

**Note.** This is a representative of subsect. *Spryginiana* Kamelin with interesting morphological features. Within the sect. *Xiphidium* (more than 60 species in Central Asia) is distinguished by its life form (shrub) and is easily identified by its bare ovary and beans (Kamelin 1981). Recently, the species were noted as a new species for the flora of Uzbekistan from the Bozbu-Too-Ungortepa IPA site, and detailed information on geography and conservation issues was given by Tojibaev et al. (2019).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Tajikistan, Uzbekistan.

**Distribution in FV.** Endemic; foothills and low mountain belts of FV.

***Cousinia knorringiae* Bornm. in Beih. Bot. Centralbl. 34(2): 201 (1916)**

Figs 6M, 9D

**Note.** This species is narrowly distributed in the western Tian-Shan and is endemic to Kyrgyzstan (Sennikov 2010; Lazkov and Umralina 2015). It inhabits bare rocks and scree at elevations of 1200–1500 m above sea level. This species is of conservation interest because of its small population size and limited distribution (Sennikov 2010, 2021). *C. knorringiae* was first reported in eastern Uzbekistan on the southern foothills of Ungur-Tepa Mt., north of Paromon Village, in Yangi-Kurgan District, Namangan Region (Usmonov et al. 2021). The conservation status of the species is assessed as Endangered (EN), based on criterion D (estimated population size of 200–250 mature individuals), according to the IUCN Red List Categories and Criteria (version 3.1).

**Existing Conservation Threats.** Habitat fragmentation.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low-mountain belt of Chatkal Range. Endemic to the Bozbu-Too-Ungortepa IPA site.



***Cousinia krauseana* Regel & Schmalh. in Izv. Imp. Obshch. Lyubit. Estestv. Moskovsk. Univ. 34(2): 48 (1882)**

Figs 6N, 9E

**Note.** The species belong to *Cousinia* sect. *Jurineopsis* (Juz.) Tscherneva, which is endemic to the Central Asian Mountains (Tscherneva 1993). The section includes 11 species; most are distinguished by a comparatively small distribution area. Earlier, Tscherneva indicated *C. krauseana* in the flora of Uzbekistan (Tscherneva 1962) and Kirgiz SSR (Tscherneva 1963) with a small distribution area limited by the northern foothills of FV. During the field surveys in the IPA area, a small population of the species was found on the border of Uzbekistan and Kyrgyzstan.

A new observation also confirms that the species has a narrow distribution area and is consistent with the latest data by Tscherneva (1993). However, the species has few herbarium records.

**Existing Conservation Threats.** Habitat fragmentation, farmlands.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low-mountain belts of FV.

***Echinops knorringianus* Iljin in Bot. Mater. Gerb. Glavn. Bot. Sada R.S.F.S.R. 3: 173 (1922)**

Fig. 9F

**Note.** The genus *Echinops* L. in Central Asia represents approximately 45 species, and only 2 are annual plants (Li 1993). Among them, *E. knorringianus* can be easily distinguished by the absence of felt or cobweb pubescence on the upper surface of the leaves and stems with glandular pubescence. In contrast to *E. nanus* Bunge (the second annual species of the genus in Central Asia), *E. knorringianus* has a narrow distribution area (FV), bounded by the stony and fine-earth slopes of the foothills.

**Existing Conservation Threats.** Habitat fragmentation, farmlands.

**General distribution.** Kyrgyzstan, Tajikistan, Uzbekistan.

**Distribution in FV.** Foothills around FV.

***Eremurus czatkalicus* Lazkov in Turczaninowia 14(3): 12 (2011)**

Figs 6P, 9G

**Note.** This is another new noteworthy record from the Uzbekistan part of the FV. This species was previously known from Kyrgyzstan, and the distribution area of this species was in the Aflatun River Basin in the southern Chatkal Range (Lazkov and Pashinina 2011). Most available data on the distribution of the species belongs to the vicinity of the locus classicus. However, in 2019, V. Yusupov collected specimens of the species from the northern foothills of the FV in Kasansay town (<https://www.plantarium.ru>).

This information intensified field surveys for the species elsewhere in the northern foothills of FV (Uzbekistan). Several specimens were found between Pap and Chust towns, in the Karatag massif (near Kasansay town), and Arbagish village. The last two locations form part of the IPA site.

**Existing Conservation Threats.** Habitat fragmentation, farmlands.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low-mountain belts of Kurama and Chatkal ranges.

***Ferula incisoserrata* Pimenov & J.V.Baranova in Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol., n.s., 84(3): 87 (1979)**

Figs 6L, 9H

**Note.** The species is endemic to eastern FV with distribution in the Chatkal and Fergana ranges (Pimenov and Baranova 1979). It was previously recorded in the flora of Kyrgyzstan as a national endemic (Lazkov and Pashinina 2011; Laskov and Sultanova 2014). It was collected in the Uzbek part of FV in 2014, but was fully identified in 2020. The Uzbekistan population grows only in the Ungortepa area. The nearest populations are located in the Karavan pass (around 10–15 km, Nabiev 1959, specimen stored in TASH) and Bozbu-Too (around 35–38 km, Lazkov's collection of 2021).

**Existing Conservation Threats.** Habitat fragmentation, farmlands.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; low and mid-mountains of Chatkal and Fergana ranges.

Regarding the diversity of geophyte bulbous species, FV is still an insufficiently studied area. This is evidenced by the fact that dozens of new species belonging to the genera *Allium*, *Eremurus*, *Iris*, and *Tulipa* have been described in the FV in the last two decades (Tojibaev et al. 2020; Naumenko and Zubov 2021). The genus *Fritillaria* is no exception, which is represented in the FV by at least six (Naumenko and Zubov 2021) out of eight species recorded in the Tian-Shan mountains. The last species was described recently (Naumenko and Zubov 2021), and the *locus classicus* is located in the IPA site. This species' information is provided below.

***Fritillaria rugillosa* Naumenko & Zubov in Int. Rock Gard. 140: 4–11 (2021)**

Figs 6O, 9I

**Note.** In all previous field studies conducted in this region, this species was identified as *Fritillaria stenantha* (Regel) Regel, which is endemic to western Tian-Shan. However, this species of *Fritillaria* is widespread across all mountain ranges of the region. Only Naumenko and Zubov, the authors of *F. rugillosa*, paid attention to the differences between the two species and recognized the plants from eastern Fergana as a new species. According to the authors, *F. rugillosa* differs from *F. stenantha* by an open/flat, wide-wheel-shaped perianth, sideways directed at flowering; perianth segments

without a pronounced pinch between the nectary horn and the bend of a segment; dark, violet, or purple filaments, pubescent by 2/3 at a base, white and glabrous in the upper part, or sometimes fully pubescent along the entire length (Naumenko and Zubov 2021). Naumenko and Zubov (2021) assumed that it is highly probable that it is distributed in the Uzbekistan part of the FV. Field surveys in 2021 confirmed the presence of the species in the Uzbekistan part of the FV. Populations of this species have been recorded in the vicinity of Arbagish.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low mountain belts of Chatkal Range.

***Hedysarum gypsaceum* Korotkova in Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. S.S.R. 14: 13 (1954)**

Figs 6Q, 9J

**Note.** This species is known from the boundary area between Uzbekistan and Kyrgyzstan, where it grows on rocky slopes at 900–1500 m. The distribution area of the species almost coincides with the Bozbu-Too-Ungortepa IPA site. The majority of specimens stored in TASH were collected from the Kyrgyzstan part. The latest collection from the territory of Uzbekistan was in 1951 (Nabiev 1959). According to the field surveys of 2015, the species is rare in the Uzbekistan part of the Chatkal range (vicinity of Arbagish village). Field studies in subsequent years determined the distribution area in the Uzbekistan part of the FV and the current condition of local populations. No more than 150–200 individuals of this species were found in the research area. The population consists of individuals of different ages, and seed regeneration was observed (Tojibaev et al. 2019).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills and low mountain belts of Kurama and Chatkal ranges within the FV.

***Hedysarum turkestanicum* Regel & Schmalh. in Izv. Imp. Obshch. Lyubit. Estestv. Moskovsk. Univ. 34(2): 21 (1882)**

Fig. 5, 9K

**Note.** The species is a narrow endemic to the southern slopes of the Chatkal Range. It was described in 1882 by Regel and Schmalhausen based on collections by Krause (Regel 1882). The locus classicus is in the vicinity of the village of Nanay, bordering Kyrgyzstan and Uzbekistan. For many years the plant was known only from type specimens. Another collection was carried out 69 years later, in 1951 by N.V. Galkina in the vicinity of Nanay. However, it is difficult to determine whether these specimens were collected in the Uzbekistan part (Tojibaev et al. 2014c). New infor-



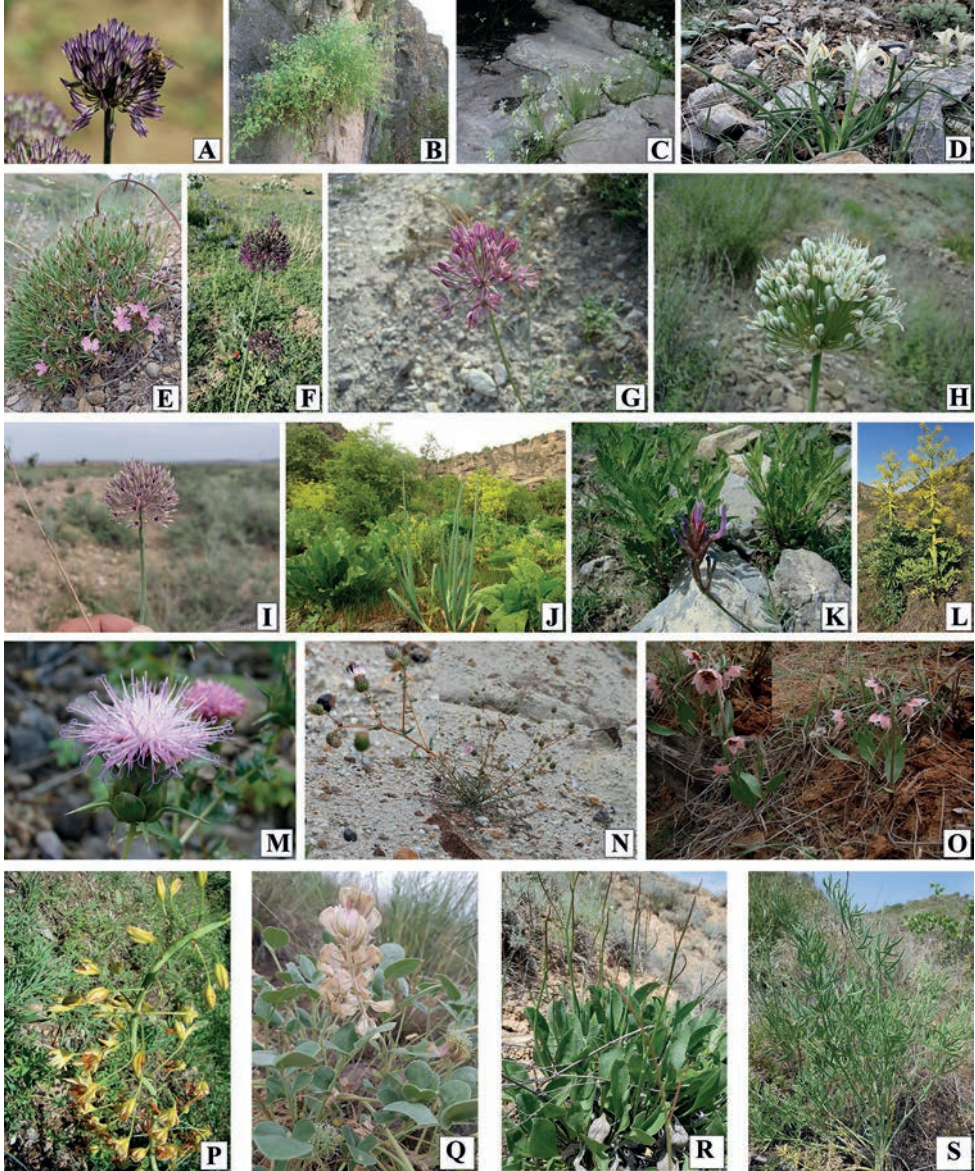
**Figure 5.** Specimen of *Hedysarum turkestanicum* Regel & Schmalh. collected 70 years after the date of the type specimens collection.

mation on species distribution became available only in 2020 and 2021 when the staff of the Institute of Botany of the Academy of Sciences (Ortikov E. and Juramuradov I., respectively) collected two specimens of this species from the species' locus classicus. However, the scientific significance of these collections lies in the fact that they indicate the preservation of the species in such a narrow area, which is directly located near a large settlement.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills of southern Chatkal Range.



**Figure 6.** The wild habitat of some plants in FV. **A** *Allium tatyanae* **B** *Corydalis bosbutooënsis* **C** *Gagea spelaea* **D** *Iris austroschatkalica* **E** *Acantholimon nabievii* **F** *Allium arkitense* **G** *Allium gracillimum* **H** *Allium oreoscordum* **I** *Allium haneltii* **J** *Allium pseudopskemense* **K** *Astragalus bosbutooënsis* **L** *Ferula incisoserrata* **M** *Cousinia knorringiae* **N** *Cousinia krauseana* **O** *Fritillaria rugilosa* **P** *Eremurus czatkalicus* **Q** *Hedysarum gypsaceum* **R** *Limonium ferganense* **S** *Seseli unicaule*.

