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ASSESSMENT OF NATURAL POPULATIONS AND BIOECOLOGICAL CHARACTERISTICS OF SOME WILD SPECIES OF THE GENUS *Allium* L. (*Alliaceae* J. Agardh.)

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Abstract. Species of the genus *Allium* L. (*Alliaceae* J. Agardh.), - bulbous, rhizome-bulb, rhizome polycarpic, often branching due to the development of axillary buds. Due to the limited research in the Caucasus, a comprehensive study of the ecological and biological characteristics of species of the genus *Allium* L. is urgently needed. The purpose of the study was to intestigate the bioecological features and assess the current state of the cenopopulations (CPs) of some species of the genus *Allium* L. in the Lesser Caucasus region of Azerbaijan. We studied 12 cenopopulations of 4 wild onions species growing under various environmental conditions. The assessment of natural cenopopulations of wild onions showed that 3 CPs are in a critical state; of these, the most vulnerable is CP IV *A. rotundum* L., which is subject to high anthropogenic pressure in the form of excessive trampling (for the purpose of collecting and selling on the market both fresh and salted) and overgrazing by cattle. The results of the studies serve as a basis for assessing the state and development prospects of natural CPs of the studied species, which is important when developing recommendations for their conservation.

Keywords: *Allium, ontogenesis, polycarpic, cenopopulations, wild onions.*

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1. Introduction

Species diversity is the basis of ecosystem integrity. The disappearance of any population, and even more of a species, is an irreparable loss to Earth's biological diversity. Recently, the importance of using wild plants for prophylactic purposes, such as medicinal raw materials and food additives, has been increasing. Species of the genus *Allium* L. rightfully occupy one of the leading places among widely used edible plants (Gurbanova, 2025).

More than 870 plant species belonging to the *Alliaceae* J.Agardh. family, compromising 30 genera, are distributed worldwide. In Azerbaijan, there are representatives of 2 genera (*Allium* L. and *Nectaroscordum* Lindl.) of this family (Askerov, 2016; Compendium of flora of the Caucasus, 2006). In the flora of Azerbaijan, 52 species of the genus *Allium* L. are distributed. All species in the territory are suitable for consumption (Gasimov *et al*., 2019). Representatives of the onion genus (*Allium* L.) have been used worldwide since ancient times as vegetables and spices, as well as medicinal preparations in folk and traditional medicine (Amagova *et al*., 2020; Gurbanov, 2024). The nutritional value of onions is determined by the high content of carbohydrates, nitrogenous substances, vitamins, mineral salts and microelements (Seredin *et al*., 2020). Recently, the intensification of anthropogenic impact has endangered plants of the genus

Allium L. in areas close to human settlements and in remote areas, raising concerns about their protection and sustainable use. According to researchers, it is impossible to develop the prospects for their use and scientific basis for their protection without a comprehensive study of the bioecological properties of plants. Studying the bioecological properties of onions in their natural habitats allows expanding the prospects for their use. The practical significance of wild onions lies in the fact that they grow quickly and abundantly in the spring, at which time their leaves are rich in vitamins, sugars and valuable microelements.When harvested, their leaves last until late autumn, quickly renewing themselves; allowing for extended use over a long period (Kukushkina & Fomina, 2021; Ivanova *et al*., 2019).

2. Material and methods

The objects of the study are 4 wild species of the genus *Allium* L.: *A. rotundum* L., *A. albidum* Fisch.ex Bieb., *A. atroviolaceum* Boiss., *A. fuscoviolaceum* Fomin. In the territory of the Lesser Caucasus (Azerbaijan), 12 coenopopulations were examined: of which 2CP *A. albidum* Fisch.ex Bieb (CPI- Goygol district, Karamli village N40°33′29″, E46°13′02″; CPII- Goygol dist. Hajimelik village N40°37′57″, E 46°24′29″), 4CP *A.fuscoviolaceum* Fomin (CPI-Goranboy dist.,Gulistan v.N40°21′30″,E 46°34′43″; CPII- Goranboy district Buzlug village N40°24′55″, E 46°25′59″; CPIII- Samukh district, Garayeri village N40°47′12″, E 46°19′00″; CPIV- Samukh district, Zazalı village N40°43′05″, E46°28′25″), 4CP *A. rotundum* L. (CPI- Tovuz d.Asrik village N40°52′02″, E 45°37′41″; CPII-Gazakh district,Urkmezli village N41°06′14″ , E 45°15′29″; CP III- Gazakh district,Garapapag village N41°04′48″, E 45°21′34″ ; CPIV- Shamkir district,Seyfali village N40° 45′ 23″,E46° 6′ 51″), 2CP *A. atrovoiolaceum* Boiss (CPI- Dashkasan district, Bayan village N40°33′16″ E46°09′22″; CPII- Gadabay district, Artepe village N40°38′38″ E45°53′55″). The work used morphology (observation, biomorphological description, comparative ontogenetic and comparative ecological methods), population biology (route method, research area method, phenological observations, population ontogenetic experience, etc.) and statistical methods.

