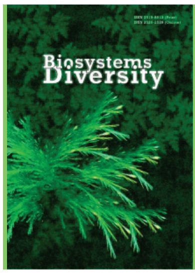

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Ontogenetic structure of cenopopulations of *Allium pskemense* (Amaryllidaceae) in Uzbekistan

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Many plants of the *Allium* genus are economically valuable as vegetables. For example, Asian countries are the largest producers of *Allium pskemense* B. Fedtsch. Ontogenetic spectrum – a sensitive population indicator of changes in the environment – has been noted as useful in recording the age condition of plants. The study focused on the ontogenetic structure of five cenopopulations of *A. pskemense*, revealing that the examined cenopopulations growing in different ecological-coenotic environmental conditions are normal, and mainly incomplete, i.e. do not include all age groups. Their ontogenetic spectrum was left-sided, and only the coenotic populations 2, 4, 5 coincided with the characteristic spectrum. Depending on ecological-phytocoenotic living conditions, density of individuals in the studied communities ranged 1.75 to 4.50 ind./m^2, whereas the ecological density was within 2.00 to 5.29 ind./m^2. The research determined that the ontogenetic spectrum shifted to the centered type temporarily due to the uneven processes of the development. Similarities of biological features (long mature generative condition, prevalence of mode of reproduction by seeds, low viability of young individuals) of individuals of this species in various locations, type of cenopopulation, characteristic actual ontogenetic spectra indicate stable conditions for the studied CPs in forbs-Ziziphora-shrub (cenopopulation 5) communities in Uzbekistan.

Keywords: food; endemic; effective density; demographics; age structure; Tian Shan.

Introduction

Due to the growing anthropogenic impact on the ecosystem, there is a need of conducting studies to identify and preserve biological diversity. Great attention needs to be paid to rare communities and species inside them, and also species growing at the border of their ranges (Zaugolnova, 1994). Ontogenetic structure is one of significant parameters of population; this side of the structural organization provides the ability of a population system to support itself and determines its resistance. Analysis of ontogenetic structure of plants provides knowledge of the further state of populations of species (Osmonova & Zhivotovsky, 2020). Studies oriented at evaluating current statuses of plant populations, preserving them in different conditions *in situ*, *ex situ*, *quansi in situ*, providing stability of populations of rare species, composing lists of them and preserving species whose natural ranges are contracting as a result of various factors, are conducted by scientists of many scientific institutions all around the world (Volis et al., 2010; Yang, 2013; Li et al., 2015). Evaluation of current statuses of populations based on the population-ontogenetic approach is of great value for solving tasks of rational use, preservation, reproduction and support of populations (Smirnova et al., 1976). Currently, the population-ontogenetic method of studies in botany and ecology has become broadly implemented, since it based not only on visual evaluations, but takes into account different parameters that characterize the development of plants in the conditions of a plant community. In particular, an important feature of each cenopopulation is its ontogenetic spectrum (distribution of individuals by ontogenetic conditions) (Osmonova & Zhivotovsky, 2020).

Currently, the problem of rational use of natural resources and preservation of their biodiversity can be solved based on detailed studies of biology of species and peculiarities of their population organization in different-type conenoses.

Allium L. is one of the largest genera of the Amaryllidaceae family, comprising around 1,100 species, distributed all around the globe (Li et al., 2010; Govaerts et al., 2021). The primary center of evolution of the genus spans across Iran-Turan biogeographic region, and Mediterranean basin and the western part of North America are considered as secondary centers of biodiversity (Friesen et al., 2006). Currently, the problem of sustainable use of natural resources and preservation of their biodiversity may be solved based on detailed studies of biology of species and peculiarities of their population organization in coenenoses of various types (Zhijie et al., 2019; Kik et al., 2021). Among wild-growing medicinal plants, special place belongs to *Allium* L. of Amaryllidaceae family, which unites perennial and biennial plants with bulbs and rhizomes with a specific strong smell and taste. Central Asia is one of the largest centers of contemporary diversity of species and forms of wild-growing onion (Yusupov et al., 2020; Pandey et al., 2021). All species of the genus are of great agricultural interest as ornamental, edible, vitamin-containing and honey-bearing, medicinal and fodder plants (Yousaf et al., 2004, 2012; Ding et al., 2016).

