Pak. J. Bot., 54(1): 205-213, 2022. DOI: http://dx.doi.org/10.30848/PJB2022-1(11)

CURRENT STATE OF POPULATIONS AND ONTOGENESIS OF *ALLIUM ALTAICUM* PALL. (AMARYLLIDACEAE) IN KAZAKHSTAN

KUBENTAYEV SERIK ARGYNBECOVICH[1], KOTUKHOV YURI ANDREEVICH[2], MUKHTUBAEVA SAULE KAKIMZHANOVNA[1], KUBENTAYEVA BALSULU BULATBEKOVNA[1], IZBASTINA KLARA SERZHANOVNA[1] AND KHALYMBETOVA AIZHAN ESENBEKOVNA[1]

[1]Astana Botanical Garden branch of the Republican State Enterprise «Institute of Botany and Phytointroduction» Committee of forestry and wildlife Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan
[2]Republican State Enterprise "Altai Botanical Garden" of the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan.
[*]Corresponding author's email: kubserik@mail.ru

Abstract

Allium altaicum Pall. is one of the most valuable food and medicinal plants. The geographical distribution of the Altai onion in the territory of Kazakhstan was studied. The ecological and phytocenotic characteristics of the habitats of the species in different ecological and geomorphological conditions are given. The ontogeny and the seasonal rhythm of development were studied, the abundance and morphometric parameters were determined, the limiting factors responsible for the decline in the number of the species were identified and protection measures proposed. The distribution of *Allium altaicum* in the East and South Kazakhstan regions is established. Altai onion in the studied region has wide ecological amplitude, grows in mountain-steppe and high-mountain regions of Kazakhstan. In ontogeny, 7 age states are identified; the Altai onion populations in the studied region belong to the generative type. In the phenological aspect, in the highlands, there is a shortened growing season (4 months) and a rapid passage of phenophases; in the mountain-steppe regions, a relatively long growing season (6 months) is noted. The main limiting factors for the decline in the number of the species are the collection of leaves by the local population, grazing and forest fires, as well as the recreational effects of the "Ayuda" and the "Sibinsky lakes". The species needs state protection; we consider it necessary to include *Allium altaicum* in the next edition of the Red Book of Kazakhstan.

Key words: Kazakhstan Altai, Phenology, Altai onion, Age composition, Distribution, Ecological and Phytocenotic features.

Introduction

The genus *Allium* is one of the largest genera in the family of Amaryllidaceae. It comprises over 1000 species, and the number is still increasing (Friesen *et al*., 2020). According to Pavlov & Polyakov (1958) and Abdulina (1998) the genus includes 120 species in Kazakhstan Flora. 45 species of four subgenera and 14 sections are given for Kazakhstan Altai, Sauro-Manrak and the Zaysan Basin (Kotukhov *et al*., 2011).

A. altaicum belongs to Siberian-North Tianshan region (Timokhina, 1973; Boyko *et al*., 1982). In modern flora of Altai, it is a cryoxerophytized psychrophyte, which is part of talus and glacial moraine plant groups, as well as unformed pioneer phytocenoses from middle to upper mountain zones (Grankina *et al*., 1986).

Fam. Amaryllidaceae, Gen. *Allium* L., subgen. - Cepa (Mill.) Radic, sect. Cepa (Mill.) Prokh.; *Allium altaicum* Pall., 1773, Reise 2:737; Vvedensky, The flora of the USSR, 1935, 4:196; Popov, The Flora of Middle Siberia, 1957, 1:198; Pavlov, Polyakov, The Flora of the Kazakhstan, 1958, 2: 170; Sobolevskaya, Notes of the flora of Tuva, 1953:57; Peshkova, The Flora of Central Siberia, 1979, 1:217; Malyshev, Identification guide of alpine plants of the South Siberia, 1968:81; Egorova, The plants of Central Asia, 1977:60; Zhengyi, Raven., The Flora of China, 2000, 24:85; Malyschev, Peschkova, The Flora of Siberia, 2001, 4:78; Grubov, Identification vascular plants of Mongolia, 1982:64. – *A. fistulosum* auct non L. Ledebor, The Flora of Russia, 1853:4, Turczaninow in Bull. Soc. Nat. Moscou, 1854; 27, 2: Regel in Acta Horti Petropol., 1887, 10, 1; Sapozhnikov, Mong. Alt., 1911:388; Krylov, The Flora of West Siberia, 1929, 3:609.

On the territory of Kazakhstan, the species was observed in Kazakhstan Altai (22. Altai) and on Tarbagatay ridge (23. Tarb.) (Pavlov & Polyakov, 1958; Kotukhov *et al*., 2011; Stepanova, 1962). General distribution: Russia (Altai Krai, Altai, Tyva and Buryatia Republics, Irkutsk and Chita Oblasts; Amur Oblasts), Mongolia (Prikhubs., Khent., Khang., Khobd., Mong. - Alt., Sr. Khalkha, Kotl. oz., Gobi-Alt., Jung. Gobi) (Urgamal *et al*., 2014), China (Zap. Heilongjiang, Ext. Mongolia, North. Xinjiang) (Sinitsyna, 2019, Najeebullah *et al.,* 2021, Khan *et al.,* 2021).

The question of the origin and distribution of species plays an essential role in the study of onions. The origin of the genus *Allium* was considered as polyphyletic, based on publications in 1996 and 1999 (Von Berg *et al*., 1996; Samoylov *et al*., 1999; Mes *et al*., 1999). Later this assumption was refuted by Friesen *et al.*, (2006) in which the authors proposed a new classification of *Allium*, based on the use of its rDNA sequences (internally transcribes spacers). The study showed that *Allium* has a monophyletic origin and consists of three evolutionary lines with 15 subgenera and 72 sections (Friesen *et al*., 2006). Subsequently, this classification was confirmed in other works and accepted by number of taxonomists of *Allium* (Friesen *et al*., 2006; Chase *et al*., 2009; Choi *et al*., 2011; Hirschegger *et al*., 2009; Choi *et al*., 2012).

