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ASSESSMENT OF THE CURRENT CONDITION OF POPULATIONS OF THE RED LIST SPECIES *LAGOCHILUS PROSKORJAKOVII* IKRAM AND *LAGOCHILUS OLGAE* R.KAM. *(LAMIACEAE)* IN NURATAU MOUNTAIN RIDGE, UZBEKISTAN

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ABSTRACT

The high-mountain ecosystems of Central Asia, are a biodiversity hotspot with unique plant communities and many endemic species. Intense human pressure and global warming have caused habitat destruction in these areas and increased the number of endangered species. In Uzbekistan the number of red listed plant species has risen in the last 30 years, from 163 in 1984 to 324 in 2009. Among those red listed species are 23 species in the *Lamiaceae* family. The aim of this study was to estimate current populations of two of these red listed species, *Lagochilus proskorjakovii* and *Lagochilus olgae*. These species are endemic to the Nuratau ridge and are under high human pressure.

I found four populations of both species in the Nuratau ridge. For each population I measured plant density and determined population maturity and ontogenetic spectrum. I also described the plant community where each population grew. At all sites population density was low, with most populations being classified as mature with centred ontogenetic structure. These results indicated that both species might in the near future become extinct in the wild. I therefore recommend that the local people be encouraged to stop using these plants and the development of methods to cultivate them.

Key words*:* Biodiversity, Conservation, Classification, delta-omega (Δ-ω), *Lagochilus,* Red Book

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1. INTRODUCTION

1.1 Background

Uncontrolled use of plant resources for human well-being drives the loss of plant biodiversity worldwide (World Conservation and Monitoring Centre 1992; IPCC 2002; Mamedov et al. 2005). Global warming is likely to drive this loss by triggering changes in vegetation cover (Ehleringer et al. 1997). In terms of biodiversity, the high-mountain ecosystems of Central Asia belong to the most valuable areas in the world, called hotspots. The ecosystems are exposed to intense human pressure which has caused habitat destruction (Rahmanov et al. 2013). These ecosystems embrace unique plant communities and many endemic species (Rahmanov et al. 2013). A high level of endemism in the mountains is linked to environmental conditions such as geological structure, high mountain ranges and climatic conditions. "This fact has an influence on forming mosaic biotopes, often isolated by orographic barriers. A problem of landscapes diversity and biodiversity of this region was mentioned in the last century" (Zakirov 1955).

Similarly, there has been an increase in the number of endangered species (Mirhoseini A. et al. 2013: Tojibayev et al. 2014). In combination with the effects of global warming, these factors have changed the flora of Uzbekistan, with an increase in red list species in the last 30 years, from 163 in 1984 to 324 in 2009 (Red Book of Uzbekistan 2009). Among those red listed species are 23 species in the *Lamiaceae* family (Red Book of Uzbekistan 2009).

Lamiaceae, a family with a cosmopolitan (wide) distribution, comprise 236 genera with 6900–7200 species, including famous economically and medicinally important herbs, horticultural shrubs, and trees (Harley et al. 2004, Wang et al. 2012). The *Lamiaceae* flora of Uzbekistan include 201 species in 41 genera (Vvedensky et al. 1961). *Lamiaceae* are interesting because they contain an important number of biologically active compounds with wide spectra of activity.

This family has pragmatic significance because many of them are useful oil bearers (Poludennyi et al. 1979) containing essential oils that are used in the medical, pharmaceutical, cosmetics, and food industries (Buiko et al. 1968; Mirhoseini et al. 2016). The genus *Lagochilus* is the most economically important of the *Lamiaceae* family. This genus comprises 46 species worldwide (www.theplantlist.org). In the flora of Uzbekistan, the genus *Lagochilus* is represented by 18 plants in the main Herbarium of Uzbekistan (TASH).

Some plants from the genus *Lagochilus* are among the red listed species from the *Lamiaceae* family. The genus *Lagochilus* includes 18 species, four of which (*Lagochilus vvedenskyi*, *L. olgae*, *L. proskorjakovii* and *L. inebrians*) are in the Red Book of the Republic of Uzbekistan (2009). These species are classified as either disappearing ("category I- disappearing- species with quantity close to the critical level of extinction from the area) and "rare species" ("category II-rare species- that are not under direct threat of disappearance, but existing in such small numbers or in such area limited and specific places of habitation, that they can quickly disappear, they need to be carefully monitored").

Species of this genus are of great economic importance and are extensively used as medicinal raw material (Pratov et al. 2006, Malikova et al. 1997, Sokolov et al. 1987). The leaves contain alcohols, lagochilin (0.6-2%), essential oils (0.03%) and vitamin K, and most of the genus' members contain narcotic, haemostatic, and other substances (Pratov et al. 2006). Locally, most species of this genus are used for treating skin illnesses, controlling bloodletting and nervous disorders (Malikova et al. 1997).

Populations of *Lagochilus* species are affected in their native range by harsh environmental conditions, such as highly eroded soils, rock slides, large rocky slopes, intense winds and few pollinators. In addition, populations of *Lagochilus* species are under pressure from anthropogenic factors, such as overgrazing, harvesting for fodder, fuel, medicinal raw material and trampling, which have resulted in a decrease in the natural habitats of these plants, as observed by Beshko (1997), Shomurodov et al. (2014) and Shomurodov et al. (2017).

To be able to develop science-based and practical measures for the preservation and rehabilitation of these focal species detailed and in-depth ecological study of these plants is needed.

1.2 The aim of this project

The overall goal of this project was to assess the status of *L. proskorjkovii* and *L. olgae* in the wild.

Specifically, the objectives were:

- To describe the plant communities and environmental conditions where *L. proskorjakovii* and *L. olgae* grow
- To describe the ontogenetic spectrum of the populations of these species
- To assess the condition of the populations of these species using population traits

2. MATERIAL AND METHODS

2.1 Study area

The study was conducted in the Nuratau ridge. The Nuratau ridge includes several mountains (Nuratau, Koytash, Gubdintau, Karachatau, Aktau and Karatau) and is located at the north-western edge of the Pamir-Alai mountain range (Fig. 1). The climate is Mediterranean, the average minimum temperature is 13.4°C and average maximum temperature 43°C. Annual rainfall exceeds 206 mm. Soils are grey-brown, sandy and brown and contain between 4 to 7% humus (Zakirov 1963).

The highest point in Nuratau reaches 2169 m above sea level (Fig. 2; Zakirov 1963). This mountain system forms part of the tectonic range in Central Asia. This system includes middle-dry lowlands and mountains, and hosts high biodiversity.

This ridge is one of the key botanical regions of Central Asia. The flora of the Nuratau mountains includes about 1285 species of vascular plants, of which 29 are endemic (Beshko et al. 2014).