Since Ancient Times, the peoples of the Central Asia have been consuming wild onions that are broadly distributed in almost all altitude belts – beginning from the hot Kyzylkum and Karakum deserts to the high Tian Shan and Pamir-Alay mountains. The conducted studies indicated that the population of the Central Asia has been using only some species, including *Allium pskemense*, *A. suworowii*, garlic, *A. oschaninii*, and others (Alekseeva et al., 2016). The first reports about using onions dates back 6 thou years (Block, 2010; Iksanova & Xovrin, 2011). In many countries, 6 species of onion are cultivated. However, which of the 6 species of section *Phyllodolon* Prokh. growing in natural conditions of Central Asia and Iran is the closest wild relative of the cultivated bulb onion (*Allium cepa* L.) is still a subject of discussion (Gurushidze, 2007). In the mountains of the Western Tian Shan, locals of Uzbekistan, Kazakhstan and Kyrgyzstan value one of the closest relatives of cultivated onion – *Allium pskemense* B. Fedtsch. Comparative analysis of wild *Phyllodolon* Prakh. species included in the section revealed that according to many morphologic-biologic features the closest species to the cultivated onion is *A. pskemense*. As is known, the onion has a complex of advantages – valuable nutrients, vitamins, honey, medicinal and technical properties and is used as ornamental plant (Sharifi-Rad et al., 2016). Since the old times, the onion has been prepared by locals, leading to significant exhaustion of its reserves in the wild (Baytulin et al., 2012). Traditional utilization of *A. pskemense* as an edible plant has reduced its resources in Uzbekistan. Bulbs of *A. pskemense* have a strong and sharp smell and taste and the green plants have a good taste (Bukharov et al., 2018). It belongs to sharp onions. In the national cuisine of the Kazakhs, the Kyrgyz, Uzbek, and Tajikistan Peoples, it is most often marinated (Baytulin et al., 2012). Characteristic of cenopopulations of *A. pskemense* give grounds to evaluate the current status of natural populations and predict their following development.

In CIS countries (Ukraine, Russia, Uzbekistan, Kazakhstan), the current status of cenopopulations according to organism and population features were evaluated in the studies by Cheryomushkina (2004), Cheryomushkina et al. (2021), Kovalenko et al. (2017, 2019), Rakhimova et al. (2020), Shomurodov et al. (2021) and others.

The objective of our work was to study the ontogenetic structure of cenopopulations of *A. pskemense* in the territory of Uzbekistan. The cenopopulations grow at the height of 1,511–2,051 m above sea level (Fig. 1).

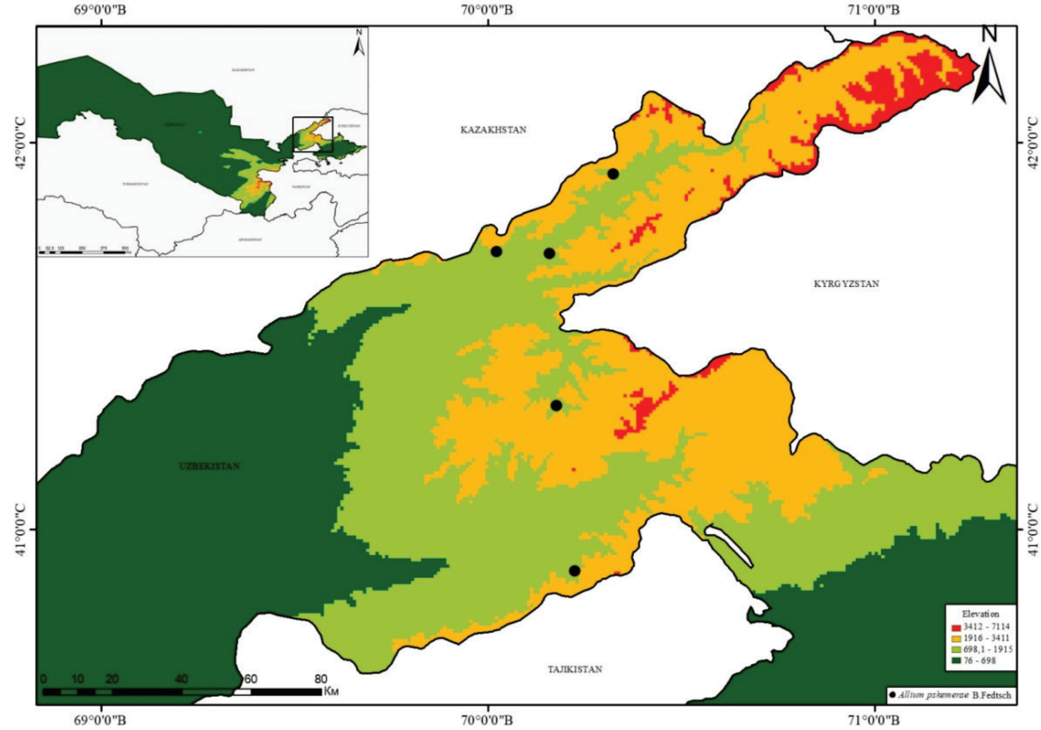

Fig. 1. Study area

Materials and methods

Allium pskemense is a perennial herbaceous rhizome-bulb plant. Bulbs come singular or in pairs, elongated-ovoid, on short rhizome, 4–6 cm wide, with red-brown thin skinlike integral membranes. The stem is thick, 50–100 (120) cm high, hollow, gently-swollen below the middle, gradually narrowed toward the top, and bears membranous sheaths at the base. Two-(three) cylindrical leaves, gradually narrowing toward the apex, tube-like, straight, 2–3 (3.5) cm wide, 2 (3) times shorter than the stem. The umbel is ball-like, dense, multiflorous. It has to be noted that this species has very important biologic properties, lasting from early spring to late autumn, and has large bulbs. It grows in cracks in rocks and stony places (Vvedensky, 1935, 1941). It was described in 1905 by B. Fedchenko. Type: Uzbekistan, the valley of Pskem River near Pskem qishlaq, 09.08.1897). Endemic to the western Tian Shan (Sennikov et al., 2016).