A significant work was carried out by Kazakhstan researchers based on ITS and matK markers for the taxonomic assessment of *Allium* species from Kazakhstan (Abugalieva *et al*., 2017). In this work, the authors constructed phylogenetic trees using ITS sequences, which corresponded well to the existing new phylogenetic classification (Mes *et al*., 1999), which also confirmed the monophyletic origin of the genus.

The Cepa section consists of 12 species, which includes Altai onion. M. Gurushidze *et al*., (2007) also confirmed that the Cepa section was monophyletic and identified three species groups in the section by using the sequences of the internal transcribed spacer (ITS) region of nuclear ribosomal DNA. These are (1) *A. altaicum* / *A. fistulosum*, (2) *A. farctum* / *A. roylei* / *A. Asaranse* / *A. cepa* / *A. vavilovii,* and (3) *A. galanthum* / *A. oschaninii* / *A. praemixtum* / *A. pskemense* (Gurushidze *et al*., 2007).

The connection of *A. altaicum* with the cultural species *Allium fistulosum* was studied by Friesen *et al*., (1999) who analyzed restriction fragment of length polymorphism (RFLP) of five regions of non-coding DNA and using random amplified polymorphic DNA (RAPD) analysis of nuclear DNA. The authors concluded that *A. fistulosum* had monophyletic origin and descended from the predecessor *A. altaicum*, which made *A. altaicum* as paraphyletic species (Friesen *et al*., 1999).

According to cytological studies, *A. altaicum* has a diploid number of chromosomes - 2n = 16 (diploid). Karyotypes of chromosomes are characterized from 12.2 to 14.4 μm (the largest), and from 5.9 to 7.4 μm (the smallest), the karyotype formula is 2n = 16 = 12m + 2sm + 2st (Konishi *et al*., 2011).

Altai onion is one of the valuable food plants used as a spice-flavor, anti-scurvy and therapeutic - prophylactic. Altai onion is also used as a decorative plant. It can be used in landscaping rocky and alpine hills, as well as in creating mountain landscapes (Danilova, 2008). It is readily consumed as food; it is often bred in gardens called "Batun". Not very well eaten by animals (Vereshchagin *et al*., 1959). *A. altaicum* contains solids (up to 6.2%), flavonols (up to 1.1%), tannins (up to 11.5%), pectin substances (up to 11.4%), sugars (up to 28.2%), ascorbic acid (up to 222.5 mg %), carotenoids (up to 102.8 mg %) in the aerial parts of plants in Western Siberia (Fomina & Kukushkina, 2019). Due to the mass collection as a food plant, its population is declining everywhere and is currently subject to state protection in Russia (Red Book, 1980; 1988; 1996; 1998; 2014). In Kazakhstan, it is still not officially protected (Red Book, 2014).

Review of literature showed that the taxonomic classification of the genus *Allium* is well studied by using the ITS rDNA sequences, ITS and matK markers (Mes *et al*., 1999; Choi *et al*., 2012; Abugalieva *et al*., 2017), also the distribution of Altai onion in the territory of Altai and Siberia (Kovtonyuk & Friesen, 2005; Kovtonyuk *et al*., 2009; Friesen, 1987; 1988; Krasnoborov & Achimova, 2005). However, in recent years, Kazakhstan has conducted little research to assess the state of populations, ontogenetic structure and phenology of rare and economically valuable plants in natural habitats (Kubentaev & Danilova, 2017, Kubentaev, 2018; Komarevtseva & Kurochkina, 2018; Izbastina *et al*., 2020, Lyakh *et al*., 2019, Orazov *et al*., 2019; Khapilina *et al*., 2021).

In this report, we studied the phytocenotic and ontogenetic structures of Altai onion populations, the seasonal rhythm of development, the biomorphology of species in different ecological and climatic conditions in East Kazakhstan.

Materials and Methods

The natural cenopopulations of Altai onion on the ranges of Kalbinsky and Southern Altai were taken as the object of study. Depending on their geographical location, they are conventionally designated by us as Kalbinsky (KP) and Southern Altai populations (SAP). These are two geographically isolated areas with different environmental conditions and altitudinal limits.

Southern Altai is located on the left bank of Bukhtarma and is separated from South-Western Altai by the Narymsk-Bukhtarma intramountain depression. The mountain ranges that make it up have a predominantly sub-latitudinal direction - Southern Altai, Southern Altai Tarbagatai, Sarymsakty, Narymsky, Kurchumsky, Azutau. Absolute heights within the region vary from 600 to 700 m in the foothills in the west and southwest, in the south - ranges of 1500-3400 m, in the northeast – 2000–2500 m, in the north - up to 4506 m (Belukha Mountain).The climatic features of Southern Altai, which is somewhat extended into the region of dry steppes and semi-deserts of Kazakhstan and merges with the mountainous semi-deserts of Mongolia in the east, are determined on one hand by altitudinal zonality and, on the other, by the influence of humid north-west Atlantic winds, which brings precipitations. The annual rainfall reaches 400 mm in the foothills, up to 800-1000 m in the mountain forest belt. Southern Altai is the coldest place in Kazakhstani Altai. The average annual air temperatures are negative, the average July temperature is + 14° + 18° C, January –14° –18°C. The sum of the positive average daily temperatures is 1200–2200. The average depth of soil freezing is from 47 cm to 100 cm. Summer is cool and short –90-100 days, summer frosts are usual (Egorina *et al*., 2003).