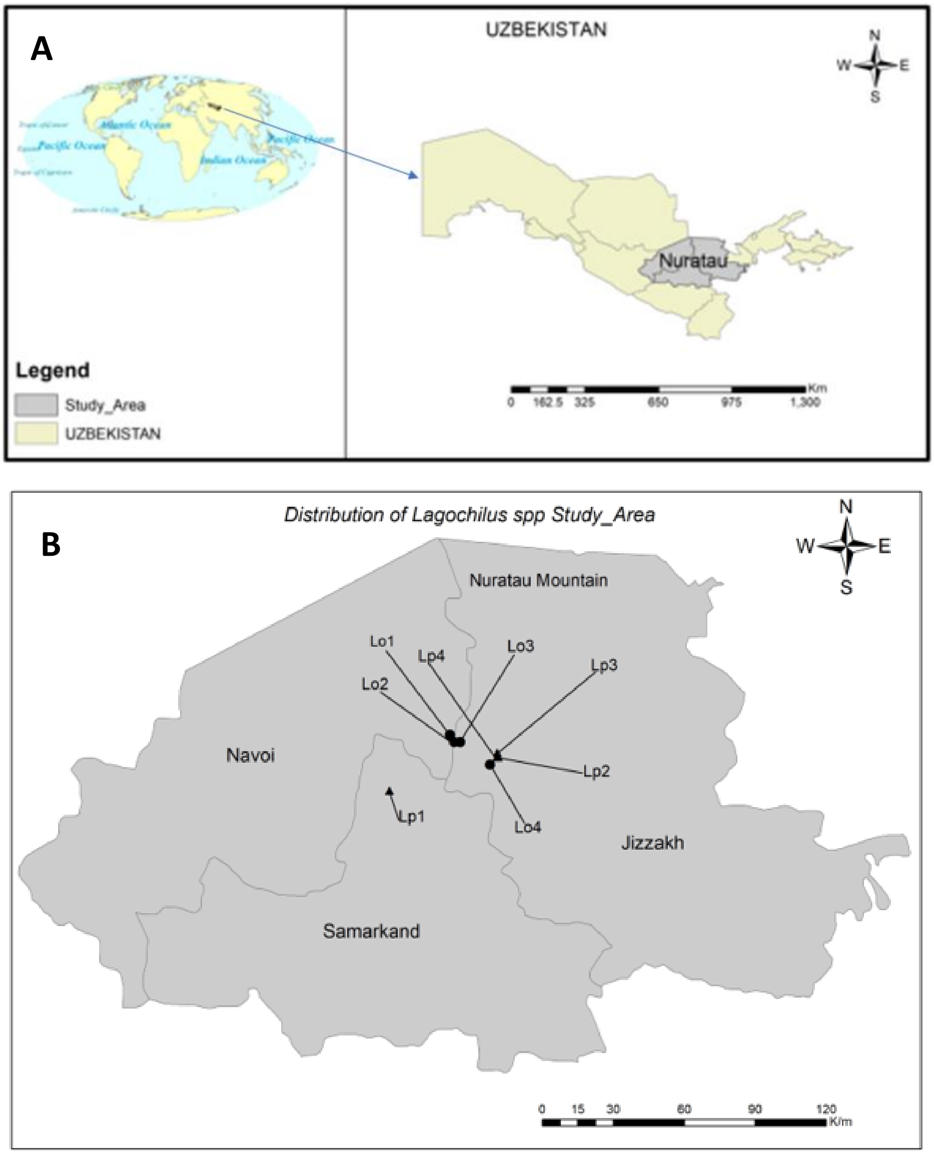


Figure 1. Maps showing the location of the study area in Uzbekistan (A) and the distribution and locations (B) of popuations of *L. proskorjakovii* (Lp) and *L. olgae* (Lo).

Figure 2. General view of Nuratau mountains (Photos: A. Akhmedov 2016). The highest point in the Nuratau ridge is 2169 m. a.s.l.

2.2 Study species

The study focuses on two red list species: *L. proskorjakovii* and *L. olgae*.

L. proskorjakovii was found and described by Ikramov in Nuratau in 1964 (Ikramov 1976). The species is endemic to Nuratau. *L. proskorjakovii* is a polycarpic semi-shrub, 20 - 35 cm height (Fig. 3A). It blooms in June-July, fruiting in August (Bondarenko et al. 1961) (Table 1). The species mainly reproduces by seeds but has a low germination rate, rapid transition to flowering, and slow development of individuals (Ikramov 1976, Akhmedov et al. 2015). Mostly *Lagochilus* species are C3 plants (Liu et al, 2004).

L. olgae was described by Beshko in 1997. This species is also endemic to Nuratau. The species belongs to caudex, polycarpic dwarf shrubs, whose perennial axes form a short multiaxial caudex (Fig. 3B). Renewal buds are at a height of 1–2 cm above the substrate. Flowering occurs in June – July. Reproduction is mainly by seeds but the species also reproduces vegetatively by particulation (Table 1).

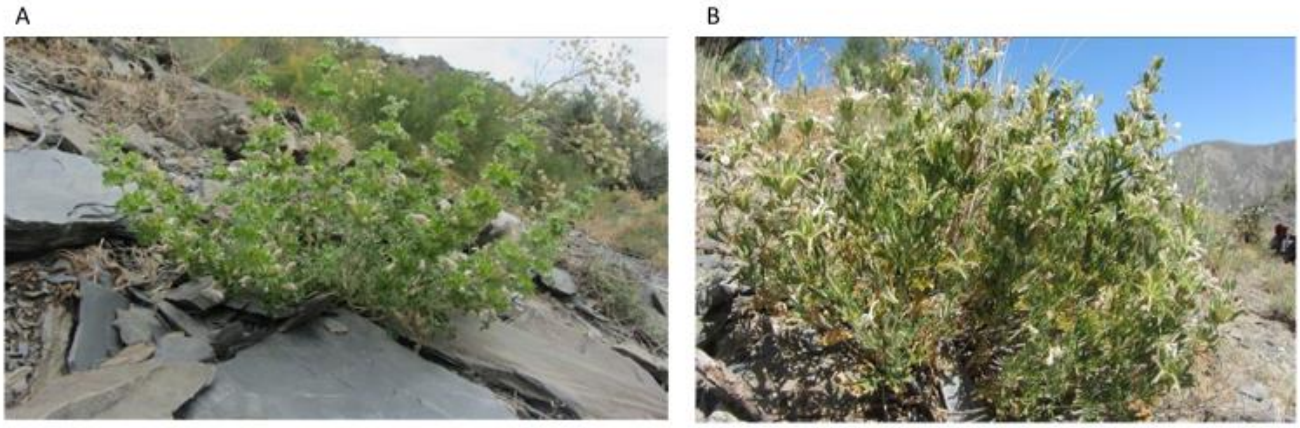


Figure 3. The two focal species of this study: *L. proskorjakovii* (a) and *L. olgae* (b) (Photos: A. Akhmedov 2015).