The nomenclature of wild species of the genus *Allium* L. was done based on the fundamental floras of Azerbaijan, APG IV (2016), WFO (2020) system and the International Plant Names Index (IPNI) (2025) database.

The study employed phenological observations methods using complex techniques (Zlobin, 1989; Iskander, 2018). The identification of age states of plants (seedlings pl, juvenile j, immature im, virginil v, young generative g_1, middle-age g_2 and old generative g_3, subsenil ss, senile s) and age spectra was carried out according to the generally accepted method (Fedulov *et al*., 2013; Rabotnov, 1992). Areology research was conducted according to the Portenier(2000) classifications. Indicators assessed viability of species coenopopulations (Ishbirdin & Ishmuratova, 2004). Life forms of plants were classified according to Serebryakov (1964). The spelling of phytocenosis is based on Kamelin (1973).

3. Results and discussion

Wild species of the genus *Allium* L. (onion) possess significant resource value, as they have numerous useful properties. Their utility as food, medicinal and fodder plants

is determined by the specific qualitative and quantitative composition of chemical constituents. Data on the cheminal composition given in the literature indicates the high nutritional value of onions. Researchers report that species of the genus *Allium* L. contain significant amounts of proteins, fats, sugars, carotene, vitamins A, B_1, B_2, PP, C, as well as steroids, flavonoids, glycosides, organic acids, coumarins and phytoncides. The chemical composition of leaves varies within a species and depends on the place of growth, development stage and age of plants, cultivation practices, population density.

In nature, onion species are distributed throughout in all regions of Azerbaijan, on dry and grassy slopes, in forests and thickets, meadows and cultivated fields. Ecologically, they range from the lowland plains to the alpine zone (Figure 1).

Figure 1. The appearance of wild onion species in the natural flora: **1** - *A. rotundum* L., **2** - *A. atroviolaceum* Boiss., **3** - *A. fuscoviolaceum* Fomin., **4** - *A.albidum* Fisch.ex Bieb.

The conducted studies provide insights into the complex of morphological characteristics, among which the permanent traits predominant. Morphological features of important taxonomic value in the taxonomy of the genus *Allium* L. include : bulb shape, presence or absence, rhizomes, leaf structure, position of the leaf base, presence or absence of the persistent or deciduous sheaths, its size, length of the flower stalk lenght, floral characteristics (petal shape and color, stamen length, etc.). Ecological and morphological analysis of the life forms of the studied species revealed that they are perennial herbaceous plants. According to the classification of life forms by K. Raunkier, these wild species of the genus *Allium* L. categorized as cryptophytes. The vegetation period in the conditions of Azerbaijan ranges from 140-160 (*A. fuscoviolaceum* Fomin),

160-170 (*A. rotundum* L.) and 210-240 (*A. albidum* Fisch.ex Bieb and *A.atroviolaceum* Boiss.,) days. When CPs grow on well-warmed undisturbed *(A.albidum* Fisch.ex Bieb, *A. fuscoviolaceum* Fomin.) and disturbed meadow (*A.rotundum*) areas, earlier seedlings emergence, a prolonged above-ground vegetation, the alignment of vegetative mass accumulation and summer growth subphases with the favorable spring-summer period,extended flowering periods are commonly observed, especially at lower altitudinal boundaries. There conditions contributes to the accumulation of reserve nutrients, generative reproduction of individuals,which are important for the introduction of ornamental species.

During the study, an assessment of the cenopopulations of the selected species was carried out. For this purpose, cenopopulations (CP) were identified in the areas where the plants spread. Each population was evaluated phytocenological methods (Tables 1-4).

Ecological analysis indicates that wild onion species have a wider ecological amplitude compared to desert, alpine and subalpine species. They grow in wormwood-cereal, feather grass-hairy, mixed grass and shrubby steppes. In terms of substrate preference, most wild species of *Allium* L. inhabit grassy, gravelly soils while some are found on sandy-stony soils. The studied species are classified asmesophytes and xeromesophytes.

The ontogenesis of the studied species includes 4 age periods (latent, pregenerative, generative and postgenerative) and 8-9 distinct age states (seedlings pl, juvenile j, immature im, virginil v, young generative g_1, middle-age g_2 and old generative g_3, subsenile ss, senile s plants). Notably, in the age spectra of two species, the subsenile ss stage is often absent (*A. rotundum* L., *A. fuscoviolaceum* Fomin.).