Kalbinsky Altai is located on the left bank of the Irtysh River. Absolute heights - 400 - 1600 m; maximum height – 1608 m. -The most widely developed type of relief is - low mountainous, having the character of a small hills or the so-called horsts on the periphery. The climate of Kalbinsky Altai is sharp continental. The annual amount of radiation balance is about 35 kcal / cm^2 per year. The average temperature of the warmest month (July) + 19° + 22°, and the coldest (January) –14°- 19° The sum of daily positive temperatures 2000°-3100°. The average annual rainfall is 280 mm-400 mm (Egorina *et al*., 2003).

Route-reconnaissance and stationary methods were chosen as methodological basis for the study of cenopopulations (Bykov, 1957). When describing plant communities with the participation of the research object, geobotanical methods were used with a visual assessment of the number of individuals according to the G. Drude scale (Bykov, 1970). The structure of each specific cenopopulation and ontogenesis were studied according to Rabotnov (1964) and Smirnova (1976). The methodology of Uranov (1969) was applied to clarify the life cycle. The basis for studying the ecological and biological features of the species in the field was taken from Golubev & Molchanov guidelines (1978). To assess the degree of variation of the studied characteristics, the coefficient of variation Cυ was used. Statistical analysis of the material was carried out according to the recommendations of Zaitsev (1973). Nomenclative names of the plants are listed in accordance with POWO

(Plants of the World Online, 2021). The morphometric indicators of the aerial parts and bulbs in both populations were studied in 20-times repetition in individuals of the mid-age generative state of *A. altaicum*. In parallel with the study of morphometric and weight indicators, a description of the relief, the species composition of higher vascular plants forming phytocenosis was carried out. For each species, a phytocenotic role in the community was noted, as well as the layering and general projective cover of the soil with plants.

In attempt to identify the distribution of the species in Kazakhstan, the herbarium materials of the Altai Botanical Gardens (further termed 'Alt') and Astana Botanical Gardens (NUR) were examined. Besides that, rare herbarium collections stored in the Herbariums of the Institute of Botany and Phytointroduction (AA) and Moscow State University (MW; Seregin, 2020) were examined. Within the region, the administrative district of distribution of the species is indicated. The data on the site observations were also taken into account https://www.plantarium.ru and literary sources.

Results and Discussion

Distribution pattern in Kazakhstan: On the territory of Kazakhstan, the species is found only in the East Kazakhstan region and Almaty region (Fig. 1).

Specimens examined: FLORISTIC REGION "ALTAI". **East Kazakhstan region: The administrative territory of Ridder city:** ***Ivanovskiy ridge:*** the upper reaches of Mount Three-Brothers, southern. slope, the edge of the placer, 12 Jul 1936, Kuban s.n. (AA!); the upper reaches of Mount Krestovaya, 1900 m above sea level, the outskirts of the placer, 27 Jun 1975, Ermakov & Kotukhov s.n. (Alt.!); **Shemonaihinskiy district:** ***Ubinsky ridge:*** "Megin Klyuch" place, 1800 m above sea level, on granite outcrops, 10 Jun 1972, Kotukhov s.n. (Alt.!); Mount Makhnatukha, near Shemonaiha, 20 Jun 1974, Kotukhov s.n. (Alt.!). **Katon-Karagayskiy district:** ***South Altai Tarbagatai Range:*** near the Burkhat pass, in the Alpine belt of the mountains, on the north-western slope in the altitude limit of 1900 m, 03 Jul 2016, Kubentayev (NUR!); ***Southern Altai range*****:** upper reaches of the Bukhtarma River, overgrown moraine, 01 Aug 1970, Kotukhov s.n. (Alt.!); near Chindogatui, 2000 m above sea level, sparse larch forest, 18 Aug 1972, Kotukhov s.n. (Alt.!); ***Narymskiy ridge*****:** near the Sarymsak River, the upper part of the forest zone, 20 Aug 1932, Voronov 838 (MW0045358!); near Katon-Karagay, on the gravelly slopes of a mountain stream, 2000 m. 11 Jul 1930, Smirnov 25 (MW0045355!); "Terekty" place, the edge of the scree, 30 Aug 1975, Kotukhov s.n. (Alt.!); near Novoberezovka, 1600 m, south-east. rocky slope, 30 Jul 1976, Kotukhov s.n. (Alt.!); hr. ***Sarymsakty ridge:*** Kumyshbay gorge, Eastern slope, near the waterfall, 22 Jul 1986, Ivashchenko s.n. (AA!); the south-eastern spurs of the ridge, the eastern slope, on the rocks, the height of 1800 m., 04 Aug 1985, Bialieva s.n. (AA!); **Kurchumskiy district:** ***Azutau ridge:*** near Matabai, larch woodlands, 18 Jul 1984, Zinchenko s.n. (Alt.!); same loc., 1900 m, larch forest, upper limit, 28 Jul 1985, Kotukhov s.n. (Alt.!); ***Kurchumsky ridge:*** of the Topolevka River, upper border of the forest, 11 Jul 1984, Zinchenko s.n. (Alt.!); **Ulansky district: Kalba ridge:** The left bank of the Bukhtarma reservoir, Ayuda Bay, 05 Jul 2010 (Glazunova, 2010); Koktau Mountains, "Taldy" place, near Algabas, 04 Jun 2014 Kubentayev (NUR!); near Gladkovsky's Key, granite rocks, 24 Jul 1956, Eremeyeva s.n. (AA!); near lake Sibinskiy, granite outcrops, 17 Aug 1970, Kotukhov s.n. (Alt.!). FLORISTIC REGION "TARBAGATAY". **Urdzharskiy district:** ***Tarbagatai ridge:*** on gravelly and stony slopes (Stepanova, 1962); Saur ridge, western slope, Uydene tract, 12 Jul 1972, Mikheeva s.n. (AA!); Tarbagatay Ridge, 1840, Schrenk s.n. (AA!). FLORISTIC REGION "DZHUNGARSKIY ALATAU". **Almaty region: Alakolskiy district:** ***Dzhungarskiy Alatau ridge:*** Lepsinsky uyezd, under the top of Abl-Tau Mountain, near Glinovka, stony placer, 07 Jun 1928, Pavlov 550 (MW0813591!); Koksu river basin, on the southern rocky slopes, height 2650 m., 23 Aug 1948, Goloskokov s.n. (AA!); The watershed of the Karasyryk River and the upper Arasan River, on the southern rocky slope near the Kumbel Pass, 2900 m, 21 Aug 1948 , Goloskokov s.n. (AA!).