***Hyalolaena intermedia* Pimenov & Kljuykov in Bot. Zhurn. (Moscow & Leningrad) 67: 887 (1982)**

Fig. 9L

**Note.** The species was described from the environs of Kyzyl-Tokay (South Chatkal, Kyrgyzstan) based on herbarium specimen of the authors of the species (Pimenov and Kljuykov 1982). Until now, this species was considered nationally endemic to Kyrgyzstan, distributed only in the Chatkal Range (Pimenov and Kljuykov 2002; Lazkov and Umralina 2015). However, during an expedition to the hard-to-reach border areas north of Namangan, Tojibaev et al. collected *H. intermedia* Pimenov & Kljuykov, a new record for Uzbekistan (Lyskov et al. 2019). The species differs from all other *Hyalolaena* species in the branched cord-like roots and stubble-like concave ultimate segments of the basal leaves (Pimenov and Kljuykov 1982).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills of Chatkal Range (Naryn and Kasansay River Basins).

***Iris narynensis* O.Fedtsch. in Izv. Imp. S.-Peterburgsk. Bot. Sada 5: 159 (1905)**

Fig. 10A

**Note.** *Iris narynensis* is endemic to the low mountain belts of the FV (both in Tian-Shan and Pamir-Alay parts). The flowers are vaguely reminiscent of *I. kuschakewiczii* and its related species (Ikinci et al. 2011). The species belong to the group of rare Juno Iris species of Central Asia. In the Tian-Shan part, it is known from Ungortepa (Kyrgyzstan), the surroundings of Arbagish (Uzbekistan), and Bozbu-Too (Kyrgyzstan).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Endemic; foothills and low mountains of FV.

***Limonium ferganense* Ikonn.-Gal. in Trudy Bot. Inst. Akad. Nauk S.S.S.R., Ser. 1, Fl. Sist. Vyssh. Rast. 2: 262 (1936)**

Figs 6R, 10B

**Note.** *Limonium ferganense* is one of the few species of the genus endemic to the FV. The majority of populations of the species grow in the foothills of the Chatkal and Fergana ranges within the Naryn River Basin (Linchevsky 1993). The closest species are *L. narynense* Lincz., another species endemic to the mountains of the middle section of the Naryn River. *L. ferganense* is distinguished by the lack of fruitless branches in the inflorescence.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills of Chatkal and Fergana ranges.

*Oxytropis gymnogyne* Bunge in *Mém. Acad. Imp. Sci. Saint Pétersbourg, Sér. 7, 22(1): 25 (1874)*

Fig. 10C

**Note.** The genus *Oxytropis* DC. in Central Asia is mainly represented by species common in the mid and high-mountain regions (Filimonova 1983). *O. gymnogyne* belongs to a group of species endemic to Central Asia, distributed from foothills (450–500 m) up to the mid-mountain belt (1800–2000 m). In the Tajikistan part of western Tian-Shan (Mogoltau), the species are found at 450–1000 m altitude (Abdusalamova 1978). In northern Fergana, including the IPA site, the species is distributed on stony and gravelly slopes of foothills between 500–900 m.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and mid-mountain belt of Chatkal, Kurama, and Mogoltau ridges.

As one of the largest genera in Lamiaceae, *Phlomoidea* Moench. is well known for its high local microendemism in Central Asia (Salmaki et al. 2012).

The tribe *Phlomideae* Mathiesen originally comprised six genera (Scheen et al. 2010), including the mostly Central Asian *Phlomoidea* (L.) Moench, and *Pseuderemostachys* Popov. According to the World Checklist (Govaerts et al. 2021) and the above circumscription, *Phlomideae* contains 200 records, whereas Kamelin and Makhmedov (1990) recognized about 250 species within the genera. The species are distributed from Europe to Mongolia, China, and India, with the highest number of species found in Central Asia, Afghanistan, Iran-Turanian, and Himalayan regions (Salmaki et al. 2012).

One of the centers of local endemism of *Phlomoidea* is in the study area. At least 26 species of the genus grow in the FV; seven of them are endemic to the FV (Gulomov 2021).

*Phlomoidea adylovii* Lazkov in *Novosti Sist. Vyssh. Rast. 36: 32 (2004)*

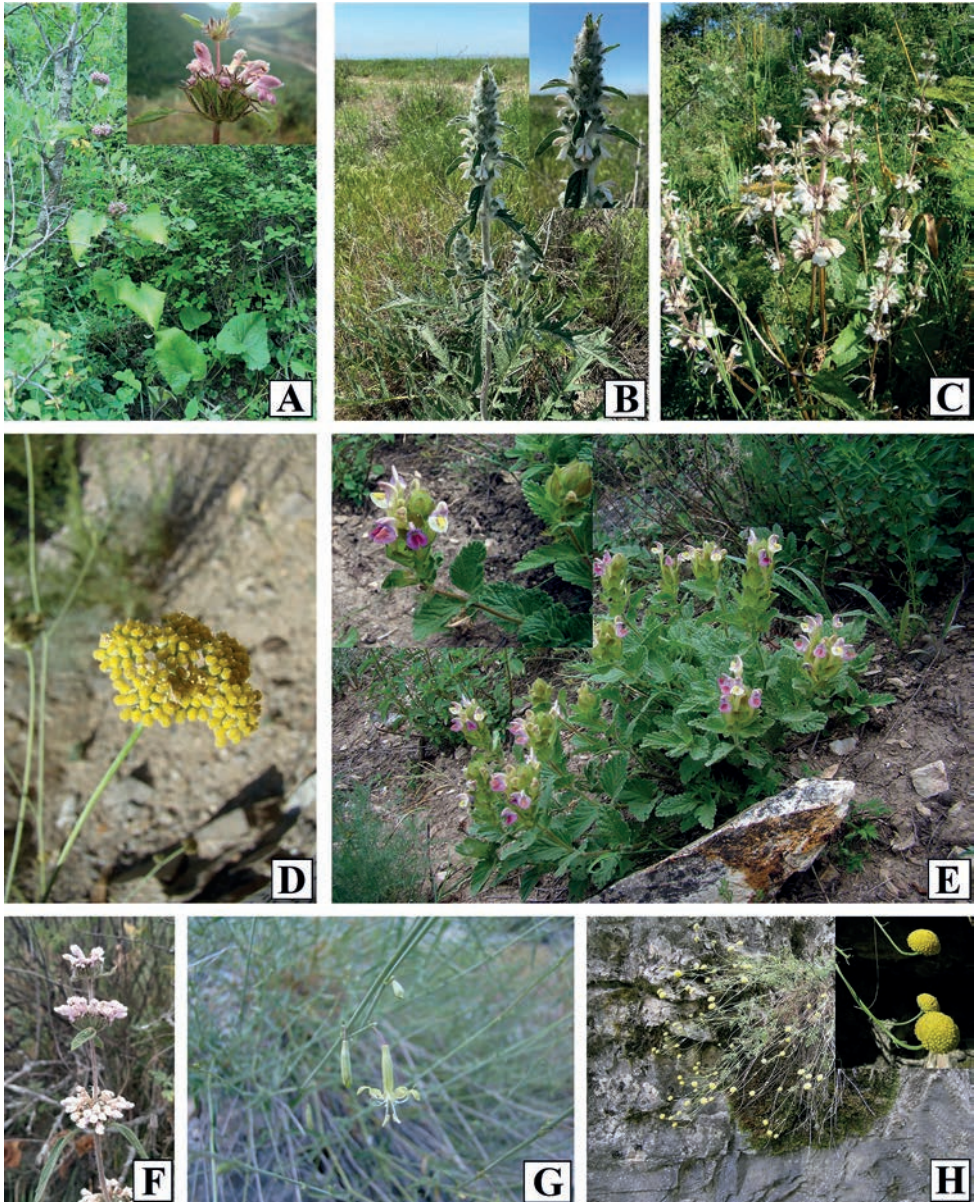
Figs 7A, 10D

**Note.** The species is considered one of the narrow endemic species of *Phlomoidea* Moench. in the FV (Lazkov 2011, 2016). It was described by G.A. Lazkov in the Kurpsay gorge (Atoynak ridge), bordering the eastern part of the IPA site (Lazkov 2004). Currently, it is known from four localities, two of which are located at Bozbu-Too, Ungortepa of this IPA site (Lazkov 2004, 2011).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

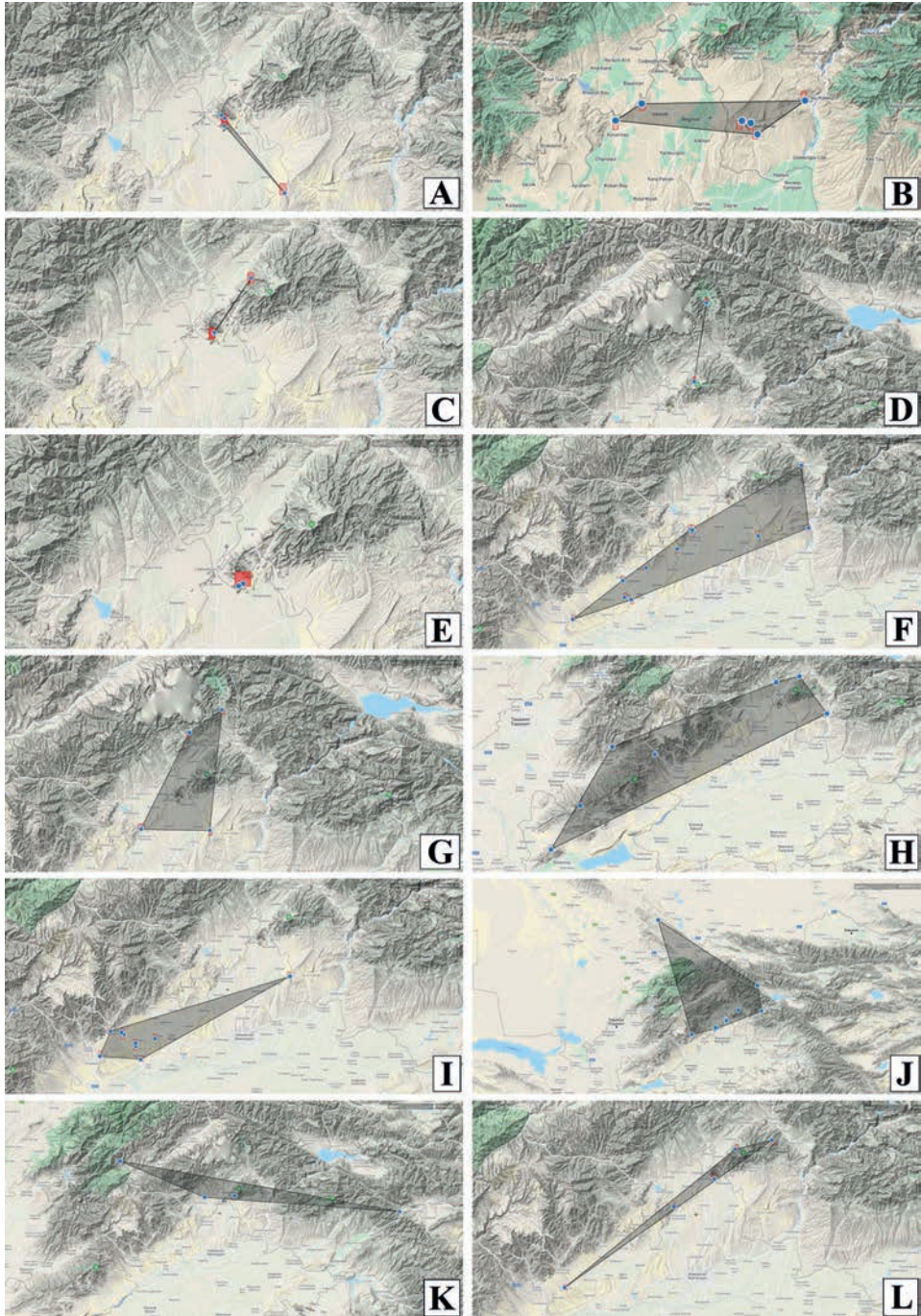
**General distribution.** Kyrgyzstan.