A. pskemense is included in the Red Book of Uzbekistan as rare species for the Republic with fragmented range (Khassanov, 2019). *A. pskemense* mainly occurs in forb communities. The status of *A. pskemense* in the studied areas varies and to a high degree depends on orthography, abiotic and anthropogenic factors. It is a typical petrophyte. However, despite that, it grows in small groups on moister north and northeast slopes. *A. pskemense* is distinct for its tolerance to drought and freezing conditions, high adaptability to soil conditions and resistance to diseases. However, the seeds of this onion often become infested by pests (Pratov & Yuldashev, 2009).

The onions occupy a variety of positions in the phytocoenosis. They can dominate or be subordinate in a phytocoenosis (Cheremushkina, 2004). Geobotanic descriptions were made for all the communities where the population structure of species had been studied according to the generally accepted methods on 100 m^2 plots (Lavrenko & Korchagin, 1964). The ontogenetic structure of cenopopulation employed was studied using generally accepted methods (Uranov, 1975; Smirnova et al., 1976; Zhivotovsky, 2001; Zlobin et al., 2013). Transects measuring 1 m in width and 5–10 m in length were divided into test plots of 1 m^2 where the ontogenetic status of every individual was assessed.

To determine the ontogenetic status of the species, we used herbarium samples collected during the field studies and the results of previous studies of this species. Ontogenetic spectrum of the cenopopulations (henceforth CPs) was determined as the ratio of plants of different ontogenetic status, expressed as a percentage of the overall number of individuals (Smirnova et al., 1976).

We characterized the population structure based on the knowledge of the characteristic ontogenetic spectrum (Zaugolnova, 1994). According to the pattern of distribution of ontogenetic groups, 4 types of the spectrum are distinguished: left-sided, centered, right-sided and biomodal. The characteristic spectrum depends on biological specifics of the species. Characteristic type of CP range was determined according to Zaugolnova (1994). To characterize the CPs, we used demographic parameters of indices of age and efficiency (Uranov, 1975; Zhivotovsky, 2001). They were analyzed in Delta-Omega software, kindly provided by L. A. Zhyvotovsky. The type of cenopopulation was determined according to Delta-Omega classification of Zhyvotovsky (2001). Delta (Δ) is age index (Uranov, 1975) that is used to evaluate the age level of a cenopopulation at each moment of time, and omega (ω) reflects the efficiency of plant of i-genetic condition (value of "pressure" on energy resources of the environment, expressed in shares of pressure imposed by plants of middle-age generative status). According to the classification data, a cenopopulation may be young, mature, intermediate, ageing and old.

Density of populations was determined by the number of individuals per unit area (Smirnova et al., 1976). At the same time, special attention was paid to the parameters of average density, i.e. number of individuals per unit of space (overall space), and ecological density – number per unit of inhabited space, which can be practically taken by a population (Odum, 1986).

Results

The studies were carried out in 2019–2021, in the territory of Uzbekistan. We studied 5 cenopopulations (CP) of *A. pskemense*.

The first cenopopulation was found near Lashkerek – a mountain qishlaq in the ravine of the Say of the same name – the left tributary of the Ohangaron, which starts from the western slopes of the Qurama Range (40.892602 N, 70.223536 E, h = 1917). Herbaceous cover of the area comprises forb-juniper forests. Projective cover of the grass stand where the studied cenopopulation grows was 55–60%, the share of the studied species in it accounted for 2%. Botanical composition comprised 28 species of vascular plants, where perennials dominated.

The next cenopopulation was distinguished near Sijjak village. Sijjak is in the valley of mountain river Pskem, its right-bank part, hemmed in by the Ugam Range. Currently, Sijjak is in the northwest bank of the Charvak water reservoir (41.718108 N, 70.021405 E, h = 1712). Herbaceous cover is composed of forb-shrub communities. General projective cover of the grass stand was 45–50%, and projective cover of *A. pskemense* did not exceed 1%. In herbaceous cover, 26 species of vascular plants were recorded.

The third cenopopulation was recorded near the Lake Kichik Urung'och of the National Forestry Burchmullo (41.920277 N, 70.324371 E, h = 1511). Herbaceous cover comprised forb-tree communities. Projective cover was around 65–70%, the share of the studied species in it was 1%. Botanical composition of the community was 29 species of flowering plants.

The fourth cenopopulation was found in the upper part of Nanai village of Bo'stonliq District, which is on the left bank of the Pskem River (41.714071 N, 70.159656 E, h = 2051). Herbaceous cover comprised forb-shrub communities. Projective cover of the grass stand was 55–60%, including the studied species accounting for 1% share. Floristic composition was 31 species of flowering plants.

The fifth cenopopulation was distinguished in the territory of Zindan Say of the Ugom-Chatqol National Natural Park (41.319733 N, 70.176887 E, h = 1528); the herbaceous cover of the district comprised forb-Ziziphora-shrub communities. The general projective cover of the grass stand was 40–45%. The botanical composition of the community included 27 flowering plants. Most *A. pskemense* individuals were found in this particular cenopopulation, accounting for 3% (Table 1).