Ecological and phytocenotic characteristics of *A. altaicum* in the Southern Altai: The SAP of Altai onion ((Fig. 2.) occupies a plot of about 1 hectare on the southwestern edge of the ridge. South Altai Tarbagatai (49º07'53 "N, 86º02'10" E) is located on the southwestern rocky microslope of the northwestern mega slope near the Burkhat gorge, 2146 m above the sea level (Fig. 3). *A. altaicum* grows along wide cracks filled with a substrate, ledges of various sizes, where there is a significant accumulation of soil material (microzems, clay formations, fine gravel, sand and primary humus). The substrate on the cornices can reach 17-23 (20) cm. The slope is well warmed up and illuminated, constantly remains under the influence of associated southwestern and northwestern winds. The upper soil layer is richly humus, constantly moistened from moderate to excess. The ground cover is well developed, composed of litter, often with a thick layer of ground mosses and lichens. The litter weight is 406,5±15,8 g/m^2. *Allium altaicum* individuals are normally developed. The total projective cover is 80–90%. The species of the alpine forb-cereal meadows (*Phlomoides alpina* (Pall.) Adylov, Kamelin & Makhm.–*Festuca borissii* Reverd.+*Carex aterrima* Hoppe–*Aquilegia glandulosa* Fisch. Ex Link. +*A. altaicum*). *Juniperus sibirica* Burgsd – sp, *Cotoneaster uniflorus* Bunge – sol, *Pentaphilloides fruticosa* (L.) O. Schwarz – sp are found in the shrub layer. The density of the shrub layer does not exceed 02. The grass stand is poor in species terms, has a not clearly expressed two-layer structure. Ecologically, the community is dominated by mesopsychrophytes and mesopetrophytes.

In the first layer, there are often 30–60 cm high *Helictotrichon versicolor* (Vill.) Pilg. – sp, *Aconitum anthoroideum* DC. – sol, *Papaver nudicaule* L. – sol, *Aegopodium alpestre* Ledeb. – sol, *Pachypleurum alpinum* Ledeb. – sol, *Bistorta elliptica* (Willd. ex Spreng.) V.V.Petrovsky, D.F.Murray & Elven – sp, *Thalictrum flavum* L. – sp, *Galium boreale* L. – sol, *Campanula cervicaria* L. – sol, *Lupinaster pentaphyllu* Moench – sol, *Poa transbaicalica* Roshev. – sp, *Gastrolychnis trisris* (Bunge) Czer. – sol, *Saussure aschanginiana* (Wyld.) Fisch.ex Herd. – sol, *Rhodiola rosea* L. – sol, *Pedicularis oederi* Vahl – sp, *P. amoena* Adams ex Steven, *Macropodium nivale* (Pall.) W.T.Aiton – sp.

