

Research Article

<https://doi.org/10.31489/2026FEB2/79-90>

UDC 581.6:615 (574):582.57

Received: 15.01.2026 | Accepted: 5.03.2026 | Published online: 30 June 2026

N.G. Gemejiyeva^{1*}, L.A. Dimeyeva¹, D.Sh. Abdildanov^{1,2}, N.V. Friesen³

¹RSE on REM "Institute of Botany and Phytointroduction" FWC MENR RK, Almaty, Kazakhstan;

²Al-Farabi Kazakh National University, Almaty, Kazakhstan;

³Botanical Garden of the University of Osnabrück, Germany

*Corresponding author: ngemed58@mail.ru

Altitudinal zonality and phytocenotic diversity of plant communities with participation of species of the genus *Allium* L. in the northern macroslope of the Kyrgyz Alatau mountains

The Kyrgyz Alatau is the westernmost range of the Northern Tien Shan. The western part of the northern macroslope of the range, with absolute heights of up to 3,700 metres above sea level, is located within Kazakhstan. This mountainous country is characterised by a "Kyrgyz type of altitudinal zonality", reflecting a connection with the vegetation of the Western Tien Shan. After identifying herbarium and expedition specimens, the revised checklist of the genus *Allium* L. includes 25 taxa, including the rare species *A. suworowii* and two subendemics (*A. margaritae*, *A. trachyscordum*). An analysis of the phytocenotic and altitudinal distribution of habitats of 19 species of the genus *Allium* L., identified during 2024-2025 in 14 gorges of the northern macroslope of the Kyrgyz Alatau range showed that their distribution in the mountains begins with the savannoid and meadow steppe subbelts, continues with the belt of juniper woodland belt, the belt of subalpine meadows and prostrate juniper thickets, and ends with the alpine belt of cryophytic meadows and communities of kobresia. The gorges of the western low- and mid-mountain part of the range are characterised by species diversity of onions: Sogety, Makpal, Ulken Almaly, Tastambek, Uzynbulak, as well as the Karakystak gorge located to the east, where 5 to 6 species of onions are found. Based on showing the locations of 19 identified wild species of the genus *Allium* L. on the northern macroslope of the studied range was created.

Keywords: altitudinal distribution, the genus *Allium* L., Kyrgyz Alatau range, phytocenotic diversity.

Introduction

The Kyrgyz Alatau range is the western most of the Northern Tien Shan ranges. The western part of the northern macro-slope of the range, with absolute heights of up to 3,700 metres above sea level, is located within Kazakhstan. This mountainous country is characterised by the "Kyrgyz type of altitudinal zonality" [1], which shows a connection with the vegetation of the Western Tien Shan, expressed in the abundance of ephemerals and ephemeroïds in the steppe zone on the foothill plains, in the appearance of a zone of juniper woodland and in the fragmentary nature of the forest zone. For the western part of the northern macroslope, patterns of zonal distribution of vegetation cover have been identified [2]. Within the highlands, there is an alpine belt of cryophytic low-grass meadows (2800–3500 m above sea level / asl) and a belt of subalpine meadows and prostrate juniper thickets (2200–2800 m asl). The middle mountains are characterised by a belt of juniper woodland (1600–2200 m asl). Within the low mountains, foothill plains and hills, there is a steppe belt with three sub-belts: meadow steppes (1200–1600 m asl), savannoid steppes (800–1200 m asl), and desert steppes (500–800 m asl). The foothill plain is home to a belt of foothill deserts (400–500 m asl).

For the territory of the Kyrgyz Alatau in Kazakhstan, based on analysis of herbarium and field research data, a preliminary list of 27 species of the genus *Allium* L. was compiled [3, 4]. To date, after the identification of expeditionary and herbarium specimens of the genus *Allium* L. of the western part of the Kyrgyz Range, the updated list includes 25 species: *Allium atosanguineum* Schrenk, *A. barszczewskii* Lipsky, *A. caeruleum* Pall., *A. caesium* Schrenk, *A. caricifolium* Kar. et Kir., *A. dasyphyllum* Vved., *A. fetisowii* Regel, *A. hymenorhizum* Ledeb., *A. karataviense* Regel, *A. leptomorphum* Vved., *A. longiradiatum* (Regel)

Vved., *A. margaritae* B. Fedtsch., *A. obliquum* L., *A. oreoprasoides* Vved., *A. oreoprasum* Schrenk, *A. parvulum* Vved., *A. platyspathum* Schrenk, *A. platystemon* Kar. & Kir. (syn. *A. oreophilum* C.A. Mey.), *A. polyphyllum* Kar. et Kir., *Allium sativum* L. (syn. *A. longicuspis* Regel), *A. semenovii* Regel, *A. suworowii* Regel, *A. taschkenticum* F.O. Khass. et R.M. Fritsch, *A. trachyscordum* Vved., *A. turkestanicum* Regel [5], including one endemic (*A. oreoprasoides*) [6], 2 sub-endemics (*A. margaritae*, *A. trachyscordum*), which are also found in Kyrgyzstan [7], and a rare species from the Red Book of Kazakhstan [8] — *A. suworowii*.

Comparison of the given list of onions from the western part of the Kyrgyz Alatau with the published regional lists of species of the genus *Allium* L. showed that, out of 42 onion species in the Zhetysu Alatau, 12 are found on both ranges under similar ecological conditions [9]. In the synopsis of onions of Eastern Kazakhstan, represented by 45 species, 5 species are common to these mountain regions (*A. hymenorhizum*, *A. obliquum*, *A. platyspathum*, *A. caeruleum*, *A. platystemon* (syn. *A. oreophilum*) [10]. For the flora of the studied and desert Aral-Balkhash regions, only 3 common species (*A. margaritae*, *A. turkestanicum*, *A. suworowii*) were noted [11], which generally indicates a wide ecological range of growth of species of the genus under study.

The purpose of these studies is to continue the analysis of the phytocenotic and altitudinal confinement of habitats of species of the genus *Allium* L., identified during field studies in 2024-2025 in the gorges of the western part of the Kyrgyz Alatau Range, which began in 2024.

Experimental

The material for the studies was the natural populations of onions identified during field studies in 2024-2025 in the gorges of the western part of the Kyrgyz Alatau Range, located within the Junggar-North Tien Shan Province, the Kyrgyz mountain subprovince [12].

When conducting field research, generally accepted methods of floristic, geobotanical and cartographic research were used. The determination of plant species was carried out on the basis of the 9-volume edition of “Flora of Kazakhstan” [13], “Illustrated Guide...” [14]. The taxonomy of species is consistent with the Internet resources Plantarium.ru and Plants of the World Online (POWO) [15, 16], but the authors adhere to their own view on the species affiliation of some taxa. To create maps of wild onion locations within the studied range, the coordinates obtained using the Garmin GPS navigator were plotted on a cartographic base and formatted in ESRI ArcGIS Desktop 10.8. On a cartographic basis, an updated digital geographical basis at a scale of 1:2500000 of the FSBI “VSEGEI” was used.