Table 1. Characteristics of the two focal species, *L. proskorjakovii* and *L. olgae*

Characteristics	***L. proskorjakovii***	***L. olgae***
Life form	Semi-shrub	Dwarf-shrub
Height (cm)	20 – 35	30-40
Colour of flower	Pink	White
Form of leaves	Lobed	Divided
Flowering	June-July	May-June
Uses	Controlling bloodletting	Fodder
Red List category	I- disappearing	II- rare
C_3 plants	+	+

2.3 Study design

Due to the limited distribution of *L. proskorjakovii* only four populations have been described in the wild. All these populations are included in this study, in addition to four native populations of *L. olgae* in the Nuratau mountains (Table 2).

2.3.1 Description of the vascular plant communities and environmental conditions

In this study, I focus on the eight populations of *L. proskorjakovii* and *L. olgae* with each population representing one study site (1.0-10 ha). The sites were surveyed in Nuratau 2014-2016.

At each of the sites I described the plant community and then inventoried all plant species occurring in one randomly selected 25×25 m plot. Unidentified plant species were collected for identification. Total vegetation cover was estimated in each plot using the method developed by Braun Blanquet (1965), where each species cover was assessed based on cover classes (0-5%, 5-25%, 25-50%, 50-75%, and 95-100%). The life form of plants was described according to the 9th volume of *Plant Identifier of Central Asia* (Abdullayeva et al. 1987) into trees, shrubs, semi-shrubs, dwarf-shrubs, or herbs (perennial, biennial and annual). Plant taxonomy was according to Cherepanov (1995).

Figure 4. Grazing by cattle in Nuratau ridges (Photos: A. Akhmedov 2015).

Figure 5. Overgrazing by domestic animals (cows, sheep and goats in Nuratau ridges (Photos: Akbar Akhmedov 2016).

For each site, I estimated the following environmental variables: aspect, slope, distance to water, annual precipitation and anthropogenic factors. Aspect was measured using GPS (Garmin 62) and slope was visually estimated slopes of mountains, 40-60 degrees. Distance to water was the nearest distance to Lake Aydar (40-50 km). At each study site any signs of anthropogenic influences were noted and identified, such as evidence of grazing and type of grazing animals (Fig. 4, Fig. 5).

2.3.2 Description of the ontogenetic spectrum of the populations of the focal species

At each of the sites I set out three transects, starting from a common random point. From this point, one transect was established to the north, one to the south and one to the east. Each transect was 1 m wide and 10 m long and was subdivided into 10-1 m^2 squares. In each of the squares I counted the number of individuals in each ontogenetic stage (p - plantule, j - juvenile, im - immature, v - virginile, g1 - young generative, g2 – mature generative, g3 - old generative, ss - subsenile, s – senile; Rabotnov 1950; Uranov 1975; Cenopopulations, 1976, Fig. 6).

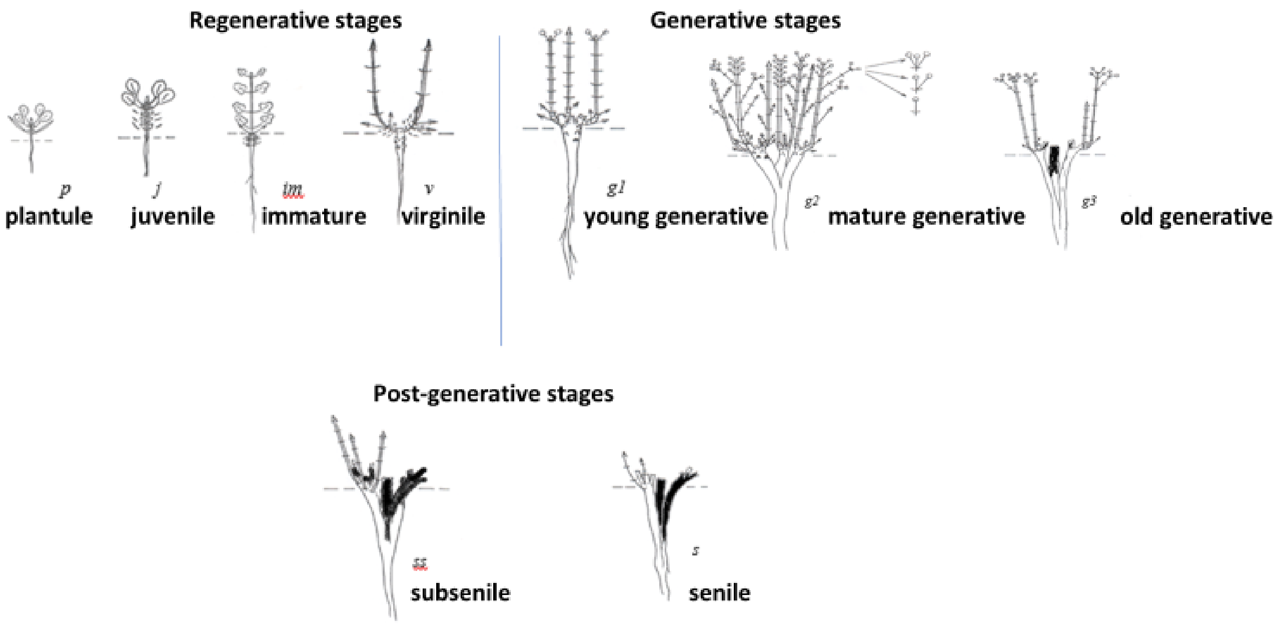


Figure 6. Ontogenetic stages used to determine the stage of measured of *Lagochilus spp* individuals. Ontogenetic states: p – plantule, j - juvenile, im - immature,
v - virginile, g1 - young generative, g2 - mature-generative, g3 - old generative, ss - subsenile, s – senile (Drawing by V. Cheryomushkina and A. Akhmedov).

The ontogenetic spectrum of the population was then determined according to the standard method by Uranov (1975) and Uranov, Smirnova (1969). (Fig. 7). Four types of ontogenetic spectra can be distinguished (Zaugolnova 1994), depending on the proportion of individuals in the pre-generative state (plantule, juvenile, immature, virginile), generative state (young generative, mature generative, old generative) and post-generative state (subsenile, senile).

1. Left-sided spectrum. This consists of prevalent individuals in the pre-generative state or in one of the generative states. This type of spectrum is very dynamic and members of the groups in specific populations are quite diverse.
2. Centred spectrum. Individuals of the average age generative ontogenetic state (nine) prevail.
3. Bimodal spectrum. For this type of spectrum, two maximums are characteristic, one in the regenerative part and one in older (less often mature) generative plants.
4. Right-sided spectrum. In this spectrum, old individuals are dominant and there are no increases in the young part of the spectrum.