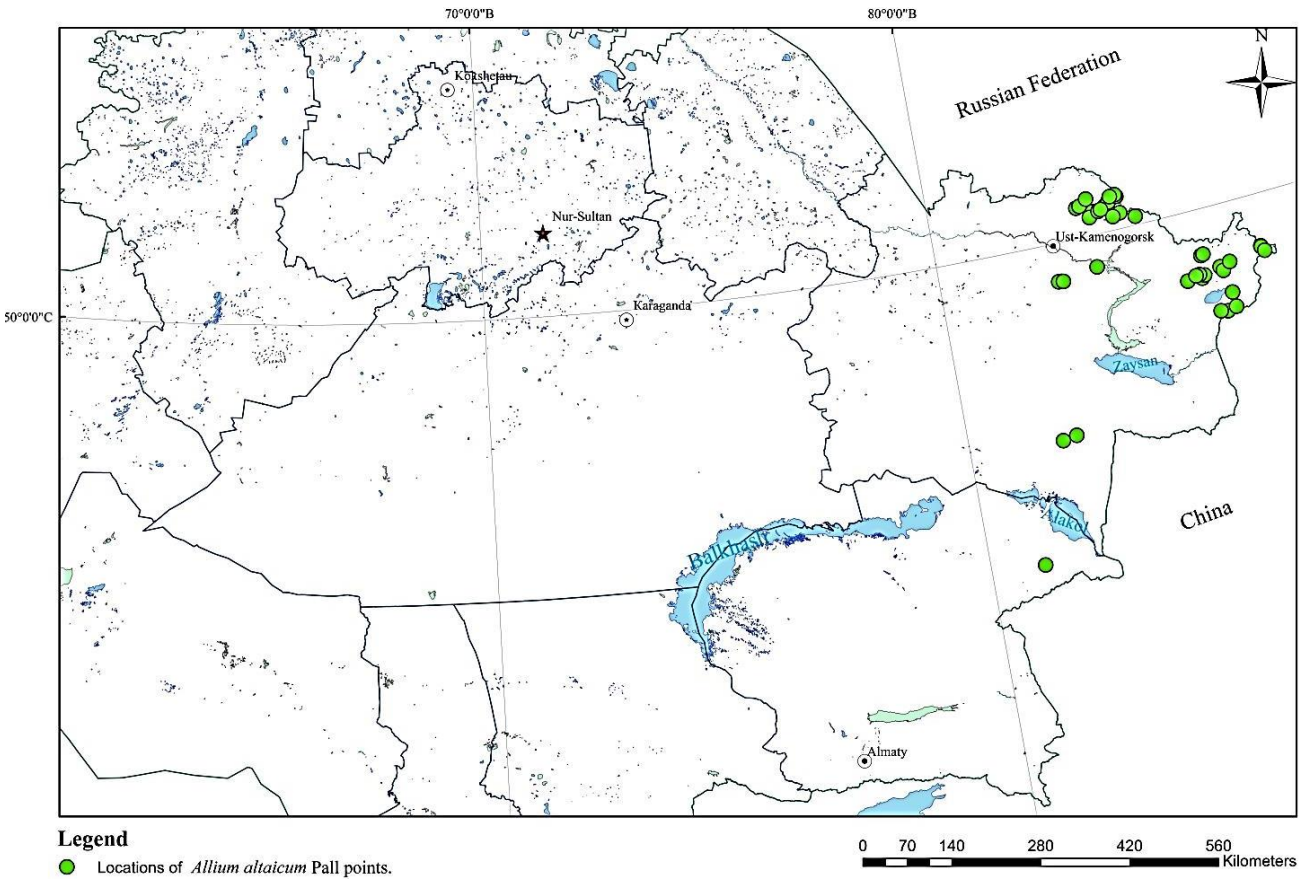

Fig. 1. Distribution of *A. altaicum* in Kazakhstan.

Fig. 2. The population of the *A. altaicum* growing on the high mountain range of the Kazakhstan Altai (photo by Kubentayev S.A.)

The second layer is formed by10–25 cm high *Festuca kryloviana* Reverd. – sp, *Thalictrum alpinum* L. – sp, *Orostachys spinosa* (L.) C.A. Mey. – sol, *Iris bloudowii* Ledeb. – sol, *Saussurea schanginiana* (Wyld.) Fisch.ex Herd. – sol, *Allium rubens* Schrad. Ex Willd. – sol, *A. schoenoprasum* L., *Silene graminifolia* Otth – sol, *Eremogone formosa* (Fisch. ex Ser.) Fenzl – sol, *Potentilla argentea* L. - sol, *Pedicularis oederi* Vahl – sol, *Oxytropis sulphurea* (Fisch. ex DC.) Ledeb. – sp, *Patrinia sibirica* (L.) Juss. – sol, *Hylotelephium ewersii* (Ledeb.) H. Ohba – sol, *Hedysarum neglectum* Ledeb. – sp, *Carex rupestris* All. – sp, *Gentiana grandiflora* Laxm. – sol, *G. algida* Pall. – sol, *Oxytropis alpina* Bunge – sol, *Phedimus hybridus* (L.) 't Hart – sp.

Ecological and phytocenotic characteristics of *A. altaicum* in the Kalbinskiy Altai: Altai onions in KP are a glacial relic of the Pleistocene epoch (Kotukhov *et al*.,

2011). On the territory of the Kalbinsky Altai, they currently grow only within the Sibin depression in the Koktau mountains. In comparison with Southern Altai, Kalbinskiy Altai is distinguished by a relatively low species composition of vegetation, most likely due to harsh continental climate, limited migration processes and complex geomorphological structure.

A. altaicum of Kalbinskiy Altai surveyed on Kalbinsky ridge, Koktau mountains, Taldy tract (49º29'27 "N, 82º36'23" E), in the vicinity of village Algabas (Fig. 3) The species grows on the southeastern slope of elevations of granitoid massifs, steepness up to 35^0, in the altitude limit of 700-900 m above sea level. The relief consists of huge granitoid blocks in the form of ledges of various shapes. The soils in the places of growth are mountain podzolized blacksoils, the mechanical composition of the soil is dominated by small granite crumbs 0.5–4 cm in size (up to 34.3%) and coarse sand up to 0.5 cm in size (35.9%). The soil layer in some places reaches 35 cm, but, in general, it is not more than 15–25 cm, the underlying parent rocks lie below. *A. altaicum* grows along shallow cracks, faults, and cornices where humus accumulates. The soil pores are not evenly distributed, formed by the fall of leaves and needles, decomposition products of vegetation and lichens, the weight of the litter is 130.2 ± 7.8 g/m^2.

The vegetation of the cenopopulation is relatively poor in terms of species. The species is a part of forb-shrub pine forests on dry rocky slopes of granitoid uplands (*Pinus sylvestris* L. –*Spirea trilobata* L.–*Phedimus hybridus* (L.) 't Hart–*Achillea millefolium* L.+*Allium nutans*+*A. altaicum*). The total projective cover is 35–40%, where the share of *A. altaicum* is 1.5–2%. The arboreal layer consists of undersized *Pinus sylvestris* with a fullness of 05–07; undersized *Popolus tremula* L. – sol. Of the shrubs *Spirea trilobata* dominates, its share in the cover is 20–30%. Of the accompanying shrubs, *Caragana arborescens* Lam is often found. – *Rosa spinosissima* L. – *Cotoneaster melanocarpus* Fisch. ex Blytt – sol, *Spirea hypericifolia* L. - sol, *Lonicera tatarica* L. – sol, *Lonicera microphylla* Willd. ex Schult. – sol, *Juniperus sabina* L. – sol.