To characterize the vegetation of the high-altitude zones, the following stock materials collected during the implementation of the program: “Botanical diversity of wild relatives of cultivated plants of Kazakhstan as a source of enrichment and preservation of the gene pool of agrobio diversity for the implementation of the food program” (2013–2015) were also used, and the characteristics of the floristic composition of individual gorges (Merke, Karakystak) were supplemented by materials from the article by N.V. Nelina et al. [17].

The study of altitudinal-zonal patterns of vegetation cover was carried out using traditional methods of field geobotanical research [18], including landscape-ecological profiling and description of the main plant communities.

Results and Discussion

Field studies conducted during 2024-2025 have so far identified the localities of 19 species of the genus *Allium* L. in 14 surveyed gorges of the range and established that their distribution in the altitude range in the mountains begins from the subbelt of savannoid steppes, where, in the vegetation cover, in addition to typical steppe bunch grasses, savannoids are distributed. Steppes are combined with thickets of shrubs, rocks and screes with sparse aggregations of upland xerophytes and petrophytes, gallery forests with a layer of shrubs and grass-forb meadows. On the slopes with steppe vegetation and steppe meadows, species grow: *A. barsczewskii*, *A. caeruleum*, *A. karataviense*, *A. suworowii*, *A. caesium*, *A. fetisowii* (Table 1).

Altitudinal distribution of species of the genus *Allium* L. identified in the western part of the Kyrgyz Alatau Mountains

Altitudinal belt	Height (m asl)	Floristic diversity of communities with participation of <i>Allium</i> L. species	Species
Cryophytic low-grass meadows	2800–3500	<i>Alchemilla retropilosa</i> Juz., <i>Bistorta vivipara</i> (L.) Delarbre, <i>Potentilla crantzii</i> (Crantz) Beck ex Fritsch, <i>Festuca kryloviana</i> Reverd., <i>Poa alpina</i> L., <i>Carex alatauensis</i> S.R. Zhang, <i>C. capillifolia</i> (Decne.) S.R. Zhang, <i>Thylacospermum caespitosum</i> (Cambess.) Schischk., <i>Rhodiola coccinea</i> (Royle) Boriss., <i>Saxifraga macrocalyx</i> Tolm., <i>Lonicera semenovii</i> Regel, <i>Ephedra regeliana</i> Florin, <i>Potentilla crantzii</i> (Crantz) Beck ex Fritsch, <i>Allardia tomentosa</i> Decne., <i>Saussurea gnaphalodes</i> (Royle ex DC.) Sch. Bip. [1].	<i>A. atosanguineum</i>
Subalpine meadows and prostrate juniper thickets	2200–2800	<i>Juniperus pseudosabina</i> Fisch. & C.A. Mey., <i>J. semiglobosa</i> Regel, <i>Phlomoides oreophila</i> (Kar. & Kir.) Adylov, Kamelin & Makhm., <i>Bistorta elliptica</i> (Willd. ex Spreng.) V.V. Petrovsky, D.F. Murray & Elven, <i>Trifolium repens</i> L., <i>T. pratense</i> L., <i>Ziziphora clinopodioides</i> Lam., <i>Potentilla nivea</i> L., <i>Acantholimon fetissoyii</i> Regel, <i>A. purpureum</i> Korovin, <i>A. alberti</i> Regel, <i>Sibbaldianthe bifurca</i> (L.) Kurtto & T. Erikss.), <i>Rhodiola kirilowii</i> (Regel) Maxim., <i>Myosotis asiatica</i> (Vesterg.) Schischk. & Serg., <i>Iris ruthenica</i> Ker Gawl., <i>Alchemilla retropilosa</i> Juz., <i>A. sibirica</i> Zämelis, <i>Koenigia alpina</i> (All.) T.M. Schust. & Reveal, <i>Lamium album</i> L., <i>Achillea millefolium</i> L., <i>Artemisia stechmanniana</i> Besser, <i>Asperugo procumbens</i> L., <i>Alopecurus arundinaceus</i> Poir., <i>Helictochloa hookeri</i> (Scribn.) Romero Zarco, <i>Poa pratensis</i> L., <i>P. angustifolia</i> L., <i>Phleum phleoides</i> (L.) H. Karst., <i>Dactylis glomerata</i> L., <i>Festuca valesiaca</i> Schleich. ex Gaudin.	<i>A. atosanguineum</i> , <i>A. hymenorhizum</i> , <i>A. fedtschenkoanum</i> , <i>A. filifolium</i> , <i>A. polyphyllum</i> , <i>A. schoenoprasoides</i>
Juniper woodlands	1600–2200	<i>Juniperus pseudosabina</i> , <i>J. semiglobosa</i> , <i>Sorbus tianshanica</i> Rupr., <i>Lonicera microphylla</i> Willd. ex Schult., <i>Salix triandra</i> L., <i>Rosa platyacantha</i> Schrenk, <i>Spiraea lasiocarpa</i> Kar. & Kir., <i>Ephedra equisetina</i> Bunge, <i>Atraphaxis pyrifolia</i> Bunge, <i>Atragene sibirica</i> L., <i>Festuca valesiaca</i> , <i>Helictochloa hookeri</i> , <i>Stipa kirghisorum</i> P.A. Smirn., <i>Phleum phleoides</i> , <i>Phlomoides pratensis</i> (Kar. & Kir.) Adylov, Kamelin & Makhm., <i>Melica transsilvanica</i> Schur, <i>Catabrosa aquatica</i> (L.) P.Beauv., <i>Bromus inermis</i> Steven, <i>Lolium pratense</i> (Huds.) Darbysh., <i>Phleum phleoides</i> , <i>Patrinia intermedia</i> (Hornem.) Roem. & Schult., <i>Delphinium oreophyllum</i> Huth, <i>Hypericum perforatum</i> L., <i>Medicago falcata</i> L., <i>Potentilla inclinata</i> Vill., <i>Thalictrum minus</i> subsp. <i>saxatile</i> Gaudin, <i>Eremurus tianschanicus</i> Pazij & Vved. ex Pavlov	<i>A. caesium</i> , <i>A. fetisowii</i> <i>A. leptomorphum</i> , <i>A. renardii</i> , <i>A. talassicum</i>