Table 1. Phytocenological assessment of *A.albidum* Fisch.ex Bieb, populations

Territorial association of cenopopulation	Composition of associations (main species shown)	Project cover%	Abundanse
CPI Goygol district, Karamli village	*Cousinia macrocephala + Zizifora tenuior+ Herbosum*	30	sol
CP II Goygol district, Hajimelik village	*Tussilago farfara+Arctium lappa + Chondrilla juncea*	60	cop1

Table 2. Phytocenological assessment of *A.atroviolaceum* Boiss. populations

Territorial association of cenopopulation	Composition of associations (main species shown)	Project cover%	Abundanse
CPI Dashkasan district, Bayan village	*Nepeta cataria+Poa bulbosa+Allium mariae*	30	sol
CP II Gadabay district, Artepe village	*Origanum vulgare+Tussilago farfara+Saturea macrantha*	60	cop1

Table 3. Phytocenological assessment of *A. fuscoviolaceum* Fomin. Populations

Territorial association of cenopopulation	Composition of associations (main species shown)	Project cover%	Abundanse
CPI Goranboy district, Gulistan village	*Poligonatum orientale +Zizifora tenuior + Allium schoenoprasum*	45	soc
CP II Goranboy district Buzlug village	*Zizifora tenuior + Zygophyllum atriplicoides*	30	sol
CP III Samukh district, Garayeri village	*Cichorium intybus+ Centaurea behen+ Cousinia macrocephala*	30	Cop1
CP IV Samukh district, Zazalı village	*Scorzonera laciniata+ Lactuca serriola*	30	Cop2

Table 4. Phytocenological assessment of *A. rotundum* L. populations

Territorial association of cenopopulation	Composition of associations (main species shown)	Project cover%	Abundanse
CPI Tovuz district, Asrik village	*Eremurus spectabilis +Erigeron orientalis +Achillea bibersteinii +İris imbricata*	40	Cop2
CP II Gazakh district, Urkmezli village	*Slipa capillata + Festuca valesiaca + Salvia macrantha +Thymus caucasica*	30	Cop3
CP III Gazakh district, Garapapag village	*Eremurus spectabilis +Astragalus euoplus +Gladiolus kotschyanus*	30	Cop2
CP IV Shamkir district Seyfali village	*Achillea millefolium +Astragalus regelii +Conyza canadensis*	40	Cop2

The main features of the age structure of the CP are determined by the biological properties of the species. Exogenous environmental factors are: the degree of anthropogenic load and the nature of the substrate (*A.albidum* Fisch.ex Bieb.). Under stressful conditions caused by these factors, onion species are often exhibit delayed development at the v-stage, a decrease in the proportion of pl- and j-rpynn, intensification of the aging process, less often - rapid death of old plants. However moderate anthropogenic pressure, by reducing the intensity of competitive relations in the cenosis, can have a positive effect on the efficiency of seed regeneration (CPII *A.albidum* Fisch.ex Bieb., *A.rotundum* L.).

All CPs are of the normal type, most are full-membered. Vegetatively oriented (CP *A.albidum* Fisch.ex Bieb.) (Figure 2a) and generatively oriented (CP *A. fuscoviolaceum* Fomin.) spectra are widely represented (Figure 2c).

The increased proportion of pregenerative (in particular virginile) individuals in the age spectra of *A.albidum* Fisch. ex Bieb can be attributed to the high intensity of juvenile particulation. In contrast, for the bulbous weakly particulating monocentric species *A.fuscoviolaceum* Fomin., the accumulation of individuals in the generative period within the age spectrum is primarily determined by favorability of habitat conditions. Single

individuals of this species, mainly of seed origin, appear to pass through the early stages of ontogenesis quite quickly, reaching the generative state, which accounts for the maximum percentage of plants observed in the characteristic age spectra noted during the studies. The high intensity of vegetative reproduction processes is the main reason for the increased proportion of pregenerative individuals in the CP of the species *A. rotundum* L. and *A. atroviolaceum* Boiss. The basic age spectra of these species are presented with an absolute maximum in juvenile fraction (Figures 2b, 2d).