The herbage is formed mainly by petroxerophytic species; the layering in the phytocenosis is not expressed. The community often contains *Orostachys spinosa* (L.) Sweet – *Allium rubens*, *Patrinia intermedia* (Hornem.) Roem. & Schult. – sp, *Linaria vulgaris* L. – r, *Galatella hauptii* (Ledeb.) Lindl. ex DC. – sp, *Origanum vulgare* L. – sol, *Achillea millefolium* – sol, *Galium verum* L. – sp, *Artemisia frigida* Willd. – sp, *Phleum phleoides* (L.) Karst. – sol, *Fragaria vesca* L. - sol, *Fallopia convolvulus* (L.) A. Love - sol, *Chenopodium album* L. - sol, *Cynoglossum viridiflorum* Pall. ex Lehm. – r, *Hesperis sibirica* L. – sol, *Saussurea elegans* Ledeb. – r, *Bromopsis inermis* (Leyss.) Holub – sol, *Ranunculus polyrhizos* Stephan ex Willd. – sp, *Phlomoides tuberosa* (L.) Moench – sp, *Fritillaria verticillata* Willd. – sol, *Valeriana capitata* Pall. ex Link – sol.

Morphological and quantitative characteristics of *A. altaicum*: The results of the study showed that morphometric and counting characters in *A. altaicum* vary at different levels of variability in SAP and KP (Table 1).

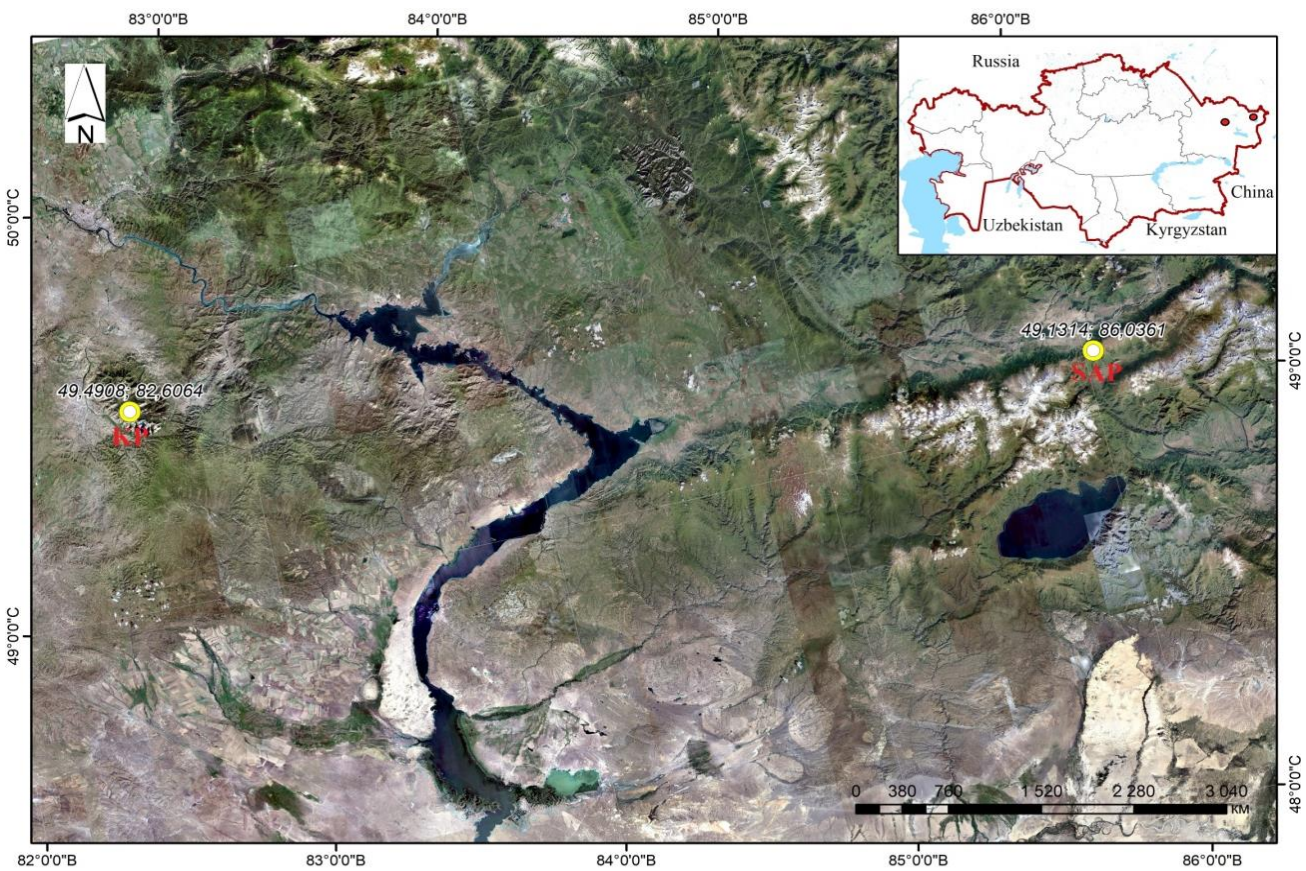

Fig. 3. Schematic map of the habitats of the explored populations of Altai onion in KP and SAP.

Table 1. Biometric indicators of *A. altaicum* in SAP and KP.

Indicator	Population			
	SAP		KP	
	M±m	C_V, %	M±m	C_V, %
Generative shoot height, cm	59,43 ± 3,93	21	50,73 ± 2,00	23
Inflorescence diameter, cm	2,77 ± 0,78	28	3,59 ± 0,68	19
Leaf length, cm	38,73 ± 2,18	17	37,33 ± 2,2	18
Bulb height, cm	3,28 ± 0,20	18,	5,13 ± 0,48	9
Bulb diameter, cm	1,44 ± 0,08	20	1,92 ± 0,12	17
Width of leaves at the base, cm	2,51 ± 0,29	36	2,03 ± 0,14	21
The number of generative shoots in the nest, pcs	2,40 ± 0,40	43	2,53 ± 0,79	39
The number of vegetative shoots in the nest, pcs	1,7 ± 0,54	51	6,13 ± 0,92	47
The number of seeds in the box, pcs	3,47 ± 0,27	9	4,20 ± 0,34	6
The number of flowers in inflorescence, pcs	83,80 ± 9,31	35	67,87 ± 4,72	26
The number of leaves on the shoot, pcs	4,07 ± 0,29	21	4,2 ± 0,29	23
The number of bolls that started in inflorescence, pcs	45,50 ± 4,29	17	28,27 ± 3,70	13
Bulb weight, gr	4,3 ± 0,29	13	16,05 ± 0,92	16

Ontogenetic states of *A. altaicum* populations: The age status of individuals serves as an indicator of its development and allowed us to identify 7 age groups for the development of the species.