We carried out analysis of higher plants in 5 cenopopulations. Species composition of the community was 71 species, including trees – 6, shrubs – 7, subshrubs – 2, perennials – 49, biennials – 2 and annuals – 5 (Table 2).

Table 1
Characteristics of cenopopulations of *Allium pskemense*

No.	Locations of cenopopulations	Community / dominating species	Species composition	Overall projective cover, %	Projective cover of species, %
1	Qurama Range, Lashkerek mountain qishlaq (h 1,917 m above sea level)	forbs-juniper forests	28	55–60	2
2	Valley of the Pskem River, Sijjak village (h 1,712 m above sea level)	forbs-Artemisia-shrub	26	45–50	1
3	Ugom-chatqol range, Nephrite Lakes, (h 1,511 m above sea level).	forbs in forests	29	65–70	1
4	Left bank of the Pskem river, upper part of Nanay qishlaq (h 26051 m above sea level)	forbs-shrubs	31	55–60	1
5	Ugom-chatqol, Zindan Say (h 1,528 m above sea level).	forbs-*Ziziphora*-shrub	27	40–45	3

Note: h – height above sea level.

Pskem onions start growing in early spring after the snow melts. Total life expectancy of *A. pskemense* in the wild is 20–25 years. In more favourable conditions, individuals blossom on 4–5th year of vegetation, and in drier locations the blossoming begins in 7–8th year of life of the plants. Seeds germinate in early spring, late February and early March. The plant germinates above ground. The seedling bears 1 or 2 leaves. The leaf is 0.5–0.6 and 0.2–0.3 cm wide. The length of the main root is up to 0.5 cm. The bulb does not form. After the cotyledon dies, the plant becomes juvenile. Juvenile stage lasts for 4–5 years. Juvenile individuals bear 2–3 leaves. The plant is 16–17 cm high. The bulb is poorly distinct. The bulb is covered by remains of leaf sheaths, and becomes membranous the following year. The main root dies off. Immature stage begins after gradual death of leaves, the underground part of the growing monopodial ramified shoot forms a vertical hypogean rhizome. In virginile plants, the primary shoot ramifies. Bulbs form with their own rhizome system.

First the parent shoot begins blossoming, then the oldest daughter stem. Length of generative shoot is 60–70 cm. After scapes and leaves die off, individuals grow sympodially. Each year, after ramification, loose sod forms. Young generative plants have a dense sod and 3–4 daughter bulbs form. Length of bulb is 0.3–0.4 cm, the width is 0.2–0.3 cm. In middle-aged generative condition, the height of the plant is around 4.5 cm. In this ontogenetic condition, the sod begins to divide into 2–4 ramified stolons. In each grass, there are 2–3 bulbs. In large grasses, 23–29 shoots develop. Individuals have ramified stolons that can exist for no less than 13–15 years. In old generative condition, the turf starts to decay. The bulbs die, and then the stolons die off as well. The dead remains stay in the soil. In senile condition, plants are single shoot. On rosette shoot, 1–2 leaves of juvenile type unfold.

The ontogenetic structure of cenopopulations of *A. pskemense* in Uzbekistan has not been studied earlier. Ontogenetic spectrum of the species was studied in 2006–2016 by Cheremushkina and others in the basins of the Aksu River in the State National Aksu-Zhabagly Nature Reserve (Kazakhstan). They found only one cenopopulation of the species. The characteristic spectrum of the species was left-sided. There were two types of ontogenetic structure of the studied cenopopulations of *A. pskemense*: centered (cenopopulations 1, 3) and left-sided (cenopopulations 2, 4, 5). Inferring from the species' biology, the characteristic ontogenetic spectrum of cenopopulations of this species would be left-sided type peaking with pre-generative individuals (Fig. 2).

Cenopopulations of left-sided type of the spectrum. Left-sided spectra are one- or two-peaked. Ratio of individuals of various age conditions in the left side of the spectrum varied. According to Zaugolnov (1994), ontogenetic spectra of left-side type are quite dynamic by ratio of ontogenic groups: position of absolute maximum may change (j, im, v, g_1), and local maxima in the spectrum occur. Those changes are caused by non-uniform seed reproduction. Fast rates of pre-generative period, and also longevity of ageing processes, first of all, cause concentration of old individuals in cenopopulations.

The high numbers of virginile individuals are explained by the long life expectancy of plants in this ontogenetic condition compared with the rest of the pre-generative groups. For cenopopulation 2, absolute values were seen for juvenile individuals (51.6%). This variant of the spectrum is formed during abundant bulb-bearing and in places with regular precipitations. Drastic decrease in the number of immature individuals in forb-*Artemisia*-shrub community is associated with loss of fragile plants as a result of trampling by cattle.