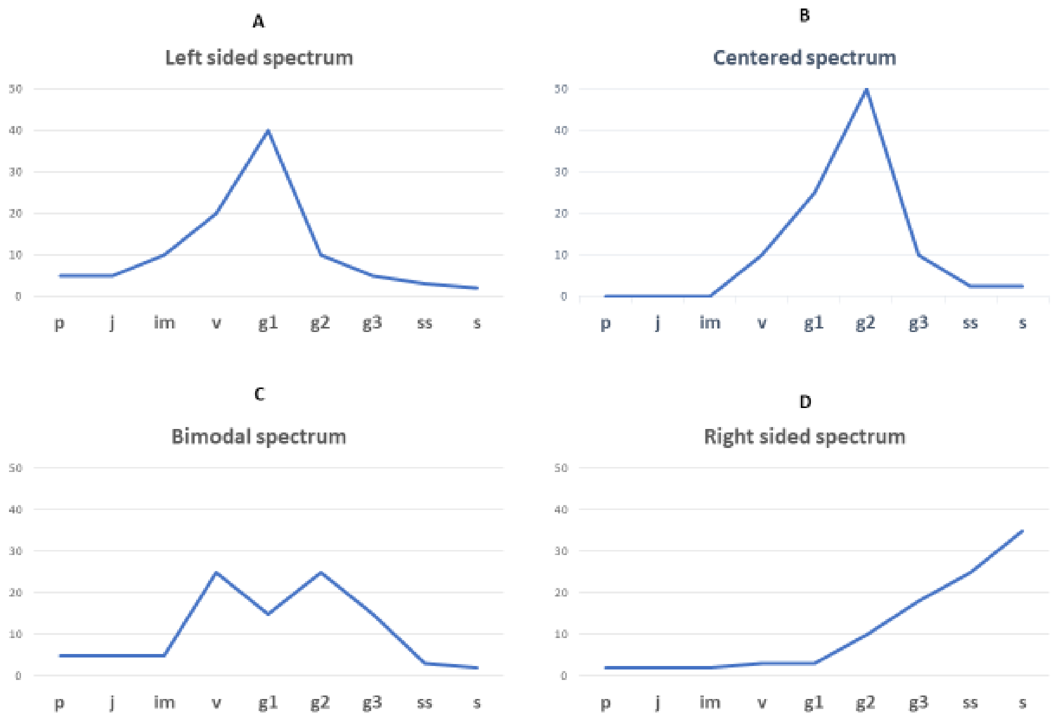


Figure 7. Four types of ontogenetic spectrum of plant populations: left-sided spectrum (A), centred spectrum (B), bimodal spectrum (C) and right-sided spectrum (D).

2.3.3 Assessment of the population of the focal species using population traits

Assessment of population structure was carried out using population traits (Zaugolnova 1994). For each population six population traits were measured: delta-omega, average density of individual, ecological density and the age structure of the population.

Population type was classified with the "delta-omega" (Δ-ω) method (Zhivotovsky 2001). Delta (Δ)—an index of population age, which assesses the age level of populations at any moment of time (equation x), and omega (ω)—the effectiveness of the plant ontogenetic stages, the value of "load" on the energetic resources of environment, expressed as a fraction load produced by middle-aged generative condition plants of this population. According to the delta=omega classification, the population can be classified as young, maturing, transition, senescent and old.

Average density of individuals per m^2 was measured as the average number of individuals in each of the 30 m^2 quadrates within a population. Ecological density was measured according to Odum (1986). The effective ecological density was determined according to the formula proposed and this software identified the type of population automatically (Zhivotovsky 2001).

The age structure of the population was determined by calculating the proportion of young individuals, the fraction of juvenile and young generative (j- g1) and the proportion of individuals of generative fraction mature generative-old generative (g2 - g3). The age index of population was determined by formula (Fig. 8).

$M = \sum n_i$	Physically density of individuals age
$n=\sum n_i$	Ecological density of population
$\omega = \frac{\sum n_i \cdot m_i}{\sum n}$	Average energy efficiency of population
$M_e = \omega \cdot M$	Effective density of population
$\Delta = \frac{\sum m_i \cdot n_i}{\sum n}$	Index of population age

Figure 8. Formula of densities.

2.4 Data analysis

Descriptive statistics such as mean, frequency and distribution graphs were carried out on the data.

Ordination was used to analyse the distribution of plant species along the gradient axes. Ordination is a general term used to describe multivariate techniques that arrange sites along axes on the basis of species composition data. Sites with similar species composition are located closer to each other in the diagram, and sites with different species composition are displayed far from one another in an ordination biplot (Jongman, Ter Braak, & Van Tongeren, 1995). The aim of the ordination is to find and display the axes of greatest variability in community composition (Leps & Smilauer, 2003). Here I used non-dimensional multivariate scaling (NDMS).

Descriptive statistics were conducted in Excel and R for windows version 3.4.1 was used for NDMS. Maps were created by ArcGIS 10.3.1 software. A WGS84 geographic coordinate system was used as reference.

3. RESULTS AND DISCUSSION

3.1 Description of the vascular plant communities and environmental conditions where *L. proskorjakovii* and *L. olgae* grow

The first population of *L. proskorjakovii* was in the central part of the Nuratau ridge, 10-12 km to the north of the Nuratau (Hayotsoy village), at an altitude of 1835 m a.s.l (Table 2). This population was on the north-western slope of this mountain, the steepness of which was 50-60°. The soil was stony and gravelly. The vegetation was wastage and the total vegetation cover was 20%. The total cover of *L. proskorjakovii* was less than 1% (Table 2). I found 30 species of vascular plants in the community (Appendix A), of which two were shrubs, eight semi-shrubs and 20 perennials.

The second population of *L. proskorjakovii* was in the south-western part of the Nuratau ridge. This population was located 4-6 km east of the Mekhayam village, at an altitude of 1470 m a.s.l. (Table 2). The exposure was southern and the steepness of the slope was 60-70°. The soil here was largely stony. The total vegetative cover was 15% and the total cover of *L. proskorjakovii* about 1% (Table 2). One of the characteristic features of this vegetation was the presence of two species of trees *Acer pubescens* and *Crataegus pontica*. I found 20 species of vascular plants in the community, of which two were trees, four were shrubs, four semi-shrubs, nine perennials nine and one annual.

The third population of *L. proskorjakovii* was recorded 8-10 km east of Mekhayam village, on the south-eastern slope of Nuratau, at an altitude of 1523 m a.s.l. (Table 2). The exposure was southern, the slope 60-70 °. The soil was large stones. Total vegetation cover was 12%, and the total cover of *L. proskorjakovii* was less than 1% (Table 2). I found 18 species of vascular plants in the community, of which two were shrubs, four were semi-shrubs, ten perennials and two annuals.

The fourth population of *L. proskorjakovii* was in the central part of the Nuratau ridge, 6-8 km east of the settlement of Mekhayam village, at an altitude of 1365 m a. s. level (Table 2). This population was located on the north-western slope of this mountain, the steepness of which was 40-50°. The soil of this area was mainly with large stones. The vegetation had been destroyed, leaving a total vegetative cover of only 10%, and the total cover of the two focal species was less than 1% (Table 2). I found 13 species of vascular species in the fourth population, of which two were shrubs, two were semi-shrubs, with seven perennials and two annuals (Fig. 9).

The first population of *L. olgae* was in the northern part of the Nuratau ridge, 4-6 km from Ukhum village (Table 2). The soil was described as fine gravelly. The total vegetative cover was 30% and the total cover of *L. olgae* in the community was less than 4%. I found 30 species of plants in the community, of which four were shrubs, three were semi-shrubs, one dwarf-shrub, with 17 perennials and five annuals.