**Distribution in FV.** Endemic; foothills of Chatkal and Fergana ranges.

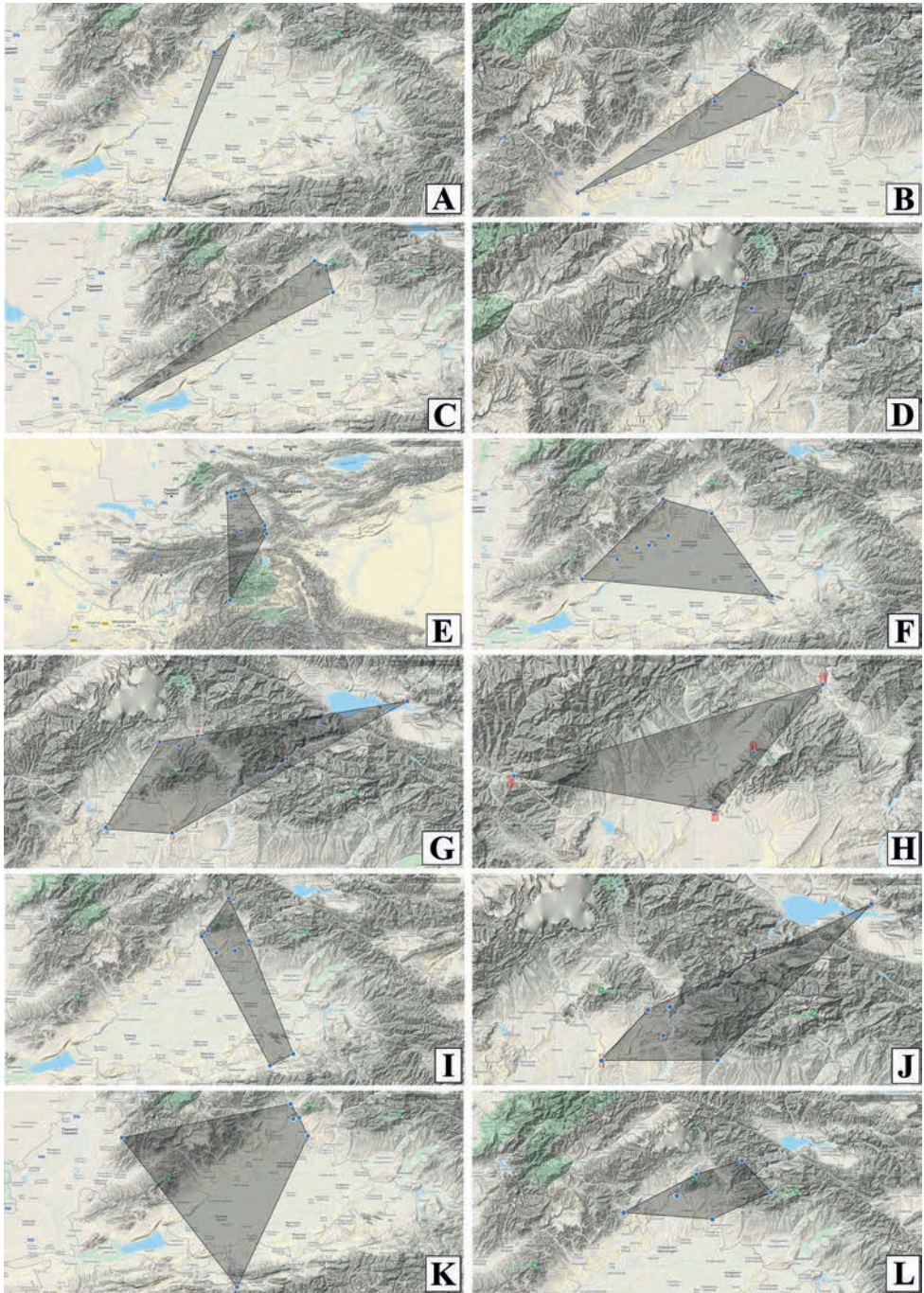


**Figure 7.** The wild habitat of some plants in FV **A** *Phlomoides adylovii* **B** *Phlomoides kirghisorum* **C** *Phlomoides urodonta* **D** *Seseli giganteum* **E** *Scutellaria xanthosiphon* **F** *Phlomoides alaica* **G** *Silene fetissoyii* **H** *Tanacetopsis ferganensis*.

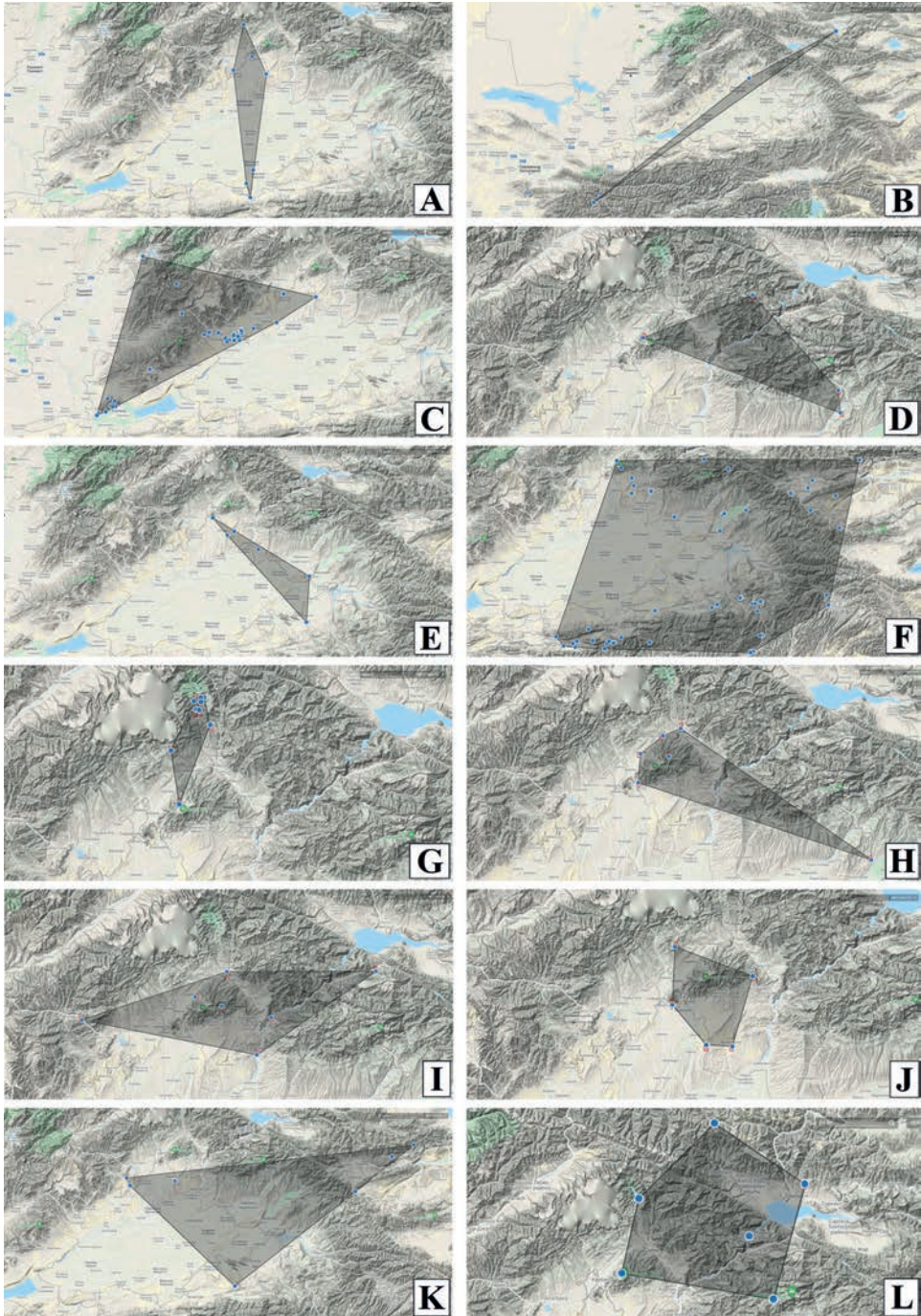




**Figure 8.** Distribution map of the species of sub-criterion Aiii, based on GeoCAT **A** *Allium tatyanae* **B** *Astragalus allotricholobus* **C** *Corydalis bosbutooënsis* **D** *Gagea spelaea* **E** *Iris austrotschatkalica* **F** *Acantholimon nabievii* **G** *Allium arkitense* **H** *Allium gracillimum* **I** *Allium haneltii* **J** *Allium oreoscordum* **K** *Allium pseudospkemense* **L** *Astragalus bosbutooënsis*.



**Figure 9.** Distribution map of the species of sub-criterion *Aiii*, based on GeoCAT **A** *Astragalus melanocomus* **B** *Astragalus pseudodianthus* **C** *Astragalus spryginii* **D** *Cousinia knorringiae* **E** *Cousinia krauseana* **F** *Echinops knorringianus* **G** *Eremurus czatkalicus* **H** *Ferula incisoserata* **I** *Fritillaria rugilosa* **J** *Hedysarum gypsaceum* **K** *Hedysarum turkestanicum* **L** *Hyalolaena intermedia*.



**Figure 10.** Distribution map of the species of sub-criterion *Aiii*, based on GeoCAT **A** *Iris narynensis* **B** *Limonium ferganense* **C** *Oxytropis gymnogyne* **D** *Phlomooides adylovii* **E** *Phlomooides kirghisorum* **F** *Phlomooides alaica* **G** *Phlomooides urodonta* **H** *Scutellaria xanthosiphon* **I** *Silene fetissovii* **J** *Seseli giganteum* **K** *Seseli unicaule* **L** *Tanacetopsis ferganensis*.

***Phlomoïdes kirghisorum* Adylov, Kamelin & Makhm. in Opređ. Rast. Sred. Azii 9: 99 (1987)**

Figs 7B, 10E

**Note.** Originally, the species was described as *Eremostachys ferganensis* Ubuk. based on specimens collected from the Bozbu-Too Mountains (Ubukeyeva 1960). Adylov and Makhmedov (1987) reported this species in Kyrgyzstan in the foothills and low mountains of Alay, Chatkal, and Fergana ranges. Current knowledge of the distribution area of this species shows that it is limited by FV (Lazkov and Sultanova 2014). Most of the population is located on the border between Kyrgyzstan and Uzbekistan. During field surveys in 2020–2021, several plants belonging to this species were collected in the Uzbekistan part of the IPA site (Arbagish and surrounds).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills of Chatkal Range.

***Phlomoïdes alaica* (Knorring) Adylov, Kamelin & Makhm. in Opređ. Rast. Sred. Azii 9: 107 (1987)**

Figs 7E, 10F

≡ *Phlomis alaica* Knorring in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 15: 338 (1953).

= *Phlomis knorringiana* Popov in V.L.Komarov, Fl. URSS 21: 648 (1954).

≡ *Phlomoïdes knorringiana* (Popov) Adylov, Kamelin & Makhm. in Opređ. Rast. Sred. Azii 9: 107 (1987).

**Note.** The type specimens described as *Phlomis knorringiana* Popov differ from *Phlomis alaica* Knorring (currently *Phlomoïdes alaica*) in having short stellate (not stellate with longer middle rays) hairs on the bracts and the calyx (Lazkov 2011). Because plants with similar morphological characteristics do not have separate geographical distribution areas and plants with intermediate forms were observed, Lazkov (2011, 2016) combined the two species while maintaining the priority of the epithet “*alaica*”.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills of Alay and Fergana ranges, Ak-Shyyrak, At-Oynok, Bozbu-Too, Chaar-Tash, and Moldo-Too Mts.

***Phlomoides urodonta* (Popov) Adylov, Kamelin & Makhm. in Opređ. Rast. Sred. Azii 9: 106 (1987)**

Figs 7C, 10G

**Note.** According to Lazkov, *P. urodonta* is the type species of the monotypic series *Urodontae* Lazkov, characterized by white or whitish corolla and narrowly triangular calyx teeth on the sides without denticles (Lazkov 2011). The conservation value of the species is increasing due to the small distribution area. The species is endemic to southern Chatkal in Kyrgyzstan. Previously, Lazkov (2011) reported four herbarium specimens (three of them were collected on the territory of the Sary-Chelek reserve). Later, another population was recorded by him in the study area.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Low mountains of Chatkal Range.

***Scutellaria xanthosiphon* Juz. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 14: 367 (1951)**

Figs 7E, 10H

**Note.** Described from the Kugart river basin in the Fergana range, Kyrgyzstan. Alay and Fergana ranges in Kyrgyzstan cover the current distribution area of this species (Abdul-laeva 1987). These ranges surround the FV from the northeast and south (south-east). Lazkov and Sultanova (2014) support these data and in the “Cadastre” for this species indicate near Fergana regions of Kyrgyzstan, which includes the southern slopes of the Chatkal and Fergana ranges and the northern slopes of the Alay and Turkestan ranges. Field studies in 2020–2021 showed the presence of populations of the species located in the areas between the Fergana and Alay ranges, which fall in the Bozbu-Too Mountains.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Middle mountain and subalpine belts of Chatkal, Fergana, and Alay ridges.

***Silene fetissovi* Lazkov in Novosti Sist. Vyssh. Rast. 29: 66 (1993)**

Figs 7G, 10I

**Note.** Thus far, the species is known from only a few localities in stony-rocky outcrops of the belt of forests and bushes of eastern Fergana. It was described by Lazkov (1993) in the territories adjacent to the IPA site (Chatkal Range, Padsha-Ata River Basin). Some paratype specimens were collected by Aydarova and Ubukeyev from Bozbu-Too

in 1977 (kept in FRU). Based on current literature data and field observations from 2010–2020, the species is endemic to the Chatkal and Fergana ranges within the FV.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Middle mountain belt of Chatkal and Fergana ranges.

The Flora of Kyrgyzstan is recognized as rich in species of the genus *Seseli* L. (Pimenov and Kljuykov 2002; Lazkov and Sultanova 2014). Out of 46 species known throughout Central Asia (Pimenov 1983b), 21 (Pimenov and Kljuykov 2002) or 23 (Lazkov and Sultanova 2014) species of the genus were recorded in the flora of Kyrgyzstan, and eight species are endemics (Pimenov and Kljuykov 2002). Most endemic *Seseli* species are distinguished by a small distribution area or are known from the type locality (*S. luteolum* Pimenov, *S. kashgaricum* Pimenov, Kljuykov). Some of the national endemics are distributed in eastern Fergana bordering Uzbekistan. Field surveys from 2010–2021 in Uzbekistan identified two *Seseli* species before being registered as national endemics of Kyrgyzstan (Lazkov and Umralina 2015).

***Seseli giganteum* Lipsky in Trudy Imp. S.-Peterburgsk. Bot. Sada 23: 140 (1904)**  
Figs 7D, 10J

**Note.** The species belongs to the bi-type sect. *Microseseli* Pimenov (Pimenov 1978). The second species is *S. turbinatum* Korovin, which differs in life form (polycarpic), morphology (root system, fruit, corolla color, and branching type), and geography (Pamir-Alay, Nurata).