In cenopopulation 4, absolute values were seen for virginile individuals (49.7%). Ontogenetic spectrum for cenopopulation 5 is two-peaked. Peaks occur for juvenile (24.4%) and virginile individuals (26.6%). The high share of virginile individuals in this cenopopulation is related to effective seed reproduction, as well as with longer life expectancy of this ontogenetic condition in drier locations. Furthermore, the described cenopopulation was located on pebbled soil of southern bank of the Zindan Say (Ugom-Chatqol Range). Year-round regular pasturing of cattle impedes free development of young seedlings. This is also indicated by absence of juvenile and immature individuals in 4 cenopopulations.

Table 2
Characteristics of herbaceous communities with *Allium pskemense*

Plant names	Species abundance, %					
	life form	1	2	3	4	5
Juniperus seravschanica Kom.	tree	25	1	+	-	+
Malus domestica (Suckow) Borkh.	tree	-	-	25	-	+
Crataegus chlorocarpa Lennaeus & K. Koch	tree	-	-	10	-	-
C.pontica K. Koch	tree	3	-	-	2	-
Juglans regia L.	tree	-	+	-	-	1
Pyrus asiae-mediae (Popov) Maleev	tree	-	-	3	-	-
Atraphaxis pyrifolia Bunge	shrub	-	10	-	15	-
Rosa achburensis Chrshan.	shrub	1	-	-	-	8
R.webbiana Wall. ex Royle	shrub	-	2	-	8	-
Lonicera humilis Kar. & Kir.	shrub	-	3	1	-	-
Rubus caesius L.	shrub	-	-	-	4	-
Spiraea pilosa Franch.	shrub	+	-	-	1	-
S. hypericifolia L.	shrub	+	-	-	-	3
Ziziphora pedicellata Pazij & Vved.	subshrub	2	-	+	-	12
Artemisia oliveriana J.Gay ex Besser	subshrub	+	15	3	-	-
Hypericum scabrum L.	perennial	3	-	1	-	1
Hordeum bulbosum L.	perennial	3	-	5	-	-
Allium pskemense B.Fedtsch.	perennial	2	1	1	1	3
Convolvulus pseudocantabrica Schrenk	perennial	1	-	-	-	-
Prangos fedtschenkoi (Regel & Schmalh.) Korovin	perennial	2	-	2	-	-
Eremurus turkestanicus Regel	perennial	3	-	+	-	-
Eremurus sp.	perennial	-	2	+	-	+
Allium sp.	perennial	+	-	+	2	+
Helichrysum maracandicum Popov ex Kirp.	perennial	1	-	-	-	-
Tulipa bifloriformis Vved.	perennial	2	-	1	-	1
T.dasystemon (Regel) Regel	perennial	-	-	-	-	+
T.dubia Vved.	perennial	+	-	-	-	-
T.vvedenskyi Botschantz.	perennial	-	-	-	-	1
Inula grandis Schrenk	perennial	4	-	2	+	-
Origanum tyttanthum Gontsch.	perennial	1	3	+	+	2
Poa sp.	perennial	+	-	+	-	-
Salvia sclarea L.	perennial	-	-	2	-	-
Corydalis darwasica Regel ex Prain	perennial	-	+	-	3	-
Stellaria graminea L.	perennial	-	+	-	-	-
Rumex acetosa L.	perennial	-	2	3	+	-
Koenigia coriaria (Grig.) T. M. Schust. & Reveal	perennial	-	+	-	-	1
Monotropa hypopitys L.	perennial	-	-	-	+	-
Urtica dioica L.	perennial	1	+	-	1	-
Trigonella adscendens (Nevski) Afan. & Gontsch.	perennial	-	-	-	+	-
Medicago lessingii Fisch. & C.A.Mey. ex Kar.	perennial	-	1	-	1	-
Astragalus abolinii Popov	perennial	-	-	1	-	-
A.angreni Lipsky	perennial	+	-	-	-	-
A.olgae Bunge	perennial	-	+	-	-	-
Oxytropis albovillosa B.Fedtsch.	perennial	-	+	1	-	-
O.aulieatensis Vved.	perennial	-	-	-	2	1
Hedysarum angrenicum Korotkova	perennial	+	-	-	-	-
Onobrychis chorassanica Bunge ex Boiss.	perennial	-	+	-	+	3
Dictamnus albus L.	perennial	+	-	-	2	-
Biebersteinia multifida DC.	perennial	-	-	-	2	-
Bupleurum exaltatum M.Bieb.	perennial	-	1	-	-	+
Seseli calycinum (Korovin) Pimenov & Sdob.	perennial	-	-	-	-	+
Mediasia macrophylla (Regel & Schmalh.) Pimenov	perennial	+	-	-	4	2
Ferula angreni Korovin	perennial	1	-	-	-	-
Morina kokanica Regel	perennial	-	2	4	3	-
Calystegia sepium (L.) R.Br.	perennial	+	-	-	-	-
Phlomoides ebracteolata (Popov) Adylov, Kamelin & Makhm.	perennial	+	-	-	-	-
Lamium album L.	perennial	-	1	-	1	1
Betonica betoniciflora (Rupr. ex O. Fedtsch. & B. Fedtsch.) Sennikov	perennial	-	-	1	+	-
Melissa officinalis L.	perennial	-	-	2	1	-
Ixiolirion tataricum (Pall.) Schult. & Schult.f.	perennial	-	1	+	-	2
Allium atrosanguineum var. *fedschenkoanum* (Regel) G. H. Zhu & Turland	perennial	-	-	-	2	-
Calamagrostis alajica Litv.	perennial	-	-	+	-	-
Poa alpina L.	perennial	+	-	-	1	2
Heracleum lehmannianum Bunge	perennial	-	-	1	+	-
Tragopogon capitatus S. A. Nikitin	biennial	-	+	-	-	1
Erigeron acris L.	biennial	-	-	-	2	-
Papaver pavoninum Schrenk	annual	-	1	-	+	-
Asperuginoides axillaris (Boiss. & Hohen.) Rauschert	annual	-	-	-	1	-
Capsella bursa-pastoris (L.) Medik.	annual	-	1	-	+	+
Geranium divaricatum Ehrh.	annual	-	1	+	-	1
Vicia sativa subsp. *nigra* Ehrh.	annual	-	-	+	-	1