Altitudinal belt	Height (m asl)	Floristic diversity of communities with participation of <i>Allium</i> L. species	Species
Steppes: Meadow steppes	1200–1600	<i>Prunus erythrocarpa</i> (Nevski) Gilli, <i>P. griffithii</i> var. <i>tianshanica</i> (Pojark.) Ingram, <i>Atraphaxis pyrifolia</i> , <i>A. virgata</i> (Regel) Krasn., <i>Spiraea hypericifolia</i> L., <i>Acer semenovii</i> Regel & Herder, <i>Crataegus chromorcarpa</i> Lenné & K. Koch, <i>C. sanguinea</i> Pall., <i>C. turkestanica</i> Pojark., <i>C. songarica</i> K. Koch, <i>Salix alba</i> L., <i>Rosa beggeriana</i> Schrenk ex Fisch. & C.A. Mey., <i>R. platyacantha</i> , <i>Rubus caesius</i> L., <i>Hippophae rhamnoides</i> L., <i>Festuca valesiaca</i> , <i>Stipa capillata</i> L., <i>Bothriochloa ischaemum</i> (L.) Keng, <i>Bromus lanceolatus</i> Roth, <i>Aegilops cylindrica</i> Host, <i>Taeniatherum caput-medusae</i> (L.) Nevski, <i>Hordeum murinum</i> subsp. <i>leporinum</i> (Link) Arcang., <i>Poa bulbosa</i> L., <i>Lolium pratense</i> (Huds.) Darbysh., <i>Elymus repens</i> (L.) Gould, <i>Thinopyrum intermedium</i> subsp. <i>intermedium</i> , <i>Cynodon dactylon</i> (L.) Pers., <i>Astragalus</i> L., <i>Calamagrostis pseudophragmites</i> (Haller f.) Koeler, <i>Bromus inermis</i> Leyss., <i>Eremurus tianschanicus</i> , <i>Acantholimon</i> Boiss., <i>Ziziphora clinopodioides</i> , <i>Hypericum scabrum</i> L., <i>H. perforatum</i> , <i>Mentha longifolia</i> (L.) L., <i>Glycyrrhiza uralensis</i> Fisch. ex DC., <i>Plantago lanceolata</i> L., <i>Inula britannica</i> L., <i>Galium aparine</i> L., <i>Medicago falcata</i> L., <i>Lathyrus pratensis</i> L., <i>Vicia cracca</i> L.	<i>A. barszczewskii</i> , <i>A. caeruleum</i> , <i>A. karataviense</i> , <i>A. suworowii</i> , <i>A. caesium</i> , <i>A. fetisowii</i>
Savannoid steppes	800–1200	<i>Pistacia vera</i> L., <i>Acer semenovii</i> Regel & Herder, <i>Pyrus regelii</i> Rehder, <i>Atraphaxis pyrifolia</i> , <i>Rosa platyacantha</i> , <i>Ephedra equisetina</i> , <i>Prunus griffithii</i> var. <i>tianshanica</i> , <i>Allochrysa gypsophilloides</i> (Regel) Schischk., <i>Thinopyrum intermedium</i> subsp. <i>intermedium</i> , <i>Festuca valesiaca</i> , <i>Stipa caucasica</i> Schmalh., <i>Galium verum</i> L., <i>Ziziphora clinopodioides</i> , <i>Crupina vulgaris</i> Pers. ex Cass., <i>Crambe cordifolia</i> subsp. <i>kotschyana</i> (Boiss.) Jafri, <i>Bromus japonicus</i> Houtt., <i>Taeniatherum caput-medusae</i> [19]	<i>A. barszczewskii</i> <i>A. caeruleum</i> <i>A. caesium</i> , <i>A. caricifolium</i> <i>A. fetisowii</i> , <i>A. karataviense</i> , <i>A. margaritae</i> , <i>A. sativum</i> , <i>A. suworowii</i> , <i>A. trachyscordum</i>

Savannoid woodlands with pistachio and low trees of Semenov's maple and Regel's pear are found on the steep, stony, dry slopes of southwestern exposure. Shrubs (*Atraphaxis pyrifolia*, *Rosa platyacantha*, *Ephedra equisetina*, *Prunus griffithii* var. *tianshanica*) are sporadically noted. The grass layer is represented by wheatgrass, fescue, ephemeroideis, forbs and annual savannoid grasses (*Bromus japonicus*, *Taeniatherum caput-medusae*) [19], including species of onion (*A. caricifolium*, *A. margaritae*, *A. sativum*, *A. trachyscordum*).

The identified onion species were often found in forb-grass, forb-shrub-grass, petrophytic-forb-shrub, and petrophytic-arboreal-shrub communities. In the low and middle mountains, 13 species (*A. barszczewskii*, *A. caeruleum*, *A. caesium*, *A. caricifolium*, *A. fetisowii*, *A. karataviense*, *A. leptomorphum*, *A. margaritae*, *A. renardii*, *A. sativum*, *A. talassicum*, *A. trachyscordum*, and the rare species *A. suworowii*) grew in the altitudinal range from 1050 to 1972 m asl. Six species (*A. atosanguineum*, *A. hymenorhizum*, *A. fedtschenkoanum*, *A. filifolium*, *A. polyphyllum*, *A. schoenoprasoides*) were noted in the subalpine zone at absolute altitudes of 2431–2667 m (Table 2).

The greatest phytocenotic diversity is formed in intermountain gorges and river valleys, where the main diversity of onion species is concentrated (*A. barsczewskii*, *A. caricifolium*, *A. sativum*, *A. trachyscordum*, *A. fetisowii*, *A. caesium*, etc.) (Fig. 1). Stony slopes are characterized by *A. caricifolium*, *A. karataviense*, and *A. trachyscordum*, which are found in the gorges of Tastambek, Kara-Arsha, and Makpal. A rare species of *A. suworowii* is found in the valley of the Kayindy River of the Makpal gorge under the canopy of *Acer semenovii*, *Prunus armeniaca* L., with the participation of shrubs (*Rubus caesius*, *Rosa laxa* Retz.) and forbs (*Salvia deserta* Schangin, *Sophora alopecuroides* L., *Conioselinum tataricum* Hoffm., *Origanum tyttanthum* Gontsch. etc.), and in the Sogety gorge it is noted in the river valley among tree and shrub vegetation.