*S. giganteum* is rare and endemic to the southern Chatkal. It was described from the valley of the Khoja-Ata river basin (Pimenov 1974). The species is known from a few localities outside the locus classicus, but none goes beyond the southern Chatkal (basins of the Padsha-Ata and Kasan-say rivers). According to all published data, the species is considered a strict endemic to Kyrgyzstan (Pimenov 1974, 1978; Lazkov and Sultanova 2014; Lazkov and Umralina 2015).

The species was recorded near the vicinity of Nanay village in the Uzbekistan part of FV. This is close to the Ungortepa massive of the IPA site (by Tojibaev K.Sh., Turginov O.T.). The species grows on the loessal slopes of open shrublands.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Middle mountain belt of Chatkal Range.

***Seseli unicaule* (Korovin) Pimenov in Novosti Sist. Vyssh. Rast. 11: 245 (1975)**  
Figs 6S, 10K

**Note.** In contrast to the previous species, *S. unicaule* (sect. *Scleorrhiza* Popov & Sdobnina, subsect. *Lehmanniana* Pimenov) has a wider distribution area and, accordingly, is represented by a large number of herbarium specimens kept at TASH, LE, FRU, WILR, and MW. The geography of the species was revised in detail by M.G. Pimenov

(Pimenov 1974, 1978, 1983b). The distribution area is limited to the drier foothills of eastern Fergana. The main habitats are in the Tian-Shan part of the valley, and a small disjunction is located in the eastern part of the Alay range (Pimenov 1983b).

During the recent field investigation of plant diversity in the Uzbekistan part of the IPA site specimens of *S. unicaule* were collected (<https://www.plantarium.ru>) from the neighborhood of Airbagsh village. Accurate investigations of all the surrounding areas did not give positive results. Based on field studies in 2019–2021, it can be concluded that the Uzbekistan populations are represented only in the foothills of Arbagish.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Middle mountain belt of Chatkal Range.

*Tanacetopsis ferganensis* (Kovalevsk.) Kovalevsk. in *Novosti Sist. Vyssh. Rast.* **9: 270 (1972)**

Figs 7H, 10L

**Note.** This species is endemic to eastern Fergana and is known from several localities in the eastern part of the Chatkal, Atoynak, and Fergana ranges (Kamelin and Kovalevskaya 1993). It grows between rocks on the stony slopes of the middle and upper mountains. Only one locality is known in the study area; the gorge of the Archaly-Sai river, which is part of the Bozbu-Too.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Middle and high mountain belts of Chatkal and Fergana ranges.

### Category *Aiv*

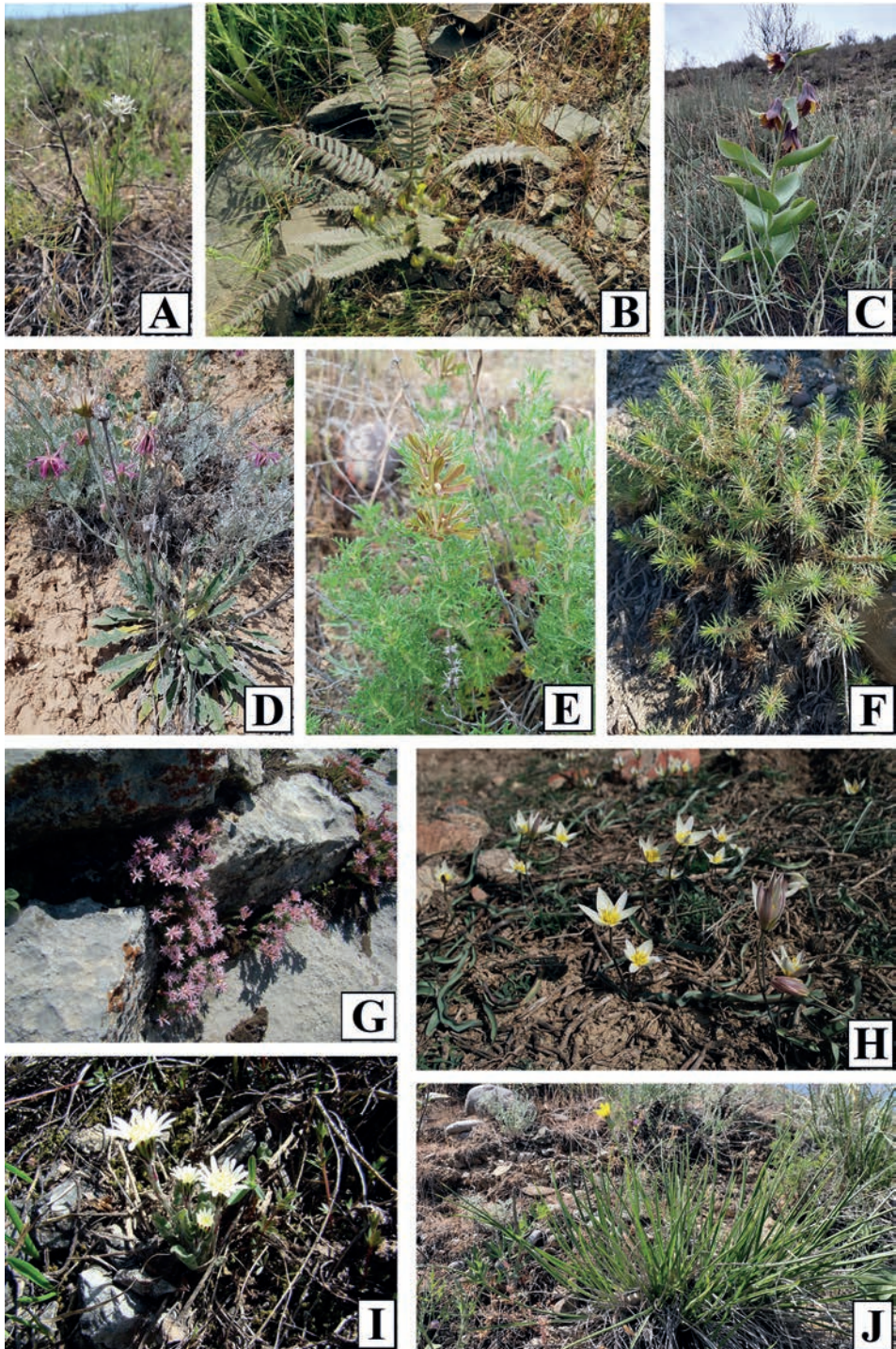
Ten species were included in category *Aiv*.

As noted by Darbyshire et al. (2017) for the large majority of plant species belonging to IPA sub-criteria *Aiv* there are no formal global conservation status assessments in Central Asia. This is also an actuality because many cases focus on country-level distributions. Poor representation is a common problem for Central Asian species (Wilson et al. 2021), and international evaluation is rare due to the lack of close cooperation between neighboring countries.

*Allium minutum* Vved. in *Byull. Sredne-Aziatsk. Gosud. Univ.* **19: 124 (1934)**

Figs 11A, 12A

**Note.** During field observations in the vicinity of the Arbagish village in 2014 and later in 2021, a white-flowered *Allium* species was collected for the first time from the foothills of the Chatkal range in Uzbekistan. The species grew on the Artemisia steppe between 1100 and 1200 m. Detailed studies revealed that they did not match any *Allium*



**Figure 11.** The wild habitat of some plants in FV **A** *Allium minutum* **B** *Astragalus syreitschikovii* **C** *Fritillaria sewerzowii* **D** *Jurinea winkleri* **E** *Lagochilus knorringianus* var. *drobovii* **F** *Polycnemum perenne* **G** *Pseudosedum ferganense* **H** *Tulipa bifloriformis* **I** *Leibnitzia knorringiana* **J** *Takhtajiantha tau-saghyz*.



species reported from the foothills or low mountain belt of the Chatkal range. After examining all *Allium* species from FV, the morphological characters of these specimens were identical to those of *Allium minutum* Vved., which was previously recorded only in the Alay and Trans-Alay ranges, and in Kyrgyzstan and Tajikistan (Vvedenskiy 1971; Lazkov and Sultanova 2014). Therefore, *A. minutum* is here reported as a new record for the flora of Uzbekistan and the Chatkal range in particular.

According to Vvedenskiy (1971) and Khassanov and Esankulov (2015), *A. minutum* is growing on gravelly and variegated outcrops of the upper belt of mountains. Examination of all published data (Vvedenskiy 1971; Khassanov 2000; Khassanov and Esankulov 2015) and herbarium specimens kept in Tashkent (TASH) showed the absence of data outside the Alay and Trans-Alay ranges. There is a high probability that the plants from southern Chatkal belong to a new species of the *Allium* genus. However, the plants from the highlands of the Alay Range and the low mountains of Chatkal do not differ morphologically.

Therefore, the lack of data, especially regarding the distribution in the intermediate regions between Chatkal and Alay ranges, necessitated us to accept southern Chatkal plants as *A. minutum*.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Tajikistan, Uzbekistan.

**Distribution in FV.** Middle and high mountain belts of Chatkal and Fergana ridges.

***Astragalus syreitschikovii* Pavlov in Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol., n.s., 44: 34 (1935)**

Figs 11B, 12B

**Note.** The species belong to sect. *Myobroma* (Stev.) Bunge in sensu Kovalevskaya (1981) or sect. *Caprini* in sensu Podlech and Zarre (2013: 702). Initially, the species was described by N. Pavlov as endemic to the Syr Darya Karatau, Kazakhstan (Pavlov 1935). The author classified the species as an autochthonous Turanian element and assumed they would hardly be found in other regions of Central Asia. According to current data, *A. syreitschikovii* is endemic to limestone in the foothills and low mountains of western Tian-Shan (Kovalevskaya 1981) and is distributed to the north of the Chullu mountains, Syr Darya Karatau, Santalash, and Chatkal range. The southern border of the species distribution falls to the northern side of the Akhangaran river basin.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kazakhstan, Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low mountains of Chatkal Range.

***Fritillaria sewerzowii* Regel in Bull. Soc. Imp. Naturalistes Moscou 41(I): 443 (1868)**

Figs 11C, 12C

≡ *Korolkowia sewerzowii* (Regel) Regel, Gartenflora 22: 163 (1873).

= *Fritillaria discolor* Mottet, Dict. Prat. Hort. 2: 431 (1893–1894).

= *Korolkowia discolor* Regel, Gartenflora 35: 349 (1886).

**Note.** Endemic to western Tian-Shan and one of the most ornamental species in the flora of Central Asia. Widespread in almost all mountain ranges of western Tian-Shan.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kazakhstan, Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low mountains of Alay, Chatkal, and Kurama ranges.

***Jurinea winkleri* Iljin in V.L. Komarov (ed.), Fl. URSS, 27: 722, 616 (1962)**

Figs 11D, 12D

**Note.** The species are mostly distributed in FV. A disjunction is located in the Zirabulak low mountains (western Pamir-Alay). Current field surveys show that populations of the species survived only in the foothill zone. In the northern part of the valley, several isolated and fragmented populations are found in the Chust-Pap foothills (Tojibaev et al. 2022). This population stretches in fragments in a northeastern direction via the north of Namangan city, and relatively good micro populations are recorded in the variegated slopes of the vicinity of Arbagish and adjacent territories of Kyrgyzstan.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills of FV.