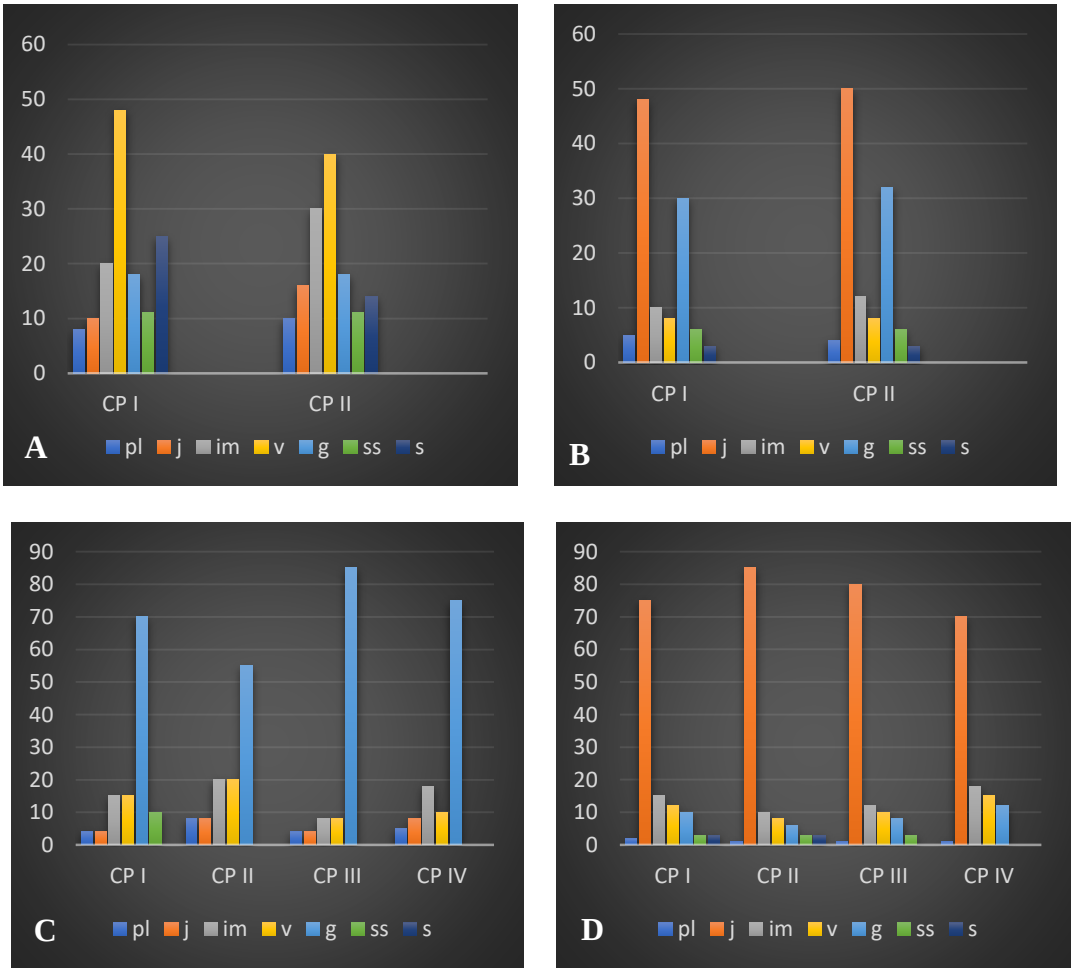

Figure 2. Age structure of the CP:**A -** *A.albidum* Fisch.ex Bieb.; **B -** *A.atroviolaceum* Boiss.; **C-** *A. fuscoviolaceum* Fomin.; **D-** *A. rotundum* L.

4. Conclusions

The studies have shown that several examined species are characterized by liability of the life form, which expressed in various growing conditions. Key external factors are the nature of the substrate and the degree of saturation of the upper soil horizon with the roots of accompanying species. The potential of morphological polyvariance of *A.albidum* Fisch. ex Bieb. is realized under conditions of low projective cover through the formation of rhizomes, allowing individuals to retain themselves in the soil and colonize open spaces. The high degree of heterogeneity of individual CPs reflects the protective component of variability under conditions of unfavorable abiotic (CPIII *A.*

rotundum L.), cenotic (CPIII *A. fuscoviolaceum* Fomin.) and anthropogenic (CPI *A. albidum* Fisch. ex Bieb.) influences.

The assessment of natural onion cenolopulations showed that 3 CPs (CP IV *A.rotundum* L,CP I *A. albidum* Fisch. ex Bieb,CP II *A. fuscoviolaceum* Fomin.) are in a critical state; of these, the most vulnerable is CP IV*A. rotundum* L., which is subject to high anthropogenic pressure in the form of excessive trampling (for the purpose of collecting and selling on the market both fresh and salted) and overgrazing by cattle. The remaining studied CP species of the genus *Allium* L. are in a satisfactory condition.

Thus, within the plain, foothill and mountain zones of the Lesser Caucasus on the territory of Azerbaijan, 12 coenopopulations of 4 species of the genus *Allium* L. were studied. The number, density and spatial extend of the cenopopulations of the studied species frequently decrease under the influence of unfavorable soil and climate conditions, phytocenotic tension and anthropogenic pressure. The studied species are phenologically plastic and complete their seasonal development cycle in various growing conditions. The main features of the age structure of the CP are associated with the biological properties of the species. The lability of the life form of wild onion species is related to enhanced of rhizome growth, the divergence of separated particles, fluctuations in vegetative reproduction activity. The primary external factors influencing these processes including substrate mobility and composition, as well as the level of interspecific competition within the phytocenosis.

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