Table 2

**Altitudinal confinement of species of the genus *Allium* L identified in 2024-2025
in the surveyed gorges of the Kyrgyz Alatau**

Species	Gorges / altitude, m asl													
	Auliekol	Ulken Almaly	Kaska-su	Kara-kystak	Kara-sai	Kara- Arsha	Kur-sai	Mak-pal	Merke	Mola-ly	Kyzyl-kaynar Pass	Sogety	Tastam-bek	Uzyn-bulak
<i>Allium atrosanguineum</i>			3390	2520							2667			
<i>A. barsczewskii</i>		1387						1182						1100
<i>A. caeruleum</i>		1200 1387			1391		1100					1270 1290	1113	1100
<i>A. caesium</i>				1808				1182		1761		1320	1113	1100
<i>A. caricifolium</i>								1182						
<i>A. hymenorhizum</i>	2431													
<i>A. fedtschenkoanum</i>											2637			
<i>A. fetisowii</i>		1387		1808		1052	1100			1972		1270	1113	1100
<i>A. filifolium</i>	2431 2440													
<i>A. karataviense</i>		1200 1387			1391		1100		1391			1270	1113	1100
<i>A. leptomorphum</i>				1660										
<i>A. margaritae</i>		1200												
<i>A. polyphyllum</i>											2667			
<i>A. renardii</i>										1911				
<i>A. sativum</i>								1070				1170		
<i>A. schoenoprasoides</i>	2440													
<i>A. suworowii</i>								1182 1070				1270		
<i>A. talassicum</i>				1808										
<i>A. trachyscordum</i>						1050 1069		1123					1083 1131	
Total species	3	5	1	5	2	2	3	6	1	3	3	6	5	5

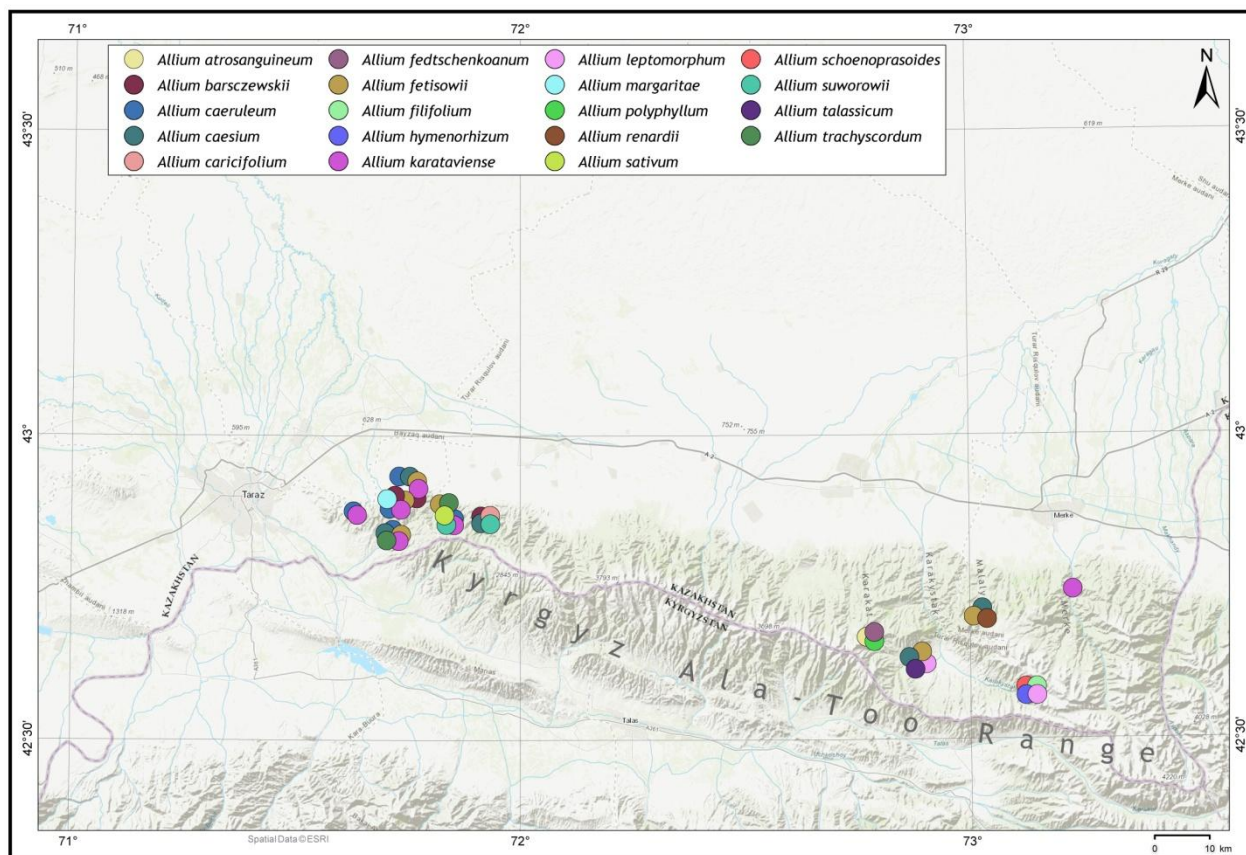


Figure 1. — Map of the localities of wild species of the genus *Allium* L. identified in 2024-2025 on the northern macroslope of the Kyrghyz Alatau range

Wild garlic (*A. sativum*) was found in the Sogety gorge in the weed-bluegrass community, where *Poa bulbosa*, *Euphorbia virgata* Waldst. & Kit., *Galium aparine*, *Mentha longifolia*, *Achillea millefolium*, *Sonchus palustris* L., *Artemisia dracunculus* L., *Sisymbrium loeselii* L. are also noted in the species composition. In the Makpal gorge, this species is found in abundance of “sp” in floodplain meadows.

In the Ulken Almaly gorge, on the stony southern slope, three species of onions grow at once (*A. margaritae*, *A. caeruleum*, *A. karataviense*) as part of an ephemeroïd-grass with the participation of spirea and bassia (*Stipa caucasica*, *Bromus japonicus*, *Eremurus* sp, *Rheum cordatum* Losinsk., *Spiraea hypericifolia*, *Bassia prostrata* (L.) Beck) community.

In the Makpal gorge on the right bank of the Kayindy River, six species of onions (*A. barszewskii*, *A. caesium*, *A. caricifolium*, *A. sativum*, *A. suworowii*, *A. trachyscordum*) were found, confined to forbs and shrubs (*Spiraea hypericifolia*, *Atraphaxis pyrifolia*, *Rosa plathyacantha*, *Hypericum perforatum*, *H. scabrum*, *Salvia deserta*, *Rheum cordatum*, *Haplophyllum latifolium* Kar. & Kir, *Betonica betoniciflora* (Rupr. ex O. Fedtsch. & B. Fedtsch.) Sennikov, *Helichrysum maracandicum* Popov ex Kirp., *Ziziphora clinopodioides*, *Centaurea virgata* subsp. *squarrosa* (Boiss.) Gugler) cenoses.

The subendemic species *A. trachyscordum* was found in the Tastambek, Makpal and Kara-Arsha gorges on stony screes in separate clumps among the thickets of shrubs (*Prunus griffithii* var. *tianshanica*, *Spiraea hypericifolia*, *Atraphaxis pyrifolia*) and forbs (*Gypsophila paniculata* L., *Salvia sclarea* L., *Hypericum scabrum*, *Rheum cordatum*, *Euphorbia virgata*, *Alcea nudiflora* (Lindl.) Boiss., *Tulipa greigii* Regel, *Capparis spinosa* var. *herbacea* (Willd.) Fici.).