***Leibnitzia knorringiana* (B.Fedtsch.) Pobed. in Fl. URSS 28: 594 (1963)**

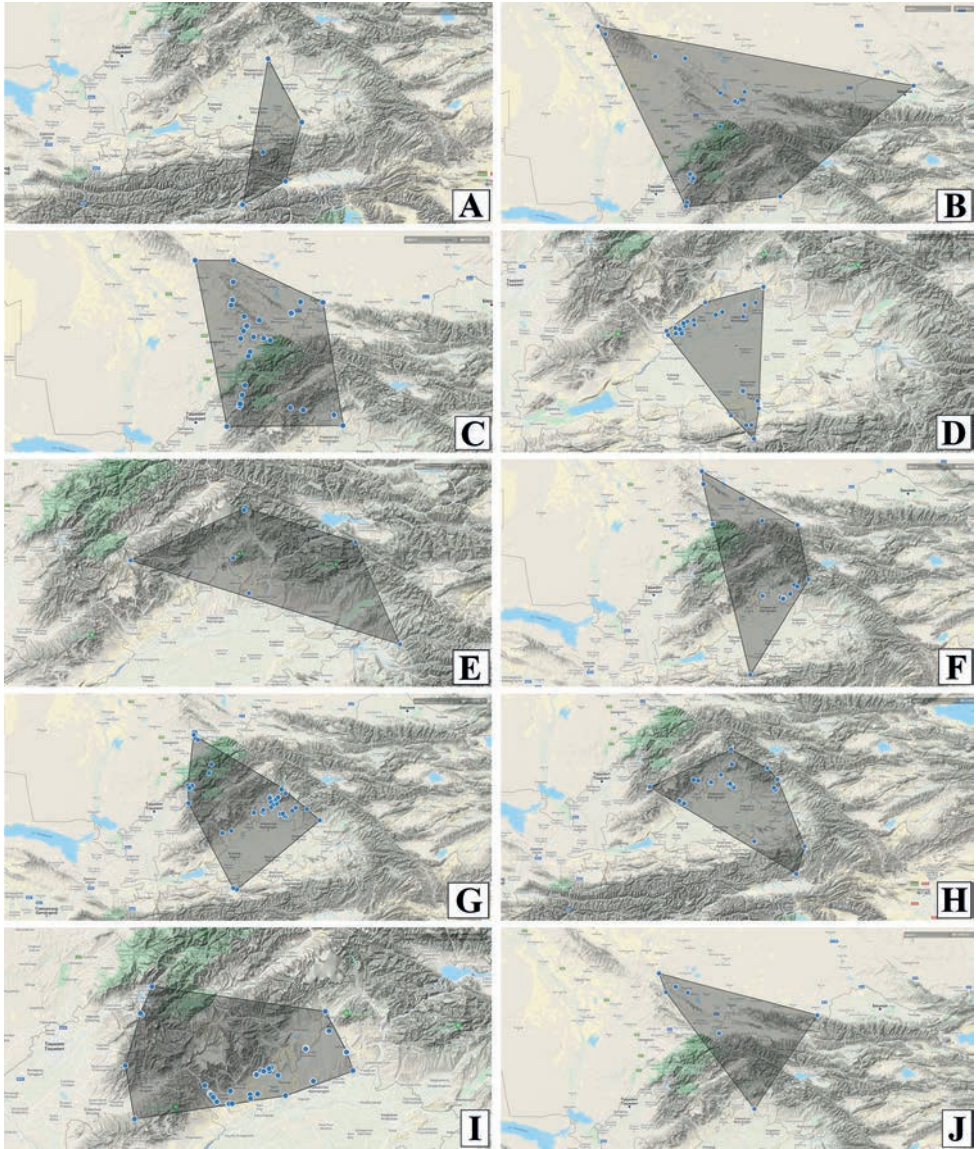
Figs 11I, 12E

**Note.** The genus *Leibnitzia* Cass. are a unique example of the Asian–North American biogeographic disjunction pattern (Hansen 1988; Baird 2009). Two species of the genus, i.e., *L. lyrata* (Sch.Bip.) G.L.Nesom and *L. occimadrensis* G.L.Nesom, are of biogeographic interest because they are two American members of a predominately Asian genus (Nesom 1983). The other four Asian members of *Leibnitzia* occupy mostly high-altitude (upper limits of 3100–5000 m above sea level vary by species), semi-arid habitats in the Himalayan region, China, Japan, Korea, Bhutan, Mongolia, Siberia (Hansen 1988), and Kyrgyzstan (Nesom 1983; Hansen 1988; Lazkov and Sultanova 2014). Among them, *L. knorringiana* is distinguished by the smallest distribution area, limited to the Naryn river valley, Talas, and the Chatkal and Fergana Ranges within Kyrgyzstan (Tulaganova 1993b). Only one population was found at the Bozbu-Too-Ungortepa IPA site, growing in the tract of Taldi-Bulak (Mountain Bosbu-Too).

**Existing Conservation Threats.** Farmlands, overgrazing.

**General distribution.** Kyrgyzstan.

**Distribution in FV.** Middle mountain belt and highlands of Naryn River Valley, Talas, Chatkal, and Fergana ranges.



**Figure 12.** Distribution map of the species of sub-criterion *Aiv* based on GeoCAT. **A** *Allium minutum* **B** *Astragalus syreitschikovii* **C** *Fritillaria sewerzowii* **D** *Jurinea winkleri* **E** *Leibnitzia knorringiana* **F** *Lagochilus knorringianus* var. *drobovii* **G** *Polycnemon perenne* **H** *Pseudosedum ferganense* **I** *Tulipa bifloriformis* **J** *Takhtajiantha tau-saghyz*.

*Lagochilus knorringianus* var. *drobovii* (Kamelin & Tzukerv.) Lazkov, KH Bot. Monogr. Rev. Ser. 1: 230 (2016)

Figs 11E, 12F

≡ *Lagochilus drobovii* Kamelin & Tzukerv. in Novosti Sist. Vyssh. Rast. 20: 166 (1983).

**Note.** Originally, the species was described as *Lagochilus drobovii* Kamelin & Tzukerv. and was limited to a narrow range in the villages of Shakaftar and Sumsar in southern Chatkal, Kyrgyzstan (Kamelin and Tschukervanik 1983; Tschukervanik 1987). Later, Lazkov (2016: 230) considered these plants as a variety of *Lagochilus knorringianus*, because the type specimen of *L. knorringianus* and the type specimen of *L. drobovii* were collected together. According to Lazkov (2016) *L. knorringianus* var. *drobovii* differs from *L. knorringianus* var. *knorringianus* by calyx, and sometimes the entire plant is more or less pubescent with short and long multicellular setaceous hairs. Here we report *L. knorringianus* var. *drobovii* as a new record for the Flora of Uzbekistan based on specimens collected in Arbagish village, Uzbekistan.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Low mountains of Chatkal Range.

***Polycnemum perenne* Litv. in Trudy Bot. Muz. Imp. Akad. Nauk 7: 81 (1910)**

Figs 11F, 12G

**Note.** The genus *Polycnemum* L. is represented by 7–8 species distributed in North Africa, the Mediterranean, Europe, Asia Minor, Siberia, and Central Asia (Sidorenko 1968; corrected by POWO 2022). Three species grow in Central Asia (Pratov 1972c). Among them, *P. perenne* is distinguished by a life form (semi-shrub, the other two are annuals) and narrow distribution (endemic to western Tian-Shan and Alay). The main part of the range is located in the western Tian-Shan (from the Syr Darya Karatau in the north to the Kurama Range in the south), where it is confined to rocks, stony and gravelly slopes of foothills, and a low mountain belt (800–1600 m). The species is widespread in the study area.

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan.

**Distribution in FV.** Foothills and low mountains of Alay, Chatkal, and Kurama ridges.

***Pseudosedum ferganense* Boriss. in Trudy Bot. Inst. Akad. Nauk S.S.S.R., Ser. 1, Fl. Sist. Vyssh. Rast. 1: 112 (1933)**

Figs 11G, 12H

**Note.** The genus *Pseudosedum* (Boiss.) A. Berger falls into the category of medium size genus within Crassulaceae DC. and comprises about 14 registered taxa (Tojibaev et al. 2018b). Ten species grow in Central Asia (Pratov 1974), two species are noted for northern China (Kanjun 2001), and three isolated species belong to the “Flora Iranica” area (Jansson and Rechinger 1970).

Previously, *P. ferganense* was recorded as a new species for the flora of Uzbekistan (Tojibaev et al. 2018b). It occupies an isolated position within the genus and belongs to the monotype sect. *Tuberaria* Boriss. (Borissova 1939), with the roots forming tu-

bers. In the Uzbekistan part of the FV, the species grows in cracks in the rocks in the northern foothills and low mountains, and populations extend from the Chap tract to the Ungortepa massif and lower reaches of the Mailisay river basin (Arbagish).

**Existing Conservation Threats.** Habitat fragmentation, farmlands, overgrazing.

**General distribution.** Kyrgyzstan, Uzbekistan.

**Distribution in FV.** Foothills and low mountains of Alay, Chatkal, and Kurama ranges.

***Tulipa bifloriformis* Vved. in Opred. Rast. Sred. Azii 2: 320 (1971)**

Figs 11H, 12I

**Note.** The species is one of the most widespread tulip species, endemic to western Tian-Shan (Tojibaev et al. 2020; Dekhkonov et al. 2022). However, no threat of risk of reduction or extinction of the species has been identified in the study area and adjacent territories of western Tian-Shan. Moreover, this species showed increased seed germination and can easily colonize disturbed habitats (Tojibaev and Kadirov 2010). Nonetheless, climate modeling for Central Asian tulips suggests that climate change will have a significantly negative impact on the range size of all species, including those currently widespread like *T. bifloriformis* (Wilson et al. 2021).

**General distribution.** Western Tian-Shan.

**Distribution in FV.** Northern foothills and low mountains of FV.

***Takhtajianantha tau-saghyz* (Lipsch. & G.G.Bosse) Zaika, Sukhor. & N.Kilian in PhytoKeys 137: 72 (2020)**

Figs 11J, 12J

≡ *Scorzonera uzbekistanica* Czevr. & Bondarenko in Fl. Uzbekistan. 6: 436, 516 (1962).

≡ *Scorzonera tau-saghyz* subsp. *uzbekistanica*, in Bot. Zhurn. (Moscow & Leningrad) 71: 1672 (1986).

**Note.** This species belongs to, perhaps, the most famous and interesting group of plants studied from an economic point of view. The discovery of a new rubber plant species (*Scorzonera uzbekistanica* Czevr. & Bondarenko) back in 1949 in eastern Fergana led to the explorations of this interesting territory. According to the authors of the new species, the discovered plants belonged to *Scorzonera* L. genus and differed from the already known *S. tau-saghyz* Lipsch. & Bosse (endemic to the Karatau mountains, western Tian-Shan, Kazakhstan) in a number of morphological features, first of all by “yellow latex, bare and on the edge of the jagged outer leaves of the wrapper and achenes, pubescent only along hardly noticeable veins”. These distinctive features made it possible to recognize the Maylisay plants as new (Chevrenidi and Bondarenko 1950). However, the protologue was given diagnostic signs only in Russian. A valid description was given in the 6<sup>th</sup> volume of the Flora of Uzbekistan (Kovalevskaya 1962)..

Later, Kamelin and Tagaev (1986), *S. uzbekistanica* identified it as a subspecies of *S. tau-saghyz* (*Scorzonera tau-saghyz* subsp. *uzbekistanica* (Czevr. & Bondarenko) Tagaev. Nevertheless, subsequent research on the genus *Scorzonera* did not properly investigate the eastern Fergana plants. Even in the *Conspectus Florae Asiae Media* (Tagaev 1993), this species is referred to as a synonym of *S. tau-saghyz*. Currently, all available modern sources, including Zaika et al. (2020), POWO (2022), accept *S. uzbekistanica* as a synonym of *Takhtajaniantha tau-saghyz*.

**Existing Conservation Threats.** Habitat fragmentation, farmlands.

**General distribution.** Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

**Distribution in FV.** Foothills of southern Chatkal.

## Socio-economic issues

The FV is one of the most densely populated regions of Central Asia and one of the major areas of concern regarding the conservation of natural landscapes. For centuries, the valley ecosystems have been under the pressure of anthropogenic impacts (Tojibaev et al 2018a). Since the mid-1970s, habitats of many endemic and rare plant species of FV have been impacted by humans. However, populations of some species were not found during field surveys in the 1970s (Vernik and Rakhimova 1982).

Human impacts on the environment by uncontrolled development and climatic changes have exacerbated the threatened status of numerous plant species and habitats in FV (Tojibaev et al. 2022). In densely populated regions with limited natural ecosystems, like FV, effective conservation actions need to consider the social, cultural, and economic interests of local humans. This postulate applies to IPA programs as well (Blasi et al. 2011). Since IPAs inevitably fit into a wider context and are not designed to exist in isolation, they should be considered when designing ecological networks (Blasi et al. 2011; Jongman and Pungetti 2004) and ecological corridors, planning the zonation of existing protected areas and defining key biodiversity areas (Eken et al. 2004). In the Uzbekistan part of the FV, such programs are still relevant despite the inability to create new protected areas.

## Discussion

### IPA Assessment

Within the FV Bozbu-Too-Ungortepa, the IPA site is important for wild plant conservation. Using the IPA criteria for the FV (Tojibaev et al. 2022), Bozbu-Too-Ungortepa massif qualifies as an IPA under criteria A.

### Endemism and a new record for the national floras

Due to research within the framework of the Bozbu-Too-Ungortepa IPA, the massif has become one of the most studied areas of the FV, where many endemic and threat-

ened species of local flora are concentrated. Our research has shown that at least five species (*Allium tatyanae*, *Astragalus bosbutooënsis*, *Corydalis bosbutooënsis*, *Hedysarum turkestanicum*, and *Iris austrotschatkalica*) are endemic to this relatively small area, which is one of the highest rates in mountainous Central Asia. Of these, four species have been found and described by some of this paper's authors (G.A. Lazkov, K.Sh. Tojibaev, and F.A. Karimov). It is also noteworthy that *Iris austrotschatkalica* was described as the result of the identification of the IPA site (Tojibaev et al. 2014a).

Our inventory of the flora within the study area has significantly enriched the known flora of Uzbekistan with species previously noted only in countries adjacent to Uzbekistan. Some of these new records have been published prior to this work, including those on *Astragalus spryginii* Popov, and *Pseudosedum ferganense* Boriss. (Tojibaev et al. 2018b). Here we report the presence of more species newly discovered among the flora of Uzbekistan, including *Hyalolaena intermedia* Pimenov and Kljuykov (Lyskov et al. 2019), *Allium arkitense*, *A. minutum*, *Phlomoïdes alaïca*, *Lagochilus knorringianus* var. *drobovii*, and *Corydalis bosbutooënsis*. Additionally, modern research within the framework of the IPA has found some species here that were previously considered extinct in this area, including *Lamyropappus schakaptaricus*, and *Hedysarum gypsaceum* (Tojibaev et al. 2019).

## Contribution of the present research

The second IPA site in FV occupies a transboundary position between Uzbekistan and Kyrgyzstan. The site was selected based on species endemism at national (Uzbekistan and Kyrgyzstan), regional (FV) and botanical province (Afghan-Turkestan province) levels. The research results of the current stage of IPA identification in the FV was completed in line with the core aims of the IPAs Programme (Anderson 2002; Darbyshire et al. 2017, 2019). The best available data in Central Asia was used to highlight key sites with high concentrations of endemic and threatened plant species, growing outside of protected areas. We also considered the criteria proposed by Shaltout and Eid (2016), which allow for species vulnerability, irreplaceability, and richness of vascular plant species in the IPA site.