The second population of *L. olgae* (Buloksoy) was located 10-12 km north of the Ukhum village. The soil of the described area was fine-grained - gravelly. The total vegetation cover was 40% and the total cover of *L. olgae* was about 5% (Table 2). I found 22 species in the population of which three were shrubs, two were dwarf-shrubs, with 16 perennials 16 and one annual (Table 2).

The third population of *L. olgae* (Toshtashlarsoy) was 8-10 km of the north of Mekhayam village.The soil of the described area was gravelly with large stones. The total vegetative cover was ca. 25%, with the share of the focal species about 3% (Table 2). I found 26 species of vascular species in the population, of which four were shrubs, three were semi-shrubs, one a dwarf-shrub, with seven perennials and two annuals.

The fourth and last population of *L. olgae* was recorded on the south-eastern slope of Nuratau ridge. This population was near the settlement of Mekhayam (2 km east of the village). The soil of the surveyed area was stony gravelly. The total vegetative cover of this population was 35% and total cover of *L. olgae* was less than 3% (Table 2). I found 14 species of vascular species in the population, of which two were semi-shrubs and one a dwarf-shrub, with nine perennials and two annuals (Fig. 9).

Table 2. Description of current populations of *L. proskorjakovii* and *L. olgae* (Akhmedov et al. 2016)**.**

Species	**Population**	**Coordinates**			**Community/ dominant species**	**Total vegetation cover (%)**	**Total cover of focal species (%)**
		N	**E**	**Elevation (m a.s.l.)**			
L. proskorjakovii	*Lp*1	40°30.644´	66°43.344´	1835	*Artemisia juncea, Perovskia scrophulariifolia, Stipa hohenackeriana, Oxytropis tachtemis Poa relaxa, Tulipa turkestanica*	20	≤1
	*Lp*2	40°28.950´	66˚98.346'	1470	*Amygdalus bucharica, Perovskia scrophulariifolia, Artemisia juncea, Ferula ovina, Prangos pobularia, Poa relaxa, Bromus scoparius.*	15	≤1
	*Lp*3	40°44.075´	66°95.246´	1523	*Perovskia scrophulariifolia, Poa bulbosa, Ferula ovina, Bromus danthoniae, Hypericum scabrum*	12	≤1
	*Lp*4	40˚61.095'	66˚99.443'	1365	*Amygdalus bucharica, Ferula varia*	10	≤1
L. olgae	*Lo*1	40°29.258´	66°46.702´	1784	*Amygdallus bucharica, Artemisia tunuisecta, Galium pamiroalaicum, Poa bulbosa*	30	4
	*Lo*2	40˚50'085'	66°44.414´	1672	*Phlomis nubilans, Thalictrum sultanabadense, Lonicera nummulariifolia, Cotoneaster nummularius, Tulipa turkestanica, Iris maracandica*	40	5
	*Lo*3	40°43.904′	66°94.819′	1412	*Amygdallus bucharica, Lonicera nummulariifolia, Artemisia tunuisecta, Perovskia scrophulariifolia, Taeniatherum crinitum, Ferula ovina, Bromus scoparius*	25	3
	*Lo*4	39°67.153′	66°92.155′	1127	*Artemisia tunuisecta, Carex pachystylus, Hepyricum perforatum.*	35	3

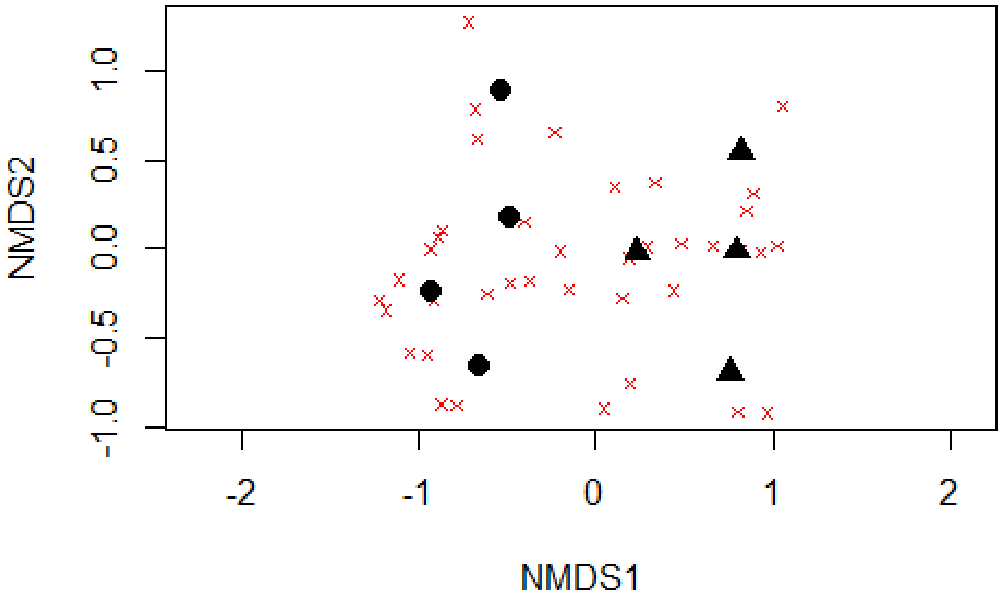


Figure 9. Nonmetric multidimensional scaling (NDMS) showing the vegetative composition of the four populations of *L. proskorjakovii* (circles) and *L. olgae* (triangles) on the Nuratau mountain. Crosses represent different vascular plant species.

3.2 Description of the ontogenetic spectrum of the populations of the focal species

My study has revealed that the studied populations do not span the entire ontogenetic spectrum as there were no plantules, juvenile, immature, or senile individuals. The characteristic spectrum of the populations of *L. proskorjakovii* and *L. olgae* was the centred type, with a peak of the mature generative individuals.

3.2.1. Ontogenetic spectrum of *L. proskorjakovii*

L. proskorjakovii was represented only by generative individuals (there are no young generative individuals in Lp2) (Fig. 10). Virginile plants (individuals) were only found in two populations (Lp 3 and Lp4).

The peak found in the spectra of the studied populations belonged to a group of middle generative plants. In Lp1, the percentage ratio of these age groups was 66.6%, in Lp2 75%, in Lp3 25%, and in Lp4 57.14% (Fig. 10). The absence of a young fraction in the populations and the peak in the middle generative plant range was probably connected with the biology of the species as it has low seed germination, rapid transition to flowering and slowed development of individuals in the mature generative state (Ikramov 1976, Akhmedov et al., 2016)

This species grows on the rock scree. These environmental conditions adversely affect the retention of seeds close to the parenting and their germination. Precipitation in autumn, winter or spring easily washes away the seeds from the scree and, as a result, prevents the plant from establishing and spreading widely. In addition, falling rocks often destroy the young plants.

This study has revealed that the studied populations are reproducing but that not all the ontogenetic stages are represented (Fig. 10).