According to previous studies, *A. caeruleum* was found in forb-grass floodplain meadows (*Elymus repens*, *Thinopyrum intermedium* subsp. *intermedium*, *Medicago falcata*, *Hypericum perforatum*, *Achillea asiatica* Serg., *Sanguisorba officinalis* L., *Mentha longifolia*) in the gorge of the Kogershin river at an altitude of 1182 m asl.

In the subbelt of meadow steppes, rich forb–grass–fescue communities are represented. Fescue (*Festuca valesiaca*) dominates, with less abundant other steppe grasses (*Stipa capillata*, *S. kirghisorum* P.A. Smirn.,

Helictochloa hookeri, *Phleum phleoides*), meadow-steppe species (*Salvia deserta*, *Nepeta nuda* subsp. *nuda*, *Galium verum*, *Phlomoides pratensis*, *Dactylis glomerata*, *Geranium collinum* Stephan ex Willd.).

Meadow steppes are combined with shrub thickets on stony slopes (*Spiraea hypericifolia*, *Rosa spinosissima* L., *Atraphaxis pyrifolia*, *Juniperus pseudosabina*) with species of *Eremurus* M.Bieb. (*E. regelii* Vved., *E. tianshanicus*, *E. cristatus* Vved.) and savannoids in the grass layer (*Taeniatherum caput-medusae*, *Aegilops cylindrica*, *Botriochloa ischaemum*). In the Sogety Gorge, among the thickets of shrubs (*Atraphaxis pyrifolia*, *Prunus griffithii* var. *tianshanica*, *Ephedra equisetina*), *A. caesium*, *A. caeruleum*, *A. fetisowii*, *A. sativum*, *A. suworowii*, and *A. karataviense*, which is confined to the outcrops of bedrock.

Gallery forests in the Makpal gorges (Kayindy river valley), Karakystak and Merke form *Salix cinerea* L., *S. alba* L., and *Acer semenovii*, in the shrub layer — *Rosa beggeriana*, *Lonicera microphylla*, *Euonimus semenovii* Regel & Herder, *Rubus caesus*, *Berberis heteropoda* Schrenk ex Fisch. & C.A. Mey. The grass layer is formed by tall grasses: *Catabrosa aquatica*, *Melica transsilvanica*, *Phalaris arundinacea* L. and variegated forbs (*Medicago falcata*, *Nepeta nuda* subsp. *nuda*, *Potentilla inclinata* Vill., *Elwendia setacea* (Schrenk) Pimenov & Kljuykov, *Impatiens parviflora* DC.).

According to early field studies, rich forb-grass steppe meadows and meadow steppes are common in the intermountain valley of the Karabulak (1485–1588 m asl). The dominant species are wheatgrass (*Thinopyrum intermedium* subsp. *intermedium*, *Elymus repens*) and fescue grass (*Festuca valesiaca*). Among the steppe forbs: *Salvia deserta*, *Elwendia setacea*, *Nepeta nuda* subsp. *nuda*, *Medicago falcata*. Meadow forbs are represented by: *Achillea millefolium*, *A. asiatica*, *Potentilla asiatica* (Th. Wolf) Juz., *P. inclinata*, *Pulsatilla patens* subsp. *multifida* (Pritz.) Zämelis, *Jacobaea vulgaris* Gaertn., *Jacobaea erucifolia* (L.) G. Gaertn., B. Mey. & Scherb., *Dipsacus azureus* Schrenk ex Fisch. & C.A. Mey., *Origanum vulgare* L., *Hypericum perforatum*, *Lathyrus tuberosus* L., *L. pratensis*, *Rumex confertus* Willd., *Phlomoides fetisowii* (Regel) Adylov, Kamelin & Makhm., *Betonica betoniciflora*, *Trifolium hybridum* L. Meadow communities are often dominated by grasses (*Dactylis glomerata*, *Elymus repens*, *Bromus inermis*), projective coverage of onion (*A. caesium*, *A. caeruleum*) is up to 10 %. According to field observations from 2024–2025, these species were also found in the Kursai, Karasai, Sogety, Uzynbulak and Tastambek gorges, where they grow not only in meadows, but also in shrub thickets (*Prunus griffithii* var. *tianshanica*, *Rosa platyacantha*, *Atraphaxis pyrifolia*, *A. virgata*, *Spiraea hypericifolia*) on the slopes of the southern exposure. In the grass layer, there are: *Alcea nudiflora*, *Rheum cordatum*, *Epilobium angustifolium* L., *Galium verum*.

Floodplain meadows in the valley of the Shalsu River (1377 m asl) are formed by cereals and forbs (*Elymus repens*, *Dactylis glomerata*, *Mentha longifolia*, *Achillea millefolium*, *Origanum vulgare*). Shrub thickets are formed by rosehips (*Rosa platiacantha*, *R. beggeriana*). Apricot, Djungarian hawthorn, juniper (*Juniperus semiglobosa*) are sporadically found on stony cliffs. The meadow vegetation of high river terraces is diverse and forb-grass (*Elytrigia repens*, *Achillea millefolium*, *Carex* sp., *Potentilla inclinata*, *Nepeta nuda* subsp. *nuda*, *Galium verum*, *Vickifunkia thomsonii* (C.B. Clarke) C. Ren, L. Wang, I.D. Illar. & Q.E. Yang, *Dipsacus azureus*), where *A. caesium* occurs in abundance with “sp”. *A. caeruleum* grew on a low river terrace in floodplain meadows (*Dactylis glomerata*, *Nepeta nuda* subsp. *nuda*, *Lathyrus pratensis*, *Mentha longifolia*, *Malva pusilla* Sm.).

In the valley of the Almaly river, in hydromorphic habitats, the consists of Semenov’s maple (*Acer semenovii*) and Sivers’ apple tree (*Malus sieversii* (Ledeb.) M. Roem.). The vegetation of the floodplain meadows is forb-grass with a predominance of reed (*Phragmites australis* (Cav.) Trin. ex Steud.) and an abundance of *Mentha longifolia*, *Lathyrus pratensis*, *Vicia cracca* L.). On the stony slopes, shrub thickets (*Lonicera microphylla*, *Spiraea hypericifolia*, *Ephedra equisetina*) are common, in which onion species (*A. barszczewskii*, *A. caeruleum*, *A. fetisowii*) are found.