The first studies on the identification of IPA sites were characterized by determining IPAs within different countries, and compiling lists of rare and threatened species (Al-Abbasi et al. 2010; Hall et al. 2011; Llewellyn et al. 2011; Artemov 2012; Olonova et al. 2013; Dimeyeva and Vesselova 2015; and etc.). Data conversion into maps was associated with a number of works (Blasi et al. 2009, 2011), methodical improvement of IPA criteria for a global approach to plant conservation (Darbyshire et al. 2017), and just a few were devoted to the transboundary IPAs (Shuka and Malo 2010; Shuka et al. 2014). The IPA research remains relevant due to the global loss of biodiversity and critical habitats around the world. Such critical habitats include the following regions: the tropics, with its high species diversity (<https://www.kew.org/science/our-science/projects/tropical-important-plant-areas>; see also Darbyshire et al. 2019; Dani Sanchez et al. 2021; andect.); Europe, with its high level of floristic data (Sparrius et al. 2019); and Central Asia (Tojibaev et al. 2022), botanically poorly-known part of Asia. Due

to this, the IPA study carried out in the FV has some advantages. In particular, among the wide range of IPA studies, ours is one of the few that applied geospatial analysis of rare and threatened species for Red List assessment (Bachman et al. 2011). In addition, we provide detailed information on the botanical geography and taxonomy of species. Together, the information provided will contribute to the rapid dissemination of recent, easily accessible, data concerning understudied species and habitats, as well as the definition of practical boundaries (Blasi et al. 2011) in botanically poorly studied areas.

### Further research

Although the current data on the plant diversity of Bozbu-Too-Ungortepa IPA is satisfactory, the next stage requires extensive botanical research in the following areas: (1) comprehensive surveys to build up a basic inventory of the plants in the area based on grid mapping; (2) vegetation studies to determine and map the major vegetation types; and (3) targeted monitoring programs taking into account threats to rare habitats and species in the future.

Lastly, any serious conservation planning within the Bozbu-Too and surrounding transboundary area should implement proper socio-economic research programs to examine ways to engage local stakeholders (Margules and Pressey 2000).

### Conclusion

The second phase of IPA research in the FV shows the effectiveness of the basic principles of IPA in the conditions of mountainous Central Asia. In contrast to the previous stage, here we explored a transboundary territory by combining the efforts of scientists in two neighboring countries (Uzbekistan and Kyrgyzstan). This is an important step in the creation of a regional database of rare and endangered species, as well as in that of a regional Red list, which can serve to focus conservation action at the transboundary level. Continuing studies, such as these in transboundary areas, contribute to increasing the level of floristic knowledge in poorly studied areas. Furthermore, the studies would attract the attention of government environmental organizations as well as international organizations at the global scale, to the conservation of threatened species and critical habitats. Capacity building requires the standardization of approaches, extensive field research on both potentially threatened species and critical habitats, as well as new research into the causes of plant habitat degradation.

### Acknowledgements

This work was supported by research grants from the Korea National Arboretum (project no. KNA1-1-26, 20-1) and in the framework of scientific programs of the National Herbarium of Uzbekistan (TASH). It is also a part of the scientific program,



Grid mapping of the flora of mountainous regions of southern Uzbekistan, funded by the government of the Republic of Uzbekistan. The authors are grateful to the TASH, FRU, MW, and LE herbarium curators. The authors would also like to thank anonymous reviewers for their insights that helped improve the manuscript.

## References

- Abdullaeva MH (1987) *Scutellaria* L. Conspectus Florae Asiae Mediae, vol. 9. Tashkent, 13–37. [In Russian]
- Abdusalamova LN (1978) *Oxytropis* DC. Flora of Tajikistan, 5. Leningrad, 426–496. [In Russian]
- Adylov TA, Makhmedov AM (1987) *Phlomooides* Moench. Conspectus Florae Asiae Mediae, vol. 9. Fan Publishers, Tashkent, 82–107. [In Russian]
- Akhani H, Khoshravesh R, Malekmohammadi M (2016) Taxonomic novelties from Irano-Turanian region and NE Iran: *Oreosalsola*, a new segregate from *Salsola* S.L., Two new species in *Anabasis* and *Salvia*, and two new combinations in *Caroxylon* and *Seseli*. *Phytotaxa* 249(1): 159–180. <https://doi.org/10.11646/phytotaxa.249.1.7>
- Al-Abbasi TM, Al-Farhan A, Al-Khulaidi AW, Hall M, Llewellyn OA, Miller AG, Patzelt A (2010) Important plant areas in the Arabian Peninsula. *Edinburgh Journal of Botany* 67(1): 25–35. <https://doi.org/10.1017/S0960428609990217>
- Anderson S (2002) Identifying Important Plant Areas: A Site Selection Manual for Europe, and a basis for developing guidelines for other regions of the world. Plantlife International, London, 52 pp. <https://www.plantlife.org.uk/uk/our-work/publications/identifying-important-plant-areas-site-selection-manual-europe>
- Artemov IA (2012) Important plant areas in the Tuva Republic. *Scientific journal, Flora of Asian Russia* 1(9): 60–71. <https://docplayer.com/27925300-Klyuchevye-botanicheskieterritorii-v-respublike-tyva-i-a-artemov-important-plant-areas-in-the-tuva-republic-i-a-artemov.html>
- Bachman S, Moat J, Hill AW, De La Torre J, Scott B (2011) Supporting Red List threat assessments with GeoCAT: Geospatial conservation assessment tool. *ZooKeys* 150: 117–126. <https://doi.org/10.3897/zookeys.150.2109>
- Baird K (2009) The phylogenetics and biogeography of *Leibnitzia* (Asteraceae: Mutiseae): American species in an Asian genus. George Mason University Fairfax, VA, 48 pp. <https://doi.org/10.1111/j.1759-6831.2010.00077.x>
- Blasi C, Marignani M, Copiz R, Fipaldini M (2009) Mapping the Important Plant Areas in Italy. Palombi & Partner srl, Roma.
- Blasi C, Marignani M, Copiz R, Bonacquisti S, Rosati L, Fipaldini M (2011) Important Plant Areas in Italy: From data to mapping. *Biological Conservation* 144(1): 220–226. <https://doi.org/10.1016/j.biocon.2010.08.019>
- Bondarenko ON (1972) *Acanthophyllum* C.A. Mey. Conspectus Florae Asiae Mediae, vol. 2. Tashkent, 294–300. [In Russian]
- Borissova AG (1939) *Pseudosedum* (Boiss.) A.Berger. Flora of the USSR. Vol. 9. Acad. Sci. Press, 99–108. [In Russian]

- CEPF (2017) Critical Ecosystem Partnership Fund. Ecosystem Profile. Mountains of Central Asia Biodiversity Hotspot. Draft for Submission to the CEPF Donor Council. Arlington, VA, 184 pp.
- Chevrenidi SKh, Bondarenko ON (1950) Tau-Sagyz in Uzbekistan. Scientific reports of the Academy of Sciences of Uzbekistan 3: 37–38.
- Dahlgren RMT, Clifford HT, Yeo PF (1985) The Families of the Monocotyledons: Structure, Evolution, and Taxonomy. Springer Science & Business Media, 520 pp. <https://doi.org/10.1007/978-3-642-61663-1>
- Dani Sanchez M, Clubbe C, Woodfield-Pascoe N, Bárrios S, Smith Abbott J, Heller T, Harrigan N, Grant K, Titley-O’Neal C, Hamilton MA (2021) Tropical Important Plant Areas, plant species richness and conservation in the British Virgin Islands. Nature Conservation 45: 11–39. <https://doi.org/10.3897/natureconservation.45.73544>
- Darbyshire I, Anderson S, Asatryan A, Byfield A, Cheek M, Clubbe C, Ghrabi Z, Harris T, Heatubun ChD, Kalema J, Magassouba S, McCarthy B, Milliken W, Montmollin B, Lughadha EN, Onana JM, Sai`dou D, Sarbu A, Shrestha K, Radford EA (2017) Important Plant Areas: Revised selection criteria for a global approach to plant conservation. Biodiversity and Conservation 26(8): 1767–1800. <https://doi.org/10.1007/s10531-017-1336-6>
- Darbyshire I, Timberlake J, Osborne J, Rokni S, Matimele H, Langa C, Datizua C, de Sousa C, Alves T, Massingue A, Hadj-Hammou J, Dhanda S, Shah T, Wursten B (2019) The endemic plants of Mozambique: Diversity and conservation status. PhytoKeys 136: 45–96. <https://doi.org/10.3897/phytokeys.136.39020>
- Davletkeldiev AA (2006) Red Data Book of the Kyrgyz Republic. 2<sup>nd</sup> edn., Bishkek, 544 pp.
- Dekhkonoov D, Tojibaev ShK, Makhmudjanov D, Na N, Baasanmunkh S, Yusupov Z, Choi HJ, Jang C-G (2021) Mapping and analyzing the distribution of the species in the genus *Tulipa* (Liliaceae) in the Fergana valley of Central Asia. Korean Journal of Plant Taxonomy 51(3): 181–191. <https://doi.org/10.11110/kjpt.2021.51.3.181>
- Dekhkonoov DB, Tojibaev KS, Yusupov ZO, Makhmudjanov DI, Asatulloev TI (2022) Morphology of tulips (*Tulipa*, Liliaceae) in its primary centre of diversity. Plant Diversity of Central Asia 1: 52–70. [https://doi.org/10.54981/PCDA/vol1\\_iss1/a1](https://doi.org/10.54981/PCDA/vol1_iss1/a1)
- Dimeyeva L, Vesselova P (2015) Identification of Important Plant Areas in Kazakhstan. In: Andrianos LA, Sneepe JW, Zorbas K (Eds) Plants for people, people for plants. 7<sup>th</sup> Planta Europa conference. Conference proceedings. Horizon Research Publishing, 52–57.
- Eastwood A, Lazkov G, Newton A (2009) The Red List of Trees of Central Asia. Published by Fauna & Flora International, Cambridge, UK.
- Eken G, Bennun L, Brooks TM, Darwall W, Fishpool LDC, Foster MD, Knox D, Langhammer P, Matiku P, Radford E, Salaman P, Sechrest W, Smith ML, Spector S, Tordoff A (2004) Key biodiversity areas as site conservation targets. Bioscience 54(12): 1110–1118. [https://doi.org/10.1641/0006-3568\(2004\)054\[1110:KBAASC\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2004)054[1110:KBAASC]2.0.CO;2)
- Fedtschenko O, Fedtschenko B (1912) Conspectus Florae Turkestanica. St.-Petersburg, 287 pp. [In Russian]
- Filimonova ZN (1983) *Oxytropis* DC. Conspectus Florae Asiae Mediae, vol. 7. Tashkent, 323–368. [In Russian]
- Fritsch RM (2016) A Preliminary Review of Allium subg. Melanocrommyum in Central Asia. IPK Gatersleben. <http://www.ipk-gatersleben.de/>

- Fritsch RM, Khassanov FO (2008) New taxa of *Allium* L. subg. *Allium* (Alliaceae) from Tajikistan and Uzbekistan. Feddes Repertorium 119(7–8): 625–633. <https://doi.org/10.1002/fedr.200811185>
- Fritsch RM, Khassanov FO, Friesen NW (1998) New taxa, new combinations, and taxonomic remarks on *Allium* L. from Fergan depression, Middle Asia. Stapfia 30(1): 281–292.
- Fritsch RM, Khassanov FO, Matin F (2002) New *Allium* taxa from Middle Asia and Iran. Stapfia 80: 381–393.
- Fritsch RM, Blattner FR, Gurushidze M (2010) New classification of *Allium* L. subg. *Melanocrommyum* (Webb & Berthel.) Rouy (Alliaceae) based on molecular and morphological characters. Phytion (Horn, Austria) 49(2): 145–220.
- Fu Q, Huang X, Li L, Jin Y, Qian H, Kuai X, Ye Y, Wang H, Deng T, Sun H (2022) Linking evolutionary dynamics to species extinction for flowering plants in global biodiversity hotspots. Diversity and Distributions 28: 2871–2885. <https://doi.org/10.1111/ddi.13603>
- Govaerts R, Dransfield J, Zona S, Hodel DR, Henderson A (2021) World Checklist of *Phlomoides*. Facilitated by the Royal Botanic Gardens, Kew. <http://wcsp.science.kew.org/>
- Gross BL, Henk AD, Forsline PL, Richards ChM, Gayle VM (2012) Identification of interspecific hybrids among domesticated apple and its wild relatives. Tree Genetics & Genomes 8(6): 1223–1235. <https://doi.org/10.1007/s11295-012-0509-4>
- Gulomov R (2021) Fluorosentotypes of *Phlomoides* Moench Species Distributed in the Fergana Valley: Central Asia. International Journal of Life Sciences & Earth Sciences 5(1): 1–9. <https://doi.org/10.21744/ijle.v5n1.1816>
- Hall M, Miller AG, Llewellyn OA, Al-Abbasi TM, Al-Harbi RJ, Al-Shammari KF (2011) Important plants areas in the Arabian Peninsula: 3. ‘Uruq Bani Ma’arid. Edinburgh Journal of Botany 68(2): 183–197. <https://doi.org/10.1017/S0960428611000047>
- Hansen HV (1988) A taxonomic revision of the genera *Gerbera* sect. *Isanthus*, *Leibnitzia* (in Asia), and *Uechtrizia* (Compositae, Mutisieae). Nordic Journal of Botany- Section of tropical taxonomy 8: 61–76. <https://doi.org/10.1111/j.1756-1051.1988.tb01707.x>
- Ikinci N, Hall T, Lledo MD, Clarkson JJ, Tillie N, Seisums A, Saito T, Harley M, Chase MW (2011) Molecular phylogenetics of the juno irises, *Iris* subgenus *Scorpiris* (Iridaceae), based on six plastid markers. Botanical Journal of the Linnean Society 167(3): 281–300. <https://doi.org/10.1111/j.1095-8339.2011.01176.x>
- IPNI (2022) International Plant Name Index. <https://ipni.org> [Accessed 25.07.2022]
- IUCN (2021) Green Status of Species: A global standard for measuring species recovery and assessing conservation impact. Version 2.0. IUCN, Gland. <https://www.iucnredlist.org/resources/green-status-assessment-materials>
- Jansson CA, Rechinger KH (1970) Crassulaceae. In: Rechinger KH (Ed.) Flora Iranica. Vol. 72. Graz.
- Jongman RH, Pungetti G (2004) Ecological Networks and Greenways: Concept, Design, Implementation. Cambridge University Press. <https://doi.org/10.1017/CBO9780511606762>
- Kamelin RV (1973) Florogenetic analysis of the native flora of the Mountain Middle Asia. Nauka press, Leningrad, 176 pp. [In Russian]
- Kamelin RV (1981) *Astragalus* L. sect. *Xiphidium* Bunge. Conspectus Florae Asiae Mediae, vol. 6. Tashkent, 193–212. [In Russian]