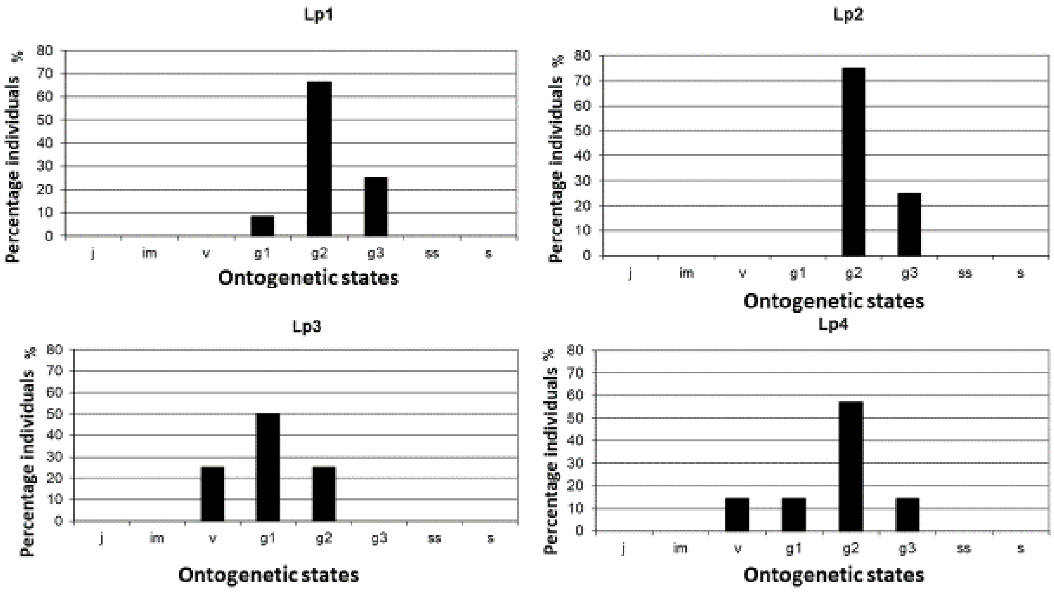


Figure 10. Developmental population spectra of each of the populations *L. proskorjakovii*. *Note*: x—developmental stage, y—distribution of individual by ontogenetic stages, %.

3.2.2. Ontogenetic structure of *L. olgae*

The ontogenetic structure of the populations of *L. olgae* has not previously been studied.

I found that the peak in the spectrum of the studied populations corresponded to a group of middle generative plants. In Lo1, the percentage ratio of these age groups was 60%, in Lo2 85%, in Lo3 93.75%, and in Lo 78.2% (Fig. 11). Proceeding from the ontogeny described, I can assume that the characteristic ontogenetic spectrum of *L. olgae,* should be centred.

Centred spectra, according to Zaugolnova (1994), are formed in caudex herbaceous plants with a long life span of individuals in the middle age ontogenetic stage, with the least elimination of individual plants and difficult germination of seeds. Accumulation of middle generative plants in populations is associated with long-term development and minimal elimination of individuals of this ontogenetic group.

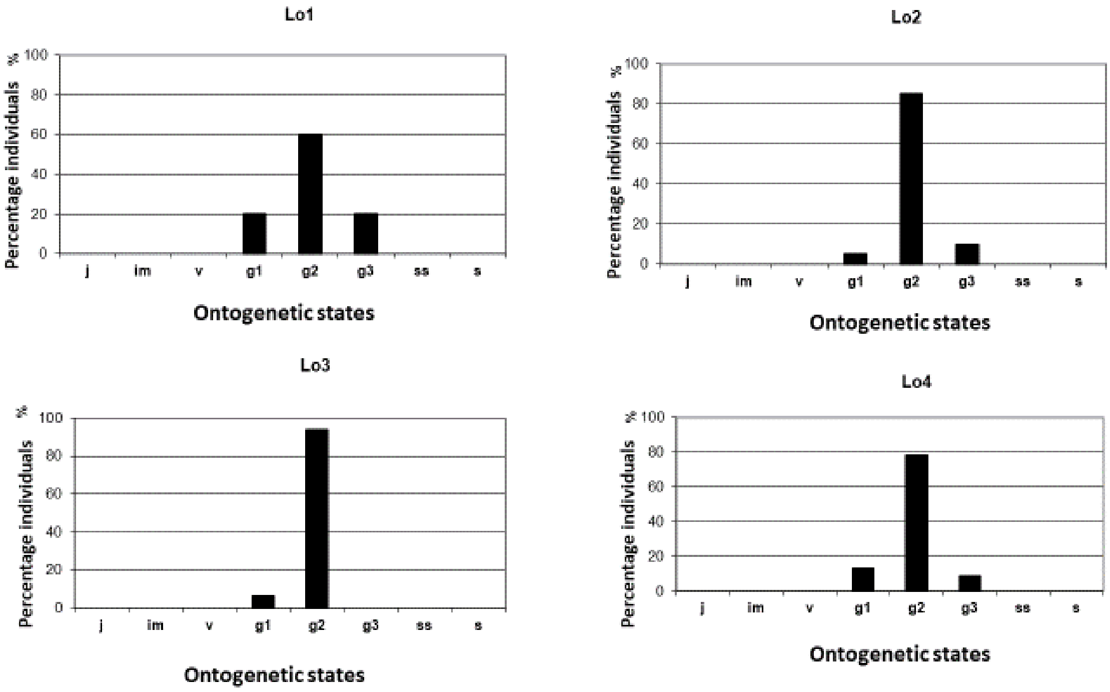
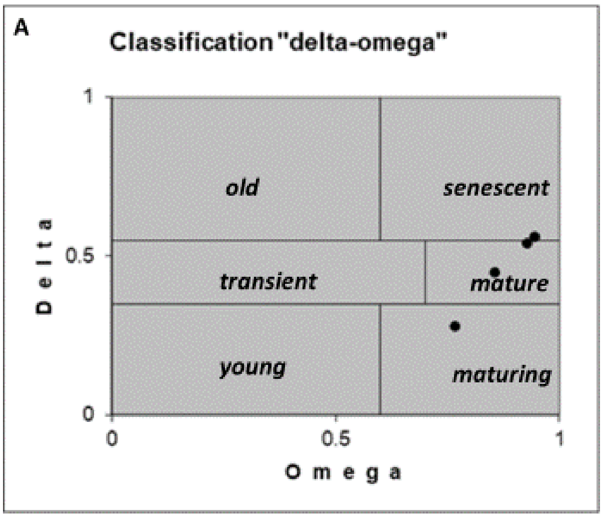


Figure 11. Developmental population spectra of each of the populations *L. olgae*. *Note*: x—developmental stage, y—distribution of individuals by developmental stages, %. stages

3.3 Assessment the population of these species using population traits.

The average density of *L. proskorjakovii* individuals in the four populations varied from 0.35 to 0.6 ind /m^2 (Table 3). According to the classification of Zhivotovsky (2001), Lp1 is mature, Lp2 is senecent, Lp3 is maturing and Lp4 is mature (Fig. 12A, Fig. 13, Table 3).