Juniper woodland belt is represented by shrub-juniper woodlands (*Juniperus pseudosabina*, *J. semiglobosa*, *Rosa platyacantha*, *Spiraea lasiocarpa* Kar. & Kir., *Ephedra equisetina*, *Atraphaxis pyrifolia*, *Atragene sibirica* L.) on stony slopes in combination with meadows and steppes (*Festuca valesiaca*, *Helictochloa hookeri*, *Stipa kirghisorum*, *Phleum phleoides*, *Phlomoides pratensis*). In the Merke Gorge, dense shrub thickets are formed by the following species: *Rosa platyacantha*, *R. beggeriana*, *Spiraea hypericifolia*, *S. lasiocarpa*, *Sorbus tianshanica*, *Lonicera microphylla*, *Salix triandra*. Grasses (*Melica transsilvanica*, *Catabrosa aquatica*, *Bromus inermis*, *Lolium pratense*, *Phleum phleoides*) and forbs (*Patrinia intermedia*, *Delphinium oreophyllum*, *Hypericum perforatum*, *Medicago falcata*, *Potentilla inclinata*, *Thalictrum minus* subsp. *saxatile* Gaudin, *Eremurus tianshanicus*, *A. caesium*, etc.) take part in the formation of the herbal layer. *A. caesium* is also found in meadow forbs in the valleys of the Terekty and Molaly rivers.

Juniper woodlands in the Kogershin Gorge are confined to steep slopes. In the lower part of the slopes, dense shrub thickets are formed with the dominance of *Rosa spinosissima* and the participation of *R. beggeriana*, *Cotoneaster uniflorus* Bunge, *Lonicera microphylla*, and *Spiraea hypericifolia*. In the herbal layer, there are meadow forbs (*Campanula glomerata* L., *Veronica spuria* L., *Lathyrus pratensis*, *Origanum vulgare*, *Achillea asiatica*, *Thalictrum minus* subsp. *saxatile*, etc.). Steppe meadows and meadow steppes are spread along the valleys and gentle slopes. Steppe grasses (*Festuca valesiaca*, *Stipa kirghisorum*, *S. capillata*, *Phleum phleoides*) and meadow grasses (*Alopecurus arundinaceus*, *Elymus repens*) occupy the same projective cover. Meadow forbs are up to 20 species, including *A. caeruleum* and many forage and resource-significant species (*Trifolium repens*, *Achillea millefolium*, *Ziziphora clinopodioides*, *Rumex confertus*, *Artemisia dracuncululus*, *Hypericum perforatum*). It should be noted that in this altitudinal belt, *A. leptomorphum*, and *A. talassicum* (Karakystak Gorge) are found on stony slopes. Habitats *A. fetisowii*, *A. renardii* is confined to steppe slopes and shrub thickets in the Molaly and Karakystak gorges.

The belt of subalpine meadows and prostrate juniper thickets is characterized by grass-rich, forb-grass and steppe meadows with the participation of prostrate (*J. pseudosabina*) and tree junipers (*J. semiglobosa*), and spiny pads (*Acantholimon fetisovii*, *A. purpureum*, *A. alberti*). On dry slopes, steppe communities grow. Steppe meadows are formed by grasses and forbs. In 2024–2025, *A. atosanguineum*, *A. hymenorhizum*, *A. filifolium*, *A. polyphyllum*, *A. schoenoprasoides*, *A. fedtschenkoanum* were recorded in this belt. They are confined to the upper reaches of the Karakystak River (Auliekol Gorge) and the Kyzylkaynar Pass.

In the alpine belt cryophytic low-grass meadows are widespread, as well as kobresia communities (*Carex alatauensis*, *C. capillifolia*). The tops of the ranges are occupied by open aggregations of cryophilic petrophytes from genera: *Thylacospermum* Fenzl, *Rhodiola* L., *Saxifraga* Tourn. ex L., *Lonicera* L., *Ephedra* Tourn. ex L., grow on stony slopes, rocks, moraines, screes. The cracks of the rock occupy *Potentilla crantzii*, *Allardia tomentosa* Decne., *Saussurea gnaphalodes* [1]. In this belt there are: *A. atosanguineum*, *A. hymenorhizum* (Kaskasu Gorge).

According to the herbarium (AA), *A. polyphyllum* grows near snowfields.

Conclusion

For the first time, an analysis of the phytocoenotic and altitudinal distribution of habitats for 19 species of the genus *Allium* L. was conducted in 14 gorges on the northern macroslope of the Kyrgyz Alatau mountain range.

It was established that the distribution of wild onions in the mountains begins at the savannoid and meadow steppe sub-belts, continues at the belts of juniper woodlands subalpine meadows and prostrate juniper thickets, and ends with the alpine belt of cryophytic meadows and communities of kobresia.

Most of the species are found in the steppe belt, where 10 of the 14 identified species grow: *A. barsczewskii*, *A. caeruleum*, *A. caesium*, *A. caricifolium*, *A. fetisowii*, *A. karataviense*, *A. margaritae*, *A. suworowii*, *A. sativum*, *A. trachyscordum*.

About half of the species (6) prefer the subalpine meadows: *A. atosanguineum*, *A. hymenorhizum*, *A. fedtschenkoanum*, *A. filifolium*, *A. polyphyllum*, *A. schoenoprasoides*.

The identified onion species were often found in forb-grass, forb-shrub-grass, petrophytic-forb-shrub, and petrophytic-arboreal-shrub communities. In the low and middle mountains, 13 species (*A. barsczewskii*, *A. caeruleum*, *A. caesium*, *A. caricifolium*, *A. fetisowii*, *A. karataviense*, *A. leptomorphum*, *A. margaritae*, *A. renardii*, *A. sativum*, *A. talassicum*, *A. trachyscordum*, and the rare species *A. suworowii*) grew in the altitude range from 1050 to 1972 m asl. Six species (*A. atosanguineum*, *A. hymenorhizum*, *A. fedtschenkoanum*, *A. filifolium*, *A. polyphyllum*, *A. schoenoprasoides*) were noted in the subalpine zone at altitudes of 2431–2667 m asl.

A wide altitudinal range is possessed by *A. fetisowii* and *A. caesium* (1100–2000 m asl), occurring from lowland steppes to juniper woodlands.

The greatest diversity is distinguished in the gorges of Sogety (6 species), Makpal (6), Ulken Almaly (5). A rare species *A. suworowii* is found in the Sogety and Makpal gorges in the thickets of shrubs and floodplain meadows of the low mountains. Subendemics (*A. margaritae*, *A. trachyscordum*) grow in the gorges of Ulken Almaly, Makpal, Kara-Arsha in forb-shrub communities in the subbelt of savannoid steppes.

Based on field research, a map of the localities of 19 identified wild species of the genus *Allium* L. on the northern macroslope of the Kyrgyz Alatau range was created.

Funding

This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant AP23484591 “Comprehensive research (floristic, molecular genetic and resource) on the *Allium* L. genus of the Kyrgyz Alatau cross-border range — a scientific foundation for the management of the region’s natural resources” (2024–2026)).

Acknowledgments

We express our gratitude to I.A. Rybakov, cartographer, senior researcher of the laboratory of plant resources, for the created cartographic models. We thank the executors of this project: Professor Vesselova P.V., Professor Kudabayeva G.M., PhD Osmonali B.B., PhD Selyutina I.Y., researcher Ussen S., junior researcher Akhmetzhanova R., junior researcher Kenesbay A., who took part in the field research.