In left-sided cenopopulations, immature individuals accounted for 6.4–17.7% and in four cenopopulations, immature individuals were almost absent. Of all the studied cenopopulations, only the fifth cenopopulation was complete, comprising all age groups, indicating a uniform course of longer life cycle of plants. Centered spectrum is a spectrum where the maximum is observed (cenopopulation 1, 3) for middle-aged generative plants (g_2). In those cenopopulations, the share of total generative individuals equaled 58.5–72.9%. This is related to gradual increase in life expectancy of individuals in the generative period and highest rate of elimination of juvenile and immature individuals, which depend on weather conditions and phyto-coenotypic environment. Cenopopulations 1 and 3 were incomplete, absence of juvenile individuals in this cenopopulation was associated with weather variability affecting the germination.

The latter is likely associated with intense cattle grazing, because the cenopopulation grows near inhabited settlements, the inhabitants of which are usually graze their cattle in the area. The second important reason for the absence of juvenile individuals in the cenopopulation is desiccation and their being blown away by the wind during the study period, as is often seen in desert conditions. In the spectrum, a gradual increase was seen in the share of a certain ontogenetic group compared with the previous, which is likely associated with increase in life expectancy of plants living in the following conditions and decrease in mortality of individuals. The ontogenetic spectra of cenopopulations (cenopopulations 1, 3) do not coincide with the characteristic one. Absence of juveniles is an artifact. The latter was associated with the late period of the vegetative season during which we were collecting material, when juvenile plants were dormant and were impossible to find without thorough excavations. On the one hand, it was related to precipitations that wash young fragile individuals off during spring and intense grazing, and on the other hand – irregularity of seed reproduction. This species is known to be broadly used by the locals as an edible plant. This does not allow the plants to develop potential seeds every year. In those cenopopulations, germination of the individuals living in tree and shrub communities is not always successful (Fig. 2).

Discussion

Relatively high projective cover and shading because of dense overgrowing by high shrubs and subshrubs would significantly improve the germination of seeds and survivability of young fragile individuals. The small amount of senile individuals in the cenopopulations is explained by many biotic and abiotic factors. Minimum values of post-generative fraction (ss) are related to fast rates of ontogenesis in old generative ontogenetic condition and mortality of individuals. The share of senile individuals did not exceed 8.1%. The greatest share of senile individuals was recorded in cenopopulation 3. Low parameters in ontogenetic range of senile individuals are among the biological peculiarities of onions.

Comparing *A. pskemense* cenopopulations in different ecological-geographic living conditions revealed that averaged range was centered, double-peak with high share of virginile and generative (g_2) individuals. The averaged ontogenetic range does not correspond to the characteristic. This is explained by the high extent of elimination of young fragile individuals as a result of temporary watercourses. Another important factor in the low share of young individuals in the studied cenopopulations is intense cattle grazing. Because of the broad spread of ephemeral and ephemeroid plants, actively consumed by all kinds of cattle, local cattle farmers actively use highland pastures in early spring for cattle grazing. This affects the structures of populations of early-vegetating plants, including *A. pskemense*. Another reason for the biomodality of averaged ontogenetic spectrum of *A. pskemense* is their germination in large stones in stoney-detritus soils. Germination rate of seeds in such conditions is not always successful (Fig. 3). Density of individuals in cenopopulations was analyzed for their multi-year dynamics. Depending on ecological-phytocoenotic living conditions, population density in the studied communities varied 1.40 to 4.50 ind./m^2, and ecological density – 1.75 to 5.29 ind./m^2. Comparative analysis of the parameters of the general number of individuals and their density revealed that those parameters were high in the Zindan Say population (cenopopulation 5) compared with Urung'och (cenopopulation 3) and Nanai (cenopopulation 4). Effectively density of the population was 0.57 to 1.75 (Table 3).