The density of *L. olgae* individuals in the populations varies depending on the ecological condition. On mountain slopes within the *Amygdallus bucharica, Artemisia tunuisecta, Galium pamiroalaicum, Poa bulbosa* communities (Lp1), with an overall grass cover of 30%, the average density of *L. olgae* was 0.5 ind /m^2, its ecological density was 1.42 and 3.83, respectively, ind /m2 (Table 4). According to the classification of Zhivotovsky (2001), all the examined populations were mature (Fig. 12B, Fig. 14).



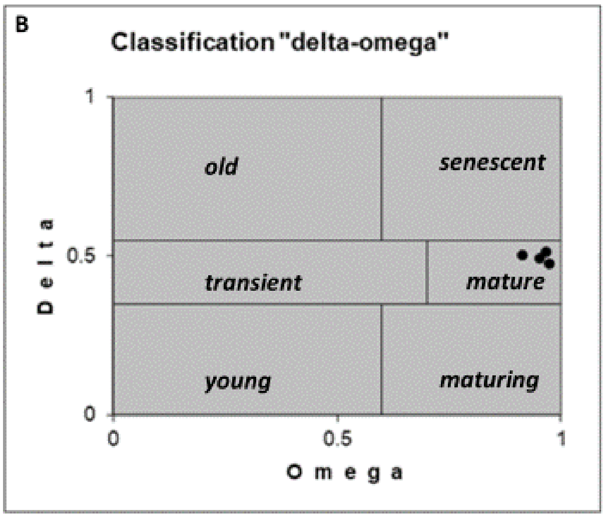


Figure 12. Population types of *L. proskorjakovii* (A), and *L. olgae* (B).

Table 3. Demographic characteristics of the population of *L. proskorjakovii.*

Population	Total number	Average density Individuals /м^2 SE	Ecological density individuals/м^2 SE
Lp1	12	0.6 ± 0.10	1.33 ± 0.01
Lp2	8	0.4 ± 0.1	2 ± 0.10
Lp3	8	0.4 ± 0.08	1 ± 0
Lp4	7	0.35 ± 0.03	1 ± 0.10

Table 4. Demographic characteristics of the population of *L. olgae*

N/ Population	Total number	Average density Individuals /м^2 SE	Ecological density individuals/м^2 SE
Lo1	10	0.5 ± 0.06	1.42 ± 0.029
Lo2	20	1 ± 0.25	1.8 ± 0.026
Lo3	17	0.85 ± 0.32	1.7 ± 0.015
Lo4	46	2.3 ± 0.51	3.83 ± 0.026

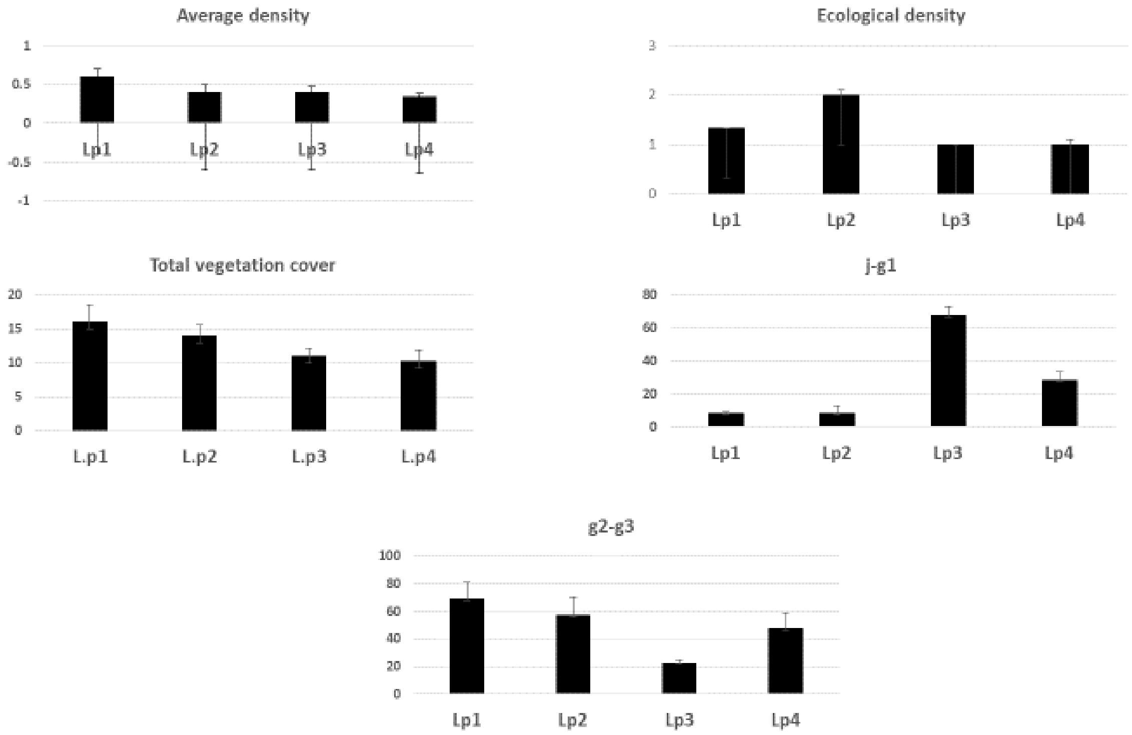


Figure 13. Mean ± standard error of population traits of *L. proskorjakovii* for 2015.

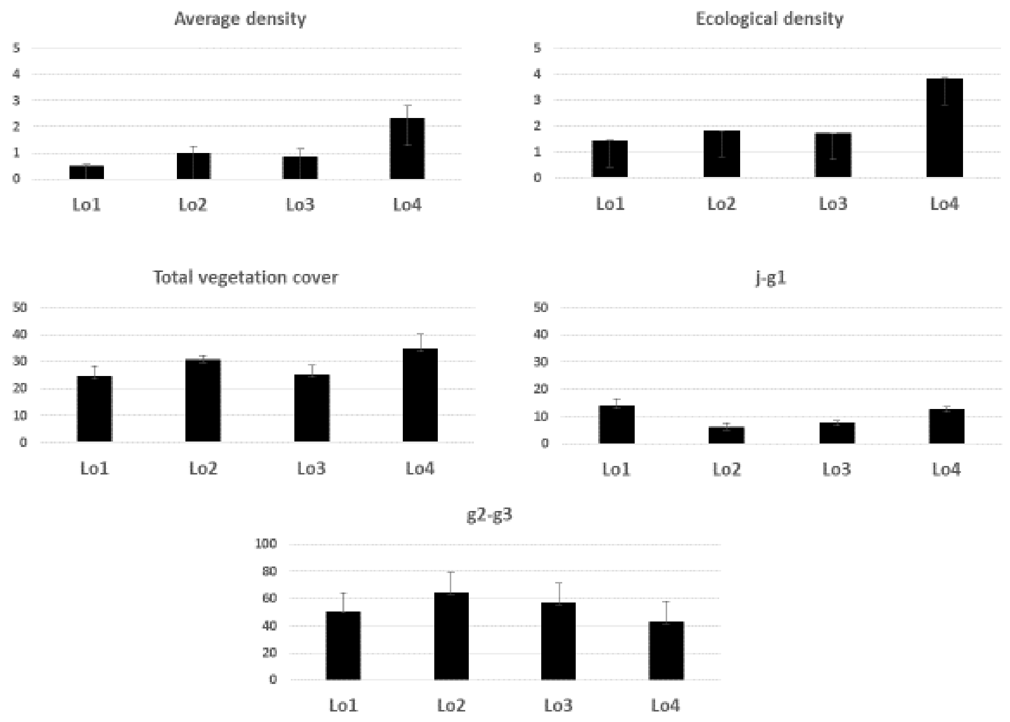


Figure 14. Mean ±standard error of population traits of *L. olgae* for 2015.