Author Contributions

The manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript. CRediT: **Gemejiyeva N.G.** — supervision, investigation, review & editing, visualization, funding acquisition; **Dimeyeva L.A.** — conceptualization, methodology, writing — original draft, writing — review & editing; **Abdildanov D.Sh.** — investigation, data curation, formal analysis; **Friesen N.V.** — investigation, writing — review & editing.

Conflict of Interest

The authors declare no conflict of interest.

References

- 1 Волкова Е.А. Растительный покров гор / Е.А. Волкова; под редакцией Е.И. Рачковской, Е.А. Волковой, В.Н. Храмова // Ботаническая география Казахстана и Средней Азии (в пределах пустынной области). — СПб.: Бостон-Спектр, 2003. — С. 167–191.
- 2 Димеева Л.А. Высотно-пооясная дифференциация растительного покрова Киргизского хребта в пределах Казахстана / Л.А. Димеева, К. Усен // Проблемы ботаники Южной Сибири и Монголии. Сб. науч. ст. по мат-лам Четырнадцатой междунар. науч.-практ. конф. — Барнаул, 2015. — С. 185–189.
- 3 Gemejiyeva N.G. Species composition and altitudinal distribution patterns of wild *Allium* L. relatives in the Kyrgyz Alatau mountain range / N.G. Gemejiyeva, G.T. Sitpayeva, L.A. Dimeyeva // XX International Botanical Congress IBC 2024, Spain. Book of Abstracts. Posters. Publisher: Fase 20 Ediciones. — P. 472.
- 4 Gemejiyeva N.G. Species of the genus *Allium* L. of the western part of the Kyrgyz Alatau range: the current status and prospects of studying / N.G. Gemejiyeva, D.Sh. Abdildanov, G.M. Kudabayeva, P.V. Vesselova, N.V. Nelina, N.V. Friesen // Fundamental and Experimental Biology. — 2025. — Vol. 30. — Issue 2(118). DOI: <https://doi.org/10.31489/2025feb2/13-25>
- 5 Vesselova P.V. Integral Assessment of Species of the Genus *Allium* L. (Amaryllidaceae) in the Western Part of the Kyrgyz Alatau / P.V. Vesselova, G.M. Kudabayeva, D.Sh. Abdildanov, B.B. Osmonali, S. Ussen, M.V. Skaptsov, N. Friesen // Plants. — 2025. — 14(18). — С. 2890. <https://doi.org/10.3390/plants14182890>.
- 6 Kubentayev S.A. Revised checklist of endemic vascular plants of Kazakhstan / S.A. Kubentayev, D.T. Alibekov, Y.V. Perezhogin, G.A. Lazkov, A.N. Kupriyanov, A.L. Ebel, K. Izbastina, O. Borodulina, B.B. Kubentayeva // PhytoKeys. — 2024. — 238. — С. 241–279. <https://doi.org/10.3897/phytokeys.238.114475>
- 7 Турдуматова Н.К. Род лук (*Allium* L.) в Кыргызстане (вопросы систематики, география и перспективы использования): автореф. дис. ... канд. биол. наук. — Бишкек, 2022. — 22 с.
- 8 Красная книга Казахстана / гл. ред. И.О. Байтулин; отв. ред. Г.Т. Ситпаева. — Изд. 2-е, исправл. и дополн. — Т. 2. — Ч. 1. Растения. — Астана: ТОО «АртPrintXX1», 2014. — 452 с.
- 9 Пермитина В.Н. Высотная приуроченность видов рода *Allium* L. (Liliaceae) гор Жетысуского Алатау [Электронный ресурс] / В.Н. Пермитина, Л.А. Димеева, А.И. Иманолинова // Проблемы ботаники Южной Сибири и Монголии, 2024. — Т. 23, № 2. — С. 308–312. — Режим доступа: <https://journal.asu.ru/bpssm/article/view/bpssm.2024110>.
- 10 Котухов Ю.А. Конспект луков Восточного Казахстана / Ю.А. Котухов, А.Н. Данилова, А.А. Сумбембаев, О.А. Ануфриева / отв. ред. А.Н. Куприянов. — Риддер: изд-во «Принт Центр», 2025. — 141 с.
- 11 Абдилданов Д.Ш. Разнообразие видов рода *Allium* флоры Арало-Балхашского региона / Д.Ш. Абдилданов, П.В. Веселова, Г.М. Кудабеева // Проблемы ботаники Южной Сибири и Монголии, 2023. — Т. 22, № 1. — С. 6–11. DOI: 10.14258/bpssm.2023001. URL: <https://journal.asu.ru/bpssm/article/view/bpssm.2023001>.
- 12 Рачковская Е.И. Принципы и основные единицы районирования / Е.И. Рачковская, И.Н. Сафронова, Е.А. Волкова. Под ред. Е.И. Рачковской, Е.А. Волковой, В.Н. Храмова // Ботаническая география Казахстана и Средней Азии (в пределах пустынной области). — СПб.: Бостон-Спектр, 2003. — С. 172–195.

13 Флора Казахстана: [в 9-и т.] / Ред. Н.В. Павлов. — Алма-Ата: Изд-во АН КазССР, 1956. — Т. 1. — 354 с.; 1958. — Т. 2. — 292 с.; 1960. — Т. 3. — 460 с.; 1961. — Т. 4. — 548 с.; 1961. — Т. 5. — 515 с.; 1963. — Т. 6. — 465 с.; 1964. — Т. 7. — 497 с.; 1965. — Т. 8. — 447 с.; 1966. — Т. 9. — 640 с.

14 Иллюстрированный определитель растений Казахстана [в 2-х т.] / Ред. В.П. Голоскоков. — Алма-Ата: Наука «Казахской ССР», 1969. — Т. 1. — 644 с.; 1972. — Т. 2. — 572 с.

15 Плантариум: открытый онлайн атлас-определитель растений и лишайников России и сопредельных стран. — 2007–2026. — [Электронный ресурс]. — Режим доступа: <http://www.plantarium.ru/>

16 POWO. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. — 2026. — [Electronic resource]. — Access mode: <https://powo.science.kew.org>.

17 Быков Б.А. Геоботаника / Б.А. Быков. — Алма-Ата: Наука, 1978. — 288 с.

18 Нелина Н.В. К видовому составу флоры ущелий Мерке и Каракыстак западной части Киргизского Алатау / Н.В. Нелина, Г.М. Кудобаева, С.К. Мухтубаева, Б.К. Билибаева // Проблемы ботаники Южной Сибири и Монголии: мат. XV Междунар. научно-практ. конф. — Барнаул, 2016. — С. 392–398.

19 Исламкулова А.Ф. Редколесья фисташников в Киргизском Алатау / А.Ф. Исламкулова, Н.Е. Зверев, К.Р. Калыбаев // Перспективы и пути развития промышленного ореховодства на юге Казахстана: сб. мат. Междунар. научно-практ. конф. — Шымкент, 2017. — С. 30–38.