1. *Latent.* It is characterized by a dormant period of seeds. The seeds are medium-sized, with strongly marked edges. The surface of the seed has a fine-grained structure, the shape is strongly curved inwards, flattened. The seminal rumen is linear, longitudinally slit-shaped. The color of the seeds is black. Length: 3.53±0.18 mm (Cv=12%), width: 2.14±0.22 mm (Cv=16%). The weight of 1000 pieces of seeds is 0.98±0.018 g (Cv=25%).
2. *Seedlings*. Germination of seeds begins with the germinal root, and then a tubular cotyledon leaf appears after 2–3 days. When leaving the ground, the seedlings look like a loop formed by a cotyledon leaf. The seedling has one green cotyledon, a fistula leaf and a weakly branching main root up to 57 cm with one, very rarely with two subordinates.
3. *Juvenile*. Plants pass into this age group after the cotyledonary leaves are died, in high mountain specimens it lasts for 4–5 years, in mountain steppes – 1–3 years. 3–5 fistula leaves develop annually. The shoot is monopodial. The root system is mixed and consists of the main and 4-7 accessory roots. A conical vertical rhizome appears, not more than 1–3 mm in length. Vaginas of leaves thicken and form an onion.
4. *Vegetative*. The growth of the shoot is monopodial, there is an intensive growth of the bulb, leaves, and a root system is formed, consisting of subordinate roots that branch intensively. This age state of plants lasts up to 5-7 years, depending on habitat conditions.
5. *Pregenerative.* It includes adult vegetative individuals. In this group it is no longer possible to accurately determine the age due to the incomplete preservation of the remnants of the bulbs of previous years, but it lasts until about 9–13 years. A nest begins to form due to vegetative reproduction. Rhizome grows obliquely apogeogenously. The root system is powerfully developed, it has 17-25 accessory string-like roots with intensive branching.
6. *Generative.* At the age of 9-13, the maternal shoot blooms. In this period, individuals reach a maximum of individual development. This period can conditionally be divided into three age groups: *young, middle-aged* and *old* generative individuals. Differences in age are manifested in morphological and biological characters. Young generative individuals are characterized by one or two generative and two to three vegetative shoots. In the middle-aged state, almost all shoots in the nest are in blooming state. In the old generative nest, vegetative individuals predominate quantitatively.
7. *Senile.* This included individuals, in which the development of only vegetative sphere was observed, the decay of the nest with the formation of bald patches in the center. Bulbs grew smaller in them, which was easily established by the ratio of the size of the covering scales and a live bulb. Senile specimens are no longer capable of flowering or vegetative reproduction. The number of green leaves decreased to 2–4, they began to fade.

Ontogenetic structure of *A. altaicum* populations: Based on the study of Altai onions life cycle in natural populations, an age classification of populations was carried out. In the KP, seedlings accounted for 34%, juvenile individuals - 18%, indicating seed renewal and a good plant survival. Young and adult vegetative individuals accounted for 13%. The participation pregenerative of individuals was rather high - 12%, generative – 23%. Senile nests were not detected (Fig. 4).

In SAP, seedlings individuals made up 14%, indicating a weak seed renewal in these living conditions. The community was dominated by *Juvenile* – 8% and adult vegetative individuals – 36%. The participation of pregenerative individuals was relatively low - 24%, generative – 11%. Senile nests - 7%. The age structure of cenopopulations of Altai onion on the territory of East Kazakhstan was normal, mature, full-term, and the degree of renewal was of the generative type (Fig. 4).

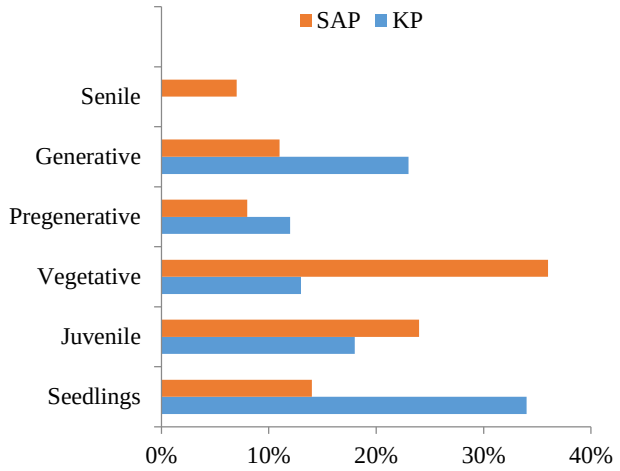

Fig. 4. Ontogenetic structure of *A. altaicum* populations in KP and SAP.

Phenology of *A. altaicum*: In nature, the considered intraspecific groups SAP and KP are characterized by the passage of phenophases at different times, with a difference of 15–20 days. In SAP, in the altitude limit of 1900–2450 m, the growing season is shortened due to the harsh climatic conditions. However, plants manage to go through a full development cycle due to the rapid passage of phenophases. From under the snow, they come out with regrown leaves, often with a flower arrow. In this region, Altai onions bloom in the second half of June, flowering lasts 10-15 days, and already in late July - early August their seeds ripen. The seeds are immediately dispersed from the capsules. They are easily carried by the wind and give abundant self-seeding. The first single shoots appear 13–18 days after seed shedding in August – September. As a rule, they die in winter. Shoots appear after the end of winter next year.