4. CONCLUSIONS

During the field research, I studied eight populations of *L. proskorjakovii* and *L. olgae* and identified 173 vascular species in Nuratau Mountain. *L. proskorjakovii* was disappearing and *L. olgae* was very rare in this study area. The small size of the populations of these focal species was unsatisfactory.

The studied revealed that ontogenetic structure was predominantly centred, with most plants in the generative (g2) state because of inadequate water, strong winds and grazing by cattle and sheep. Therefore, for regenerative (young plants) were intolerant for high pressure but g2 was tolerant in this study area.

The investigation indicated that the populations were all in all mature with most plants in the generative state. Mature generative plants were dominated in the populations because g2 was tolerant to abiotic and anthropogenic influences that's why basically populations were mature.

5. RECOMMENDATIONS

My results indicate that these focal species, especially *L. proskorjakovii,* might in the near future become extinct in the wild.

I therefore recommend to the local people and any others that they stop using these Red List species as traditional medicine: herb tea (leaves and flowers of *L. proskorjakovii*) for skin illnesses, stopping bleeding, stomach pain, allergy to dust, and tranquillizers.

L. proskorjakovii is a disappearing species. It is of great economic importance but risking its disappearance in the wild is unconscionable. I have therefore recommended its conservation and cultivation to ecological and botanical scientists, encouraging them to educate the local people as to the danger of exterminating it if they continue to use it for medicinal purposes.

In addition, for restoration and conservation of these species more detailed and in-depth knowledge about them is needed, so I recommend further studies of these species.

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Appendix A. List of species and life forms in each population of L. *proskorjakovii* and L. olgae

		L. proskorjakovii				*L. olgae*			
Species	**Life form**	**Lp1**	**Lp2**	**Lp3**	**Lp4**	**Lo1**	**Lo2**	**Lo3**	**Lo4**
Acer pubescens	Tree		x						
Crataegus pontica	Tree		x						
Amygdallus bucharica	Shrub		x	x	x	x	x	x	
Amygdallus spinosissima	Shrub		x						
Cerasus erytrocarpa	Shrub							x	
Cotoneaster nummularius	Shrub						x		
Ephedra equisetina	Shrub		x	x		x		x	
Lonicera nummulariifolia	Shrub		x	x	x	x	x		
Rosa moracandica	Shrub	x				x			
Atraphaxis virgata	Shrub	x							
Artemisia juncea	Semi-shrub	x	x	x	x				
Artemisia tenuisecta	Semi-shrub					x	x	x	x
Perovskia scrophulariifolia	Semi-shrub	x	x	x				x	
Jurinea kokanica	Semi-shrub	x				x			
Ziziphora clinopodioides	Semi-shrub	x				x		x	x
Ziziphora pedicellata	Semi-shrub		x	x					
Scutellaria ramosissima	Semi-shrub	x							
Astragalus bactrianess	Semi-shrub	x							
Phlomis nubilans	Semi-shrub	x		x	x				
Lagochilus proskorjakovii	Semi-shrub	x	x	x	x				
Lagochilus olgae	Dwarf-shrub					x	x	x	x
Astragalus sp.	Perennial					x			
Astragalus leptostachys.	Perennial						x	x	x
Centaurea squarrosa	Perennial	x	x	x	x				
Bupleurum axaltatum	Perennial	x							
Salvia submutica	Perennial	x							
Echinops nuratavicus	Perennial	x							
Dianthus helenae	Perennial	x	x			x			
Paraeremostachys anisochyla	Perennial	x				x			
Poa relaxa	Perennial	x	x			x			
Eremurus sogdiana	Perennial	x	x						
Eremurus turkestanicus	Perennial						x	x	x
Pseudoclausia olgae	Perennial	x							
Hypericum perforatum	Perennial							x	
Hypericum scabrum	Perennial	x	x	x		x	x	x	x
Tulipa affinis	Perennial						x		
Tulipa turkestanica	Perennial	x					x	x	
Bromus scoparius	Perennial	x	x	x				x	x
Ferula ovina	Perennial	x	x	x		x	x	x	x

Acanthophyllum gypsophylloides	Perennial	x		x					
Silene guntensis	Perennial	x							
Piptathorum sp	Perennial	x							
Stipa hohenackeriana	Perennial	x							
Stipa lipskyi	Perennial	x	x			x			
Oxytropis tachtemis	Perennial	x				x			
Thalictrum isopyroides	Perennial	x					x		
Thalictrum sultanabadense	Perennial						x		
Acroptylon sp	Perennial			x			x	x	x
Poa bulbosa	Perennial			x	x	x		x	x
Lolium perenne	Perennial			x	x				
Bromus danthoniae	Perennial			x	x				
Prangos pobularia	Perennial		x						
Acroptilon repens	Perennial				x				
Elytrigia trichophora	Perennial					x			
Phlomis nubilans	Perennial					x	x	x	
Pseudolinosyris grimmi	Perennial					x			
Pedicularis olgae	Perennial					x			
Aconthalimon tataricus	Perennial					x			
Linaria popovii	Perennial					x			
Galium pamiroalaicum	Perennial					x			
Lophantus schtschurowskianus	Perennial					x			
Juno maracandica	Perennial						x		
Ranunculus mindshelkensis	Perennial						x		
Allium gusaricum	Perennial						x		
Gagea sp.	Perennial						x		
Valeriana chionophila	Perennial						x		
Trichodesma incanum	Perennial						x	x	
Potentilla pamiroalaica	Perennial						x		
Onosma sp.	Perennial							x	
Crambe sp.	Perennial							x	
Biebersteina multifida	Perennial							x	
Carex pachystylus	Perennial								x
Cousenia sp.	Perennial								x
Verbascum sp.	Biennial							x	
Rochelia choridiosepala	Annual					x			
Allyssum desertorum	Annual		x	x	x			x	x
Allyssum marginatum	Annual					x			
Taeniatherum crinitum	Annual			x	x				
Ziziphora tenuior	Annual					x			
Veronica sp.	Annual					x			
Taeniatherum crinitum	Annual							x	x
Silene sp.	Annual						x	x	
Thlaspi perfoliatum	Annual					x			