- Kamelin RV, Kovalevskaya SS (1993) *Tanacetopsis* (Tzvel.) Kovalevsk. Conspectus Florae Asiae Mediae, vol. 10. Nauka press, Tashkent, 528–534. [In Russian]
- Kamelin RV, Makhmedov AM (1990) The system of the genus *Phlomooides* (Lamiaceae). Botanicheskii Zhurnal (Moscow & Leningrad) 75: 241–250.
- Kamelin RV, Tagaev IU (1986) A review of species of the genus *Scorzonera* (Asteraceae). Botanicheskii Zhurnal 71: 1672–1682.
- Kamelin RV, Tschukervanik TI (1983) Generis *Lagochilus* Bunge (Lamiaceae) species Novae ex Asia Media. Novosti Sistematiki Vysshikh Rastenii 20: 166.
- Kanjun FU (2001) *Pseudosedum* (Boissier) A. Berger. Flora of China, vol. 8. Beijing, 213–214.
- Kayıkçı S, Ocak A, Teksen M, Erkul SK (2014) *Gagea antakiensis*, a new species from Southern Anatolia, Turkey and the new finding of *Gagea lojaconoii* (Liliaceae). Phytotaxa 15(4): 44–56. <https://doi.org/10.11646/phytotaxa.170.4.4>
- Khassanov FO (2000) Subinfrageneric grouping in genus *Allium* L., subgenus *Allium*. In: Ashurmetov O, Khassanov F, Salieva Y (Eds) Plant Life in South-West and Central Asia. Tashkent, 107–112.
- Khassanov FO (2019) Red Data Book of the Republic of Uzbekistan Vol 1. Plants. Tasvir, Tashkent, 356 pp.
- Khassanov FO, Karimov F, Tirkasheva B (2013) Taxonomic Revision and Lectotypification of *Allium* L. sect. *Coerulea* (Omelcz.) F.O. Khass. Stapfia 99: 208–234.
- Khassanov FO, Esankulov AS (2015) Taxonomic revision of *Allium* L. sect. *Minuta* F.O. Khass. Stapfia 103: 62–67.
- Kovalevskaya SS (1962) *Scorzonera* L. Flora of Uzbekistan, vol. 6. Tashkent, 434–446. [In Russian]
- Kovalevskaya SS (1981) *Astragalus* L., sect. *Myobroma* (Stev.) Bunge. Pp. 142–164. *Hedysarum* L. Conspectus Florae Asiae Mediae, vol. 6. Tashkent, 142–164. [In Russian]
- Krasovskaya LS, Levichev IG (1986) Flora of the Chatkal Nature Reserve. Science Publishers, Tashkent, 173 pp. [In Russian]
- Lazkov GA (1993) Two new species of genus *Silene* L. from Tien-Shan. Novosti Sistematiki Vysshikh Rastenii 29: 66.
- Lazkov GA (2004) One new and rare species of Kyrgyzstan flora. Novosti Sistematiki Vysshikh Rastenii 36: 32.
- Lazkov GA (2006a) The family of cloves (Caryophyllaceae) in the flora of Kyrgyzstan. KMK Scientific Publishing Association, Moscow, 272 pp.
- Lazkov GA (2006b) A new species of the genus *Corydalis* (Fumariaceae) from Kirgizstan. Botanicheskii Zhurnal 91(6): 954–955.
- Lazkov GA (2011) The genus *Phlomooides* Moench. (Lamiaceae) in Kirghizia. Komarovia. 7: 1–64.
- Lazkov GA (2016) Labitae (Family Labitae Juss.) in the flora of Kyrgyzstan. KH Botanical Monograph & Revision series, vol. 1, 176–215.
- Lazkov GA, Pashinina TG (2011) New species of *Tulipa* and *Eremurus* (Liliaceae) from Kyrgyzstan. Turczaninowia 14(3): 11–13.
- Lazkov GA, Sultanova BA (2014) Checklist of vascular plants of Kyrgyzstan. Norrlinia 24: 1–166.
- Lazkov GA, Turdumatova NK (2010) New and rare species of the genus *Allium* (Alliaceae) for flora of Kyrgyzstan. Botanicheskii Zhurnal 95(11): 1637–1639.

- Lazkov GA, Umralina AR (2015) Endemic and rare plant species of Kyrgyzstan (Atlas). The second edition revised and updated. Izd-vo Ankara, Bishkek, 237 pp. [in Russian with English abstract]
- Levichev IG (1999) Phytogeographical analysis of genus *Gagea* Salisb. (Liliaceae). Komarovia 1: 45–57.
- Levichev IG (2013) Structural features of shoots in *Lloydia*, *Gagea*, *Kharkevichia* (Liliaceae) as evolutionary variability of the modules of mesome nature in monocotyledons. Botanical Studies Journal (St. Petersburg) 98(4): 409–452. [In Russian] <https://doi.org/10.1134/S1234567813040010>
- Levichev IG, Jang C, Oh SH, Lazkov GA (2019) A new species of genus *Gagea* Salisb. (Liliaceae) from Kyrgyz Republic (Western Tian-Shan, Chatkal Mountain Range, Sary-Chelek Nature Reserve). Journal of Asia-Pacific Biodiversity 12(2): 341–343. <https://doi.org/10.1016/j.japb.2019.01.010>
- Li MM (1993) *Echinops* L. Conspectus Florae Asiae Mediae, vol. 10. Tashkent, 228–240. [In Russian]
- Li W, Tojibaev KS, Hisoriev H, Shomurodov KhF, Luo M, Feng Y, Ma K (2020) Mapping Asia Plants: Current status of floristic information for Central Asian flora. Global Ecology and Conservation 24: e01220. <https://doi.org/10.1016/j.gecco.2020.e01220>
- Linchevsky IA (1993) *Limonium* Mill. Conspectus Florae Asiae Mediae, vol. 10. Tashkent, 33–41. [In Russian]
- Llewellyn O, Hall M, Miller AG, Ai-Abbasi TM, Ai-Wetaid AH, Ai-Harbi RJ (2011) Important Plant Areas in the Arabian Peninsula: 4. JABAL AJA'. Edinburgh Journal of Botany 68(2): 199–224. <https://doi.org/10.1017/S0960428611000059>
- Lyskov D, Kljuykov E, Ukrainskaja U, Tojibaev KS (2019) Notes on the genus *Hyalolaena* (Apiaceae) with description of a new species *Hyalolaena zhang-minglii* from Xinjiang, Western China. Phytotaxa 388(3): 229–238. <https://doi.org/10.11646/phytotaxa.388.3.2>
- Manafzadeh S, Staedler MY, Conti E (2016) Visions of the past and dreams of the future in the Orient: The Irano-Turanian region from classical botany to evolutionary studies. Biological Reviews of the Cambridge Philosophical Society 92(3): 1365–1388. <https://doi.org/10.1111/brv.12287>
- Margules CR, Pressey RL (2000) Systematic conservation planning. Nature 405(6783): 243–253. <https://doi.org/10.1038/35012251>
- Marignani M, Blasi C (2012) Looking for important plant areas: Selection based on criteria, complementarity, or both? Biodiversity and Conservation 21(7): 1853–1864. <https://doi.org/10.1007/s10531-012-0283-5>
- Maxwell SL, Cazalis V, Dudley N, Hoffmann M, Rodrigues ASL, Stolton S, Visconti P, Woodley S, Kingston N, Lewis E, Maron M, Strassburg BBN, Wenger A, Jonas HD, Venter O, Watson JAM (2022) Area-based conservation in the 21<sup>st</sup> century. Nature 586: 217–227. <https://doi.org/10.1038/s41586-020-2773-z>
- Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403(6772): 853–858. <https://doi.org/10.1038/35002501>

- Nabiev MM (1954) Astragali Novie Valle Ferganica. Botaniceskoe Materialy Gerbarija Botaniceskogo Instituta Uzbekistanskogo Filiala Akademii Nauk SSSR 14: 21.
- Nabiev MM (1959) Vegetation of variegated layers of the Maylisay river basin (eastern part of Fergana valey). Materials on vegetation of deserts and lowlands of Central Asia: Proceedings of Botany Institute AS UzSSR. Iss. 5: 197–308. [In Russian]
- Naumenko A, Zubov D (2021) *Fritillaria rugillosa* (subgen. Rhinopetalum; Liliaceae): a new species from the Fergana Valley, southern Kyrgyzstan. International Rock Gardener, 140.
- Nesom GL (1983) Biology and Taxonomy of American *Leibnitzia* (Asteraceae: Mutisieae). Brittonia 35(2): 126–139. <https://doi.org/10.2307/2805949>
- Neustrueva-Knorrin O, Tamamschian S (1954) *Lamyropappus* genus novum ex Asia Media. Notulae Systematicae ex herbario Instituti botanici nomine V.L. Komarovii Academiae Scientiarum URSS. Mosqua. T. XVI: 463–467.
- Olonova MV, Zhang D, Ulkhan B (2013) On the identification of important plant areas on Altai mountain country. Tomsk State University Journal of Biology 21: 59–73.
- Pachomova MG (1976) *Crataegus* L. Conspectus Florae Asiae Mediae, vol. 5. Tashkent, 149–166. [In Russian]
- Pavlov NV (1935) Tribae Astragalearum species novae e montibus Karataviensibus jaxarticis. Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol., n.s., 44: 34.
- Pazij VC (1972) *Eminium* Schott. In: Kovalevskaja SS (Ed.) Conspectus Florae Asiae Mediae, vol. 2. Tashkent, 7. [In Russian]
- Peruzzi L, Bartolucci F, Frignani F, Minutillo F (2007) *Gagea tisoniana*, a new species of *Gagea* Salisb. sect. *Gagea* (Liliaceae) from central Italy. Botanical Journal of the Linnean Society 155(3): 337–347. <https://doi.org/10.1111/j.1095-8339.2007.00710.x>
- Peterson A, Harpke D, Levichev IG, Beisenova S, Schnittler M, Peterson J (2016) Morphological and molecular investigations of *Gagea* (Liliaceae) in southeastern Kazakhstan with special reference to putative altitudinal hybrid zones. Plant Systematics and Evolution 302(8): 985–1007. <https://doi.org/10.1007/s00606-016-1313-7>
- Pimenov MG (1974) De generis *Seseli* L. speciebus nonnullis in montibus Asiae Mediae Cisferganensibus crescentibus. Novitates Systematicae plantarum vascularium 11: 241–247.
- Pimenov MG (1978) De generis *Seseli* L. notulae systematicae. II. Adumbratio specierum Florae URSS. Novitates Systematicae plantarum vascularium 11: 188–200.
- Pimenov MG (1983a) *Dorema* D. Don. Pp. 313–315; *Seseli* L. Conspectus Florae Asiae Mediae, vol. 7. Tashkent, 245–260. [In Russian]
- Pimenov MG (1983b) *Seseli* L. Conspectus Florae Asiae Mediae, vol. 7. Tashkent, 245–260. [In Russian]
- Pimenov MG (1988) Monographic revision of the genus *Dorema* D. Don (Umbelliferae). Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody. Otdel Biologicheskii 93(2): 79–90.
- Pimenov MG, Baranova YuV (1979) Synopsis of sect. *Palaeonarthex* Korovin of the genus *Ferula*. Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody. Otdel Biologicheskii 84(3): 87.
- Pimenov MG, Kljuykov EV (1982) A critical analysis of the genera *Hyalolaena* and *Hymenolyma* and related taxa Umbelliferae-Apioideae. Botanicheskii Zhurnal 67(7): 873–889. [In Russian]
- Pimenov MG, Kljuykov EV (2002) Umbelliferae of Kirghizia. KMK Scientific Press Ltd., Moscow, 288 pp. [In Russian]