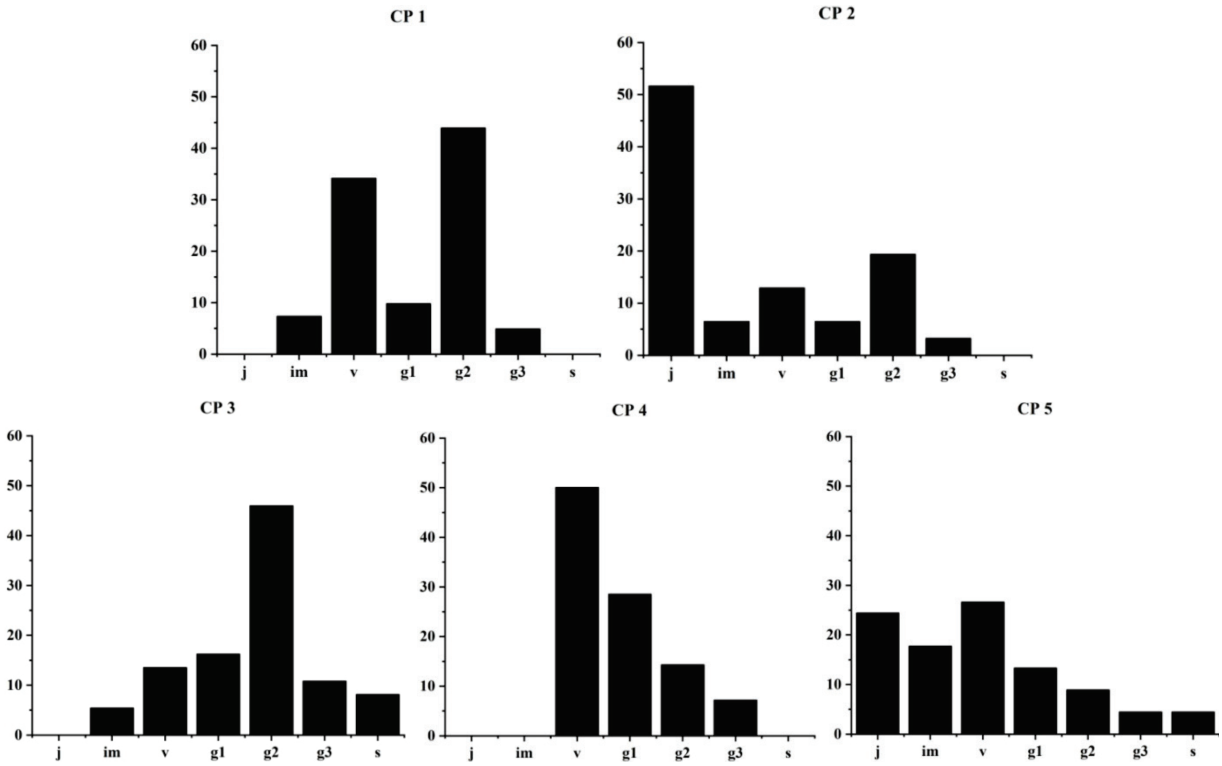

Fig. 2. Ontogenetic spectra of *Allium pskemense* cenopopulations

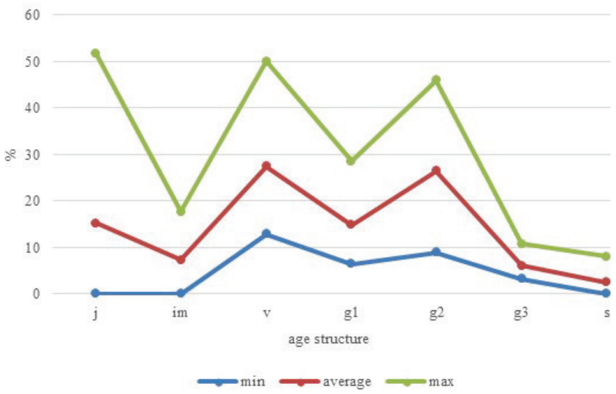

Fig. 3. Averaged ontogenetic spectrum of *Allium pskemense*: on abscissa axis – age conditions, on ordinate axis – age spectrum (%)

We also compared indices of recreation (I_b) and aging (I_c), reflecting dynamic processes in cenopopulation. In the cenopopulations, the index of recreation was 0.36 to 2.69. The ageing index in all cenopopulations was close to zero, due to the fact that most individuals die in old generative condition. A similar biological peculiarity is characteristic for most onion plants (Baranova, 1999).

Ontogenetic structure was evaluated by Uranov (1975) who proposed age index "delta" (Δ). This parameter is based on an account of energy metabolized by the plant by the start of the next ontogenetic condition. At the same time, "weight" is the share of each ontogenetic condition. In 2001, L. A. Zhyvotovsky added omega (ω) to this evaluation, which may be considered as mean energy effectiveness or energy pressure on the environment imposed by an "ordinary" plant. Comparison of two indexes led to development of delta-omega classification that allowed – based on two-dimensional approach – one to divide cenopopulations into young, adult, and old. This classification corresponds to the criterion of absolute maximum in case of single-peaked ontogenetic distributions. Furthermore, delta-omega classification takes into account the case of formation of two maxima in the studied cenopopulation, and therefore, distinguishes a new type of cenopopulation – transitional. A distinctive feature of such cenopopulations is simultaneous presence of significant share of young (younger g_2), as well as old (older g_3) plants. However, this principle of classification does not allow one to determine the subsequent fate of transitional cenopopulations, specifically – directions toward becoming younger or ageing.