For KP, growing at an altitude of 700-900 m, late flowering is characteristic, which begins in mid-July and lasts 20-25 days, seeds ripe in September. Seed reproduction can be traced, but with a low preservation of plants in the early stages of development due to a lack of moisture in the spring-summer period and harsh winter conditions.

Discussions

A detailed study of the ecological-biological, phytocenotic and ontogenetic characteristics of Altai onion given in the work of scientists Altai and Tuva was conducted by Grankina *et al.*, (1986) and Cheremushkina (2002). The distribution of onions in the territory of Altai and Siberia was studied by Kovtonyuk *et al.*, (2009), Friesen (1987; 1988), Krasnoborov & Achimova (2005) and Kotukhov (1979).

Within the administrative boundaries, the distribution of *A. altaicum* in the East Kazakhstan region (Shemonaikhinsky, Katon-Karagaysky, Ulansky and Kurchumsky districts) and one location in the South Kazakhstan region (Alakol district) were noted. The study region is located on the western border of the general habitat of the species. According to our data, *A. altaicum* in Kazakhstan is quite often found in high-mountainous regions (Tarbagatai, Southern and Western Altai) and less frequently in mountain-steppe regions (Kalbinskiy Altai) of Kazakhstan. This may be due to the ecological preferences of the species, since the main habitat of *A. altaicum* is the subalpine belts of mountains, and rubble taluses are considered optimal conditions for the existence of the species (Grankina *et al*., 1986; Cheremushkina, 2002).

It should be noted that the species in the studied region has a wide ecological plasticity. Two geographically isolated populations in Kalbinskiy and Southern Altai, growing in completely different ecological and geomorphological conditions, were examined. The habitat conditions of the species in the SAP are characterized as extreme, as evidenced by the frozen tops of leaves, buds in the phase of opening of the veil and flowers in the upper part of the inflorescence. Most often, the species is found in communities with a predominance of mesopsychrophytes and mesopetrophytes: *Pentaphilloides fruticosa, Helictotrichon versicolor, Festuca borissii, Carex orbicularis, C. aterrima, Aquilegia glandulosa, Angelica archangelellica, Thahodigia glandulosa.* The habitat conditions of the Altai onion in the KP can be characterized as unfavorable for development due to the weak ground cover, lack of moisture, constant winds that carry seeds out of the population. Communities are dominated by mesoxerophytes and petrophytes: *Pinus sylvestris, Spirea trilobata, Rosa spinosissima, Cotoneaster melanocarpus, Juniperus sabina, Orostachys spinosa, Sedum hybridum, Patrinia intermedia*.

Ontogenesis and age composition of the Altai onion were studied in cenopopulations growing in high-alpine (SAP) and mid-mountainous mountain-steppe conditions (KP). Due to the annual change of bulbs, the long life cycle of the Altai onion is a continuous (but not endless) sequence of generations of individuals, replacing each other every year. Due to the annual change of bulbs, all individuals, except the seedlings of the first year, were of vegetative origin. All individuals making up the nest descend from one seed specimen, represent one generation and have one calendar age. However, the age state of individuals in the nest is different. In the same nest, you can find adult vegetative, generative and senile specimens. The age status of an individual serves as an indicator of its development and made it possible to identify 7 age states. Total life expectancy has not been established.

On the basis of studying the life cycle of the Altai onion in natural populations, the ontogenetic structure of the populations of the Altai onion was studied. In all studied populations, there were seedlings and juveniles, indicating seed regeneration and good plant survival. Particularly prominent are KP, where seedlings make up 34%, juveniles - 18%. In SAP, seedlings account for 14%, juveniles 8%, which clearly indicates a weak seed renewal in these habitats. This is due to unfavorable conditions for seed germination, as well as the negative influence of spring-summer frosts, which damage the generative sphere almost every year. According to the age structure of the Altai onion population in the studied region, they are classified as normal, and in terms of the degree of renewal, they are classified as generative.

The study of the average metric and counting indicators of the values of the SAP of the Altai onion showed that they varied mainly at medium and high levels (Cv from 17.44 to 36.09). A very high degree of variation (Cv from 43.46 to 51.55) was characteristic of such traits as the number of generative and vegetative shoots. The low level of variability of the studied morphometric characters in the population has not been established. The KP also revealed that metric and counting indicators varied, mainly at medium and high levels (Cv from 13.85 to 39.53). The research results showed that in the examined population, only the number of vegetative shoots in the nest varied at a very high level of variability (Cv 47.20). A low level of variability was found in such indicators as the number of seeds in the capsule and the length of the bulb (Cv 6.30 and Cv 9.30).

In the phenological aspect, a shortened growing season and a rapid passage of phenophases are noted in the SAP, this is due to late snow melt and extreme habitat conditions, flowering occurs in the second half of June, and already in late July - early August their seeds ripen. In contrast to the SAP, the Altai onion of KP is characterized by a relatively long growing season, flowering begins in mid-July and lasts 20–25 days, the seeds ripe in September.

Observations have shown that the main limiting factors for the decline of the Altai onion population are the collection of leaves by the local population, grazing and forest fires. In addition, the recreational effects of the “Ayuda” and the “Sibinsky lakes” have a significant impact on the state of the Altai onion populations in the Kalbinskiy Altai. The species needs state protection; we consider it necessary to include *A. altaicum* in the next edition of the Red Book of Kazakhstan. The KP needs control over quantitative and qualitative changes, protection of habitats, and organization of work on the restoration of natural thickets by reintroduction.

Acknowledgments

This study was supported by the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan (Program, IRN: BR10264471).

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(Received for publication 9 May 2020)