- Podlech D, Zarre Sh (2013) A taxonomic revision of the genus *Astragalus* L. (Leguminosae) in the Old World. Vol. III. *Astragalus* sect. *Caprini*, 702; *Astragalus* sect. *Ornithopodium*, pp. 1782–1797; *Astragalus* sect. *Dissitiflora*, pp. 1828–1973; *Astragalus* sect. *Chaetodon*, pp. 2012–2025.
- POWO (2022) Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. <http://www.plantsoftheworldonline.org> [Accessed 25.07.2022]
- Pratov UP (1972a) *Anthochlamys*. Conspectus Florae Asiae Mediae, vol. 3. Tashkent, 70. [In Russian]
- Pratov UP (1972b) *Gamanthus* L. Conspectus Florae Asiae Mediae, vol. 3. Tashkent, 135–136. [In Russian]
- Pratov UP (1972c) *Polycnemon* L. Conspectus Florae Asiae Mediae, vol. 3. Tashkent, 34–35. [In Russian]
- Pratov UP (1974) *Pseudosedum* (Boiss.) A. Berger. Conspectus Florae Asiae Mediae, vol. 4. Tashkent, 226–232. [In Russian]
- Pratov UP (2009) Red Data Book of the Republic of Uzbekistan Vol 1. Plants. Chinor ENK, Tashkent, 334 pp.
- Puchkova EG (1967) Species of the sect. *Chaetodon* and its position in the genus *Astragalus*. FAN publishers, Tashkent, 52 pp. [In Russian]
- Puchkova EG (1981) *Astragalus* sect. *Chaetodon* Bunge. Conspectus Florae Asiae Mediae, vol. 6. Tashkent, 235–240. [In Russian]
- Regel E (1882) Descriptiones Plantarum Novarum Rariorumque. Saint Petersburg 34(2): 21.
- Salmaki Y, Zarre Sh, Ryding O, Lindqvist Ch, Scheunert A, Christian B, Günther H (2012) Phylogeny of the tribe Phlomoideae (Lamioideae: Lamiaceae) with special focus on *Eremostachys* and *Phlomoideae*: New insights from nuclear and chloroplast sequences. *Taxon* 61(1): 161–179. <https://doi.org/10.1002/tax.611012>
- Scheen AC, Bendiksby M, Ryding O, Mathiesen C, Albert VA, Lindqvist C (2010) Molecular phylogenetics, character evolution and suprageneric classification of Lamioideae (Lamiaceae). *Annals of the Missouri Botanical Garden* 97(2): 191–219. <https://doi.org/10.3417/2007174>
- Schischkin BK (1936) *Acanthophyllum* C.A. Mey. Flora of the USSR, vol. 6. Nauka press, Moscow & Leningrad, 780–802. [In Russian]
- Sennikov AN (2010) A revision of *Cousinia* sections *Alpinae* (syn. *Carduncellus*), *Subappendiculatae* and *Tianschanicae* (Asteraceae) in the Kirghizian Tian-Shan and the neighboring territories. *Phytotaxa* 5(1): 1–30. <https://doi.org/10.11646/phytotaxa.5.1.1>
- Sennikov AN (2016) Flora of Uzbekistan. Volume 1. Navro'z Publishers, Tashkent. <https://doi.org/10.11646/phytotaxa.282.2.2>
- Sennikov AN (2017) Flora of Uzbekistan. Volume 2. Navro'z Publishers, Tashkent. <https://doi.org/10.11646/phytotaxa.282.2.2>
- Sennikov AN (2019) Flora of Uzbekistan. Volume 3. Ma'naviat Publishers, Tashkent.
- Sennikov AN (2021) Distribution records of *Cousinia knorringiae*. Komarov Botanical Institute, Russian Academy of Sciences, St. Petersburg. <https://doi.org/10.15468/bq88w5>
- Sennikov AN (2022) Flora of Uzbekistan. Volume 4. Fan Publishers, Tashkent.
- Shaltout K, Eid E (2016) Important Plant Areas in Egypt. With Emphasis on the Mediterranean Region. Lambert Academic Publishing, Saarbrücken, Germany, 190 pp.

- Shuka L, Malo S (2010) The transboundary important plant areas as conservation units of European green belt (Eastern Albanian zone). *Journal of Environmental Protection and Ecology* 11(33): 866–874.
- Shuka L, Kashta L, Xhulaj M (2014) Evaluation of potential transboundary important plant areas of the north Albania. *Natura Montenegrina, Podgorica* 7(3): 425–439.
- Sidorenko GT (1968) *Polycnemum* L. Flora of Tajikistan Vol. 3. Nauka publishers, Leningrad, 314–316.
- Sidorenko GT, Kinzikayeva GK, Ovchinnikov PN (1968) *Anthochlamys* Fenzl. Flora of Tajikistan Vol. 3. Nauka publishers, Leningrad, 365.
- Signorello G, Pratob C, Marzob A, Ientileb R, Cucuzzaa G, Sciandrellob S, Martínez-López J, Stefano B, Ferdinando V (2018) Are protected areas covering important biodiversity sites? An assessment of the nature protection network in Sicily (Italy). *Land Use Policy* 78: 598–603. <https://doi.org/10.1016/j.landusepol.2018.07.032>
- Sparrus LB, van der Hak DD, Chrispijn R, van der Meer S, van der Pluijm A, Timmerman HJ, Zielman HR (2019) Important Plant Areas. Botanical biodiversity hotspots in the Netherlands. Plants, bryophytes, macrofungi and lichens. Floron report 2017.044. Floron Plant Conservation Netherlands, Nijmegen.
- Sukhorukov AP, Konstantinova AI (2012) Fruit anatomy of *Anthochlamys* (Chenopodiaceae/ Amaranthaceae). Proceedings of the Symposium. Moscow, 92–97.
- Tagaev IU (1993) *Scorzonera* L. *Conspectus Florae Asiae Mediae*, vol. 10. Tashkent, 198–211. [In Russian]
- Tamamschian S (1963) *Lamyropappus* Knorring & Tamamsch. Flora of the USSR vol. 28. Nauka press, Moscow & Leningrad, 221–222. [In Russian]
- Thiers B (2022 [continuously updated]) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/science/ih/> [Accessed: 16 August 2022]
- Tojibaev KSh (2002) The Chodaksay basin vegetation mantle and pasturelands: The abstract from the thesis of the candidate for doctor of biology. Tashkent, 19 pp.
- Tojibaev KSh (2010) Flora of South-Western Tian-Shan (within the Republic of Uzbekistan). Tashkent [In Russian]
- Tojibaev KSh, Kadirov RU (2010) Tulips of Uzbekistan. Shark Publishers, Tashkent, 224 pp.
- Tojibaev KS, Beshko NY (2014) Reassessment of diversity and analysis of distribution in *Tulipa* (Liliaceae) in Uzbekistan. *Nordic journal of Botany* 33: 324–334. <https://doi.org/10.1111/njb.00616>
- Tojibaev KS, Karimov FI, Turgunov MD (2014a) A new species of the genus *Iris* L. (Iridaceae Juss.) from the Fergana valley. *Turczaninowia* 17(4): 12–16. <https://doi.org/10.14258/turczaninowia.17.4.2>
- Tojibaev KS, Karimov FI, Turgunov OT (2014b) A new species and new records of *Allium* (Amaryllidaceae) for Uzbekistan (Central Asia). *Phytotaxa* 177(5): 291–297. <https://doi.org/10.11646/phytotaxa.177.5.5>
- Tojibaev KS, Beshko NY, Turgunov OT, Mirzalieva D (2014c) New records for Fabaceae in the flora of Uzbekistan. *Flora Mediterranea* 24: 25–35. <https://doi.org/10.7320/FIMedit24.025>
- Tojibaev KS, Beshko NY, Azimova DE, Turgunov OT (2015) Distribution patterns of species of the genus *Astragalus* L. (sect. *Macrocystis*, *Laguropsis* and *Chaetodon*) in the territory of



- Mountain Middle Asian province. *Turczaninowia* 18(2): 17–38. <https://doi.org/10.14258/turczaninowia.18.2.3>
- Tojibaev KSh, Beshko NYu, Popov VA (2016) Botanical-geographical regionalization of Uzbekistan. *Botanicheskii Zhurnal* 101(10): 1105–1132. [In Russian]
- Tojibaev KSh, Beshko NYu, Popov VA, Jang CG, Chang KS (2017) Botanical Geography of Uzbekistan. Korea National Arboretum, Pocheon, 250 pp.
- Tojibaev KS, Karimov FI, Oh B-U, Oh SH, Jang C-G (2018a) A checklist of the geophytes of Fergana Valley, Middle Asia—A monocotyledonous plant and biogeographical analysis. *Journal of Asia-Pacific Biodiversity* 11(3): 431–441. <https://doi.org/10.1016/j.japb.2018.06.003>
- Tojibaev KS, Karimov FI, Azimov II (2018b) Two new records for the flora of Uzbekistan from southwest Tian-Shan. *Journal of Asia-Pacific Biodiversity* 11(3): 449–451. <https://doi.org/10.1016/j.japb.2018.06.006>
- Tojibaev K, Karimov F, Choi HJ, Choi K, Jang C-G (2019) Relisting of the 2 species *Lamyropappus schakaptaricus* (B.Fedtsch.) Knorring & Tamamsch. and *Hedysarum gypsaceum* Korotkova in the flora of Uzbekistan. *Journal of Asia-Pacific Biodiversity* 12(4): 693–697. <https://doi.org/10.1016/j.japb.2019.08.004>
- Tojibaev KS, Jang C-G, Lazkov GA, Chang KC, Sitpaeva G, Safarov N, Beshko N, Muktabeva S, Vesselova P, Turakulov I, Na N-R, Minsu P, Choi K, Choi HJ, Oh U, Oh SH (2020) An Annotated Checklist of Endemic Vascular Plants of the Tian-Shan Mountains in Central Asian Countries. *Phytotaxa* 464(2): 117–158. <https://doi.org/10.11646/phytotaxa.464.2.1>
- Tojibaev KS, Karimov FI, Hoshimov HR, Jang C-G, Na N-R, Park M-S, Chang K-S, Gil H-Y, Baasanmunkh S, Choi HJ (2022) Important plant areas (IPAs) in the Fergana Valley (Central Asia): The badlands of the northern foothills. *Nature Conservation* 49: 1–30. <https://doi.org/10.3897/natureconservation.49.84834>
- Tscherneva OV (1962) *Cousinia* Cass. In: Vvedensky AI (Ed.) *Flora of Uzbekistan*, vol. 6. Tashkent, 230–332. [In Russian]
- Tscherneva OV (1963) *Cousinia* Cass. *Flora of Kirgiz SSR*, 11. Frunze, 212–299. [In Russian]
- Tscherneva OV (1993) *Cousinia* Cass. *Conspectus Florae Asiae Mediae*, vol. 10. Tashkent, 333–337. [In Russian]
- Tschukervanik TI (1987) *Lagochilus* Bunge. *Conspectus Florae Asiae Mediae*, vol. 9. Tashkent, 119–131. [In Russian]
- Tulaganova MT (1993a) *Lamyropappus* Knorring & Tamamsch. *Conspectus Florae Asiae Mediae*, vol. 10. Nauka press, Tashkent, 226. [In Russian]
- Tulaganova MM (1993b) *Leibnitzia* Cass. *Conspectus Florae Asiae Mediae*, vol. 10. Tashkent, 241. [In Russian]
- Ubukeyeva AU (1960) *Eremostachys* Bunge. *Flora of Kirghiz SSR*, 9. Academy of Sciences of Kirghiz SSR, Frunze, 74–95. [In Russian]
- Usmonov M, Tojibaev KS, Jang C-G, Sennikov AN (2021) Species conservation profile and amended distribution of *Cousinia knorringiae* (Asteraceae), a narrow endemic of the Western Tian-Shan. *Biodiversity Data Journal* 9: e64115. <https://doi.org/10.3897/BDJ.9.e64115>
- Vernik RS, Rakhimova TT (1982) *Vegetation of Namangan Adyrs*. Fan publishers, Tashkent, 85 pp.

- Vinogradova PM (1981) *Astragalus* L. sect. *Aureophora* Kamelin. Conspectus Florae Asiae Mediae, vol. 6. Tashkent, 212–213. [In Russian]
- Vvedensky AI (1971) *Allium* L. Conspectus Florae Asiae Mediae, vol. 2. Tashkent, 39–89. [In Russian]
- Wilson B, Dolotbakov A, Burgess BJ, Clubbe C, Lazkov GA, Shalpykov K, Ganybaeva M, Sultangaziev O, Brockington SF (2021) Central Asian wild tulip conservation requires a regional approach, especially in the face of climate change. *Biodiversity and Conservation* 30(6): 1705–1730. <https://doi.org/10.1007/s10531-021-02165-z>
- Xinqi C, Turland NJ (2000) *Gagea*. In: Zhengyi W, Raven PH (Eds) 2000. Flora of China. No. 24. Science Press, Beijing & Missouri Botanical Garden Press, St. Louis, 117–121.
- Yusupov ZO, Deng T, Volis S, Khassanov FO, Makhmudjanov D, Tojibaev KS, Hang S (2021) Phylogenomics of *Allium* section *Cepa* (Amaryllidaceae) provides new insights on domestication of onion. *Plant Diversity* 43(2): 102–110. <https://doi.org/10.1016/j.pld.2020.07.008>
- Zaika MA, Kilian N, Jones K, Krinitsina AA, Nilova MV, Speranskaya AS, Sukhorukov AP (2020) *Scorzonera* sensu lato (Asteraceae, Cichorieae) – taxonomic reassessment in the light of new molecular phylogenetic and carpological analyses. *PhytoKeys* 137: 1–85. <https://doi.org/10.3897/phytokeys.137.46544>
- Zarrei M, Wilkin P, Ingrouille MJ, Chase MW (2010a) *Gagea calcicola* (Liliaceae), a new species from southwestern Iran. *Kew Bulletin* 65(1): 89–96. <https://doi.org/10.1007/s12225-010-9185-4>
- Zarrei M, Wilkin P, Ingrouille MJ, Chase MW (2010b) *Gagea robusta* (Liliaceae), a new species from Flora Iranica area. *Kew Bulletin* 65(2): 327–336. <https://doi.org/10.1007/s12225-010-9196-1>