Evaluation of age (Δ – delta) and efficiency (ω – omega) of cenopopulations revealed that the studied cenopopulations were maturing (cenopopulations 1, 4), young (cenopopulations 2, 5) and mature (cenopopulation 3, Fig. 4).

Table 3
Demographic characteristics of Allium pskemense cenopopulation

No.	Demographic parameters								Types of cenopopulations
	I_b	I_c	Δ	ω	P_{ecol} ind./m^2	density ind./m^2	effective density, ind./m^2	overall number of individuals	
1	1.13	0	0.32	0.71	2.41	2.05	1.40	41 ± 0.48	maturing
2	0.40	0	0.16	0.37	1.93	1.55	0.57	31 ± 0.61	young
3	2.69	0.08	0.44	0.75	2.05	1.85	1.38	37 ± 0.73	mature
4	0.99	0	0.26	0.63	1.75	1.40	0.88	28 ± 0.81	maturing
5	0.36	0.04	0.19	0.39	5.29	4.50	1.75	90 ± 1.91	young

Note: I_b – restoration index; I_c – ageing index; I_{ecol} – Δ – age index; ω – efficiency index, P_{ecol} – ecological density.

Most young cenopopulations were confined to different substrates, but communities in which they were studied are subject to heavy grazing. Maturing and mature cenopopulations were small, mainly confined to stoney-detritus substrate with average to poor anthropogenic pressure. In the recorded cenopopulations, no transitional populations were found, as well as ageing and old cenopopulations. Absence of ageing and old cenopopulations, was, first of all, due to low parameters of the share of senile individuals. In summer, onions of plants are collected by the locals, preventing plants entering the senile stage.

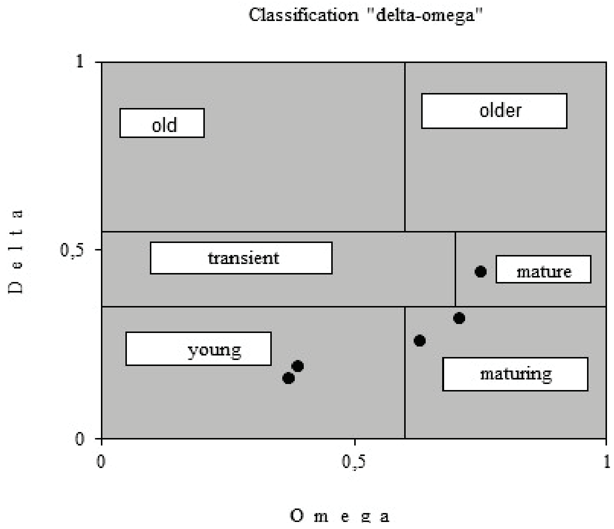

Fig. 4. Types of cenopopulations of *Allium pskemense* according to the "Delta-Omega" classification

Conclusion

The conducted study of 5 cenopopulations of the rare species *A. pskemense* revealed that the status of the populations is satisfactory. The study indicated that in different ecological-coenotypical living conditions, the examined populations were normal, mostly incomplete. Individuals do not undergo all the stages of ontogenesis and are in the worst conditions. Absence of certain ontogenetic groups in cenopopulations was related to ecological-phytocenotic condition of germination and cattle grazing level. Absence of senile age groups in certain cases is explained by species' biology and successional conditions of cenopopulations. The spectra of some of the populations (with centered spectrum) did not coincide with the characteristic one. Prevalence of pre-generative individuals in them determines the examined cenopopulations as young. This was indicated by restoration index. In most of the examined cenopopulations, higher values (in some cases over 2.69) indicated successful seed replenishment of *A. pskemense*. The almost zero values of ageing index are explained by loss of most individuals in the generative period of ontogenesis. Overall density in the cenopopulations of *A. pskemense* varied 28 to 90 individuals. Mean density was 1.75 to 4.50 ind./m^2, and ecological density equaled 2.00–5.29 ind./m^2. Status of *A. pskemense* in the examined districts varied and largely depended on orography, abiotic and anthropogenic factors. It is a typical petrophyte. However, despite this fact, they occur in small groups on more humid north and northeast slopes.

Therefore, for the study object, the demographic characteristics of cenopopulations (number and density of individuals) depended on many factors, including: peculiarities of species' biology, life form of plants and way of reproduction, types of self-support of cenopopulations, ecological-phytocoenotic environment and height above sea level, presence of anthropogenic pressure, vital strategy of species and its competitiveness. Maps have been created that depict the spread of cenopopulations, which we can recommend as initial materials for performing long-term monitoring studies of the status of the examined cenopopulations. Thus, the study indicated that anthropogenic factors decreased the number and range of *A. pskemense*. Therefore, serious measures should be taken to preserve the natural thickets.

In the territory of Tashkent Botanical Garden named after F. Rusanov in *ex situ* conditions, a collection of the gene fund of natural populations of *A. pskemense* has been made.

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