Н.Г. Гемеджиева, Л.А. Димеева, Д.Ш. Абдилданов, Н.В. Фризен

Кыргыз Алатау жотасының солтүстік макробеткейінде *Allium L.* туыс түрлерінің қатысуымен қауымдастықтардың биіктігі мен фитоценодикалық әртүрлілігі

Кыргыз Алатауы Солтүстік Тянь-Шанның ең батыс жотасы. Теңіз деңгейінен биіктігі 3700 м дейін жотаның солтүстік макробеткейінің батыс бөлігі Қазақстан шегінде орналасқан. Бұл таулы ел Батыс Тянь-Шань өсімдіктерімен байланысы бар «қырғыз белдеу түрімен» ерекшеленеді. Гербарий және экспедициялық үлгілер анықтаған *Allium L.* тұқымдас түрлерінің нақтыланған тізіміне 25 таксон кіреді, олардың ішінде *A. suworowii* сирек кездесетін түрі және 2 субэндемик (*A. margaritae*, *A. trachyscordum*) бар. 2024–2025 жылдар ішінде Кыргыз Алатауы жотасының солтүстік макробеткейінің 14 шаткалында анықталған *Allium L.* тұқымдасының 19 түрі өсетін жерлердің фитоценодикалық және биіктік сәйкестігін талдау, олардың тауларда таралуы саванноидті және шалғынды далалар белдеуінен басталатынын, аршалы белдеумен жалғасатынын көрсетті, сирек ормандар, субальпілік шалғындар мен жатаған бұталар, алпі белдеуімен аяқталады. Ең көп фитоценодикалық әртүрлілік пияз түрлерінің негізгі әртүрлілігі шоғырланған тау аралық шатқалдар мен өзен алқаптарында қалыптасады. Жотаның батыс төмен таулы және орта таулы бөлігіндегі: Сөгеті, Мақпал, Үлкен Алмалы, Тастамбек, Ұзынбұлақ шатқалдары, сондай-ақ шығысында орналасқан Қарақыстақ шатқалында пияздың 5-тен 6-ға дейін түрі кездеседі. Далалық зерттеулердің нәтижелері бойынша зерттелетін жотаның солтүстік макробеткейінде анықталған *Allium L.* тұқымдасының 19 жабайы түрінің орналасу картасы жасалды.

Кілт сөздер: *Allium L.* тұқымдасы, биіктік тектестігі, фитоценодикалық әртүрлілік, Кыргыз Алатауы жотасы.

Н.Г. Гемеджиева, Л.А. Димеева, Д.Ш. Абдилданов, Н.В. Фризен

Высотная приуроченность и фитоценотическое разнообразие сообществ с участием видов рода *Allium L.* на северном макросклоне хребта Киргизский Алатау

Киргизский Алатау является самым западным хребтом Северного Тянь-Шаня. Западная часть северного макросклона хребта с абсолютными высотами до 3700 м над ур. м. расположена в пределах Казахстана. Для этой горной страны выделяется «киргизский тип поясности», в котором проявляется связь с растительностью Западного Тянь-Шаня. После определения гербарных и экспедиционных образцов уточненный список видов рода *Allium L.* включает 25 таксонов, в числе которых редкий вид *A. suworowii* и 2 субэндемика (*A. margaritae*, *A. trachyscordum*). Анализ фитоценотической и высотной приуроченности местообитаний 19 видов рода *Allium L.*, выявленных в течение 2024–2025 гг. в 14 ущельях северного макросклона хребта Киргизский Алатау, показал, что их распространение в горах начинается с подпоясов саванноидных и луговых степей, продолжается поясом арчовых редколесий, субальпийских лугов и стлаников, завершаясь альпийским поясом. Наибольшее фитоценотическое разнообразие формируется в межгорных ущельях и долинах рек, где сосредоточено основное разно-

образии видов лука. Видовым разнообразием луков характеризуются ущелья западной низкогорной и среднегорной части хребта: Согеты, Макпал, Улькен Алмалы, Тастамбек, Узынбулак, а также расположенное восточнее ущелье Каракыстак, в которых встречаются от 5 до 6 видов лука. По результатам полевых исследований создана карта местонахождений 19 выявленных дикорастущих видов рода *Allium* L. на северном макросклоне изучаемого хребта.

Ключевые слова: род *Allium* L., высотная приуроченность, фитоценотическое разнообразие, хребет Киргизский Алатау.

References

- 1 Volkova, E.A. (2003). Rastitelnyi pokrov gor [Vegetation cover of mountains]. *Botanicheskaya geografiya Kazakhstana i Srednei Azii (v predelakh pustynnoi oblasti) — Botanical geography of Kazakhstan and Central Asia (within the desert region)* (pp. 167–191). E.I. Rachkovskaya, E.A. Volkova, V.N. Khramtsov (Ed.). Saint Petersburg: Boston-Spektr [in Russian].
- 2 Dimeyeva, L.A., & Ussen, K. (2015). Vysotno-poisnaia differentsiatsiia rastitelnogo pokrova Kirgizskogo khrebta v predelakh Kazakhstana [Altitudinal zonation of vegetation cover of the Kyrgyz Range within Kazakhstan]. *Problemy botaniki Yuzhnoi Sibiri i Mongolii. Sbornik nauchnykh statei po materialam Chetyrnadtsatoi mezhdunarodnoi nauchno-prakticheskoi konferentsii — Problems of Botany of Southern Siberia and Mongolia. Collection of scientific articles based on the materials of the Fourteenth International Scientific and Practical Conference* (pp. 185–189). Barnaul [in Russian].
- 3 Gemejyeva, N.G., Sitpayeva, G.T., & Dimeyeva, L.A. (2024). Species composition and altitudinal distribution patterns of wild *Allium* L. relatives in the Kyrgyz Alatau mountain range. In *XX International Botanical Congress. Book of Abstracts. Posters* (p. 472). Spain: Fase 20 Ediciones.
- 4 Gemejyeva, N.G., Abdildanov, D.Sh., Kudabayeva, G.M., Vesselova, P.V., Nelina, N.V., & Friesen, N.V. (2025). Species of the genus *Allium* L. of the western part of the Kyrgyz Alatau range: Current status and prospects of studying. *Fundamental and Experimental Biology*, 30, 2(118), 13–25. <https://doi.org/10.31489/2025feb2/13-25>
- 5 Vesselova, P.V., Kudabayeva, G.M., Abdildanov, D.Sh., Osmonali, B.B., Ussen, S., Skaptsov, M.V., & Friesen, N. (2025). Integral assessment of species of the genus *Allium* L. (Amaryllidaceae) in the western part of the Kyrgyz Alatau. *Plants*, 14(18), 2890. <https://doi.org/10.3390/plants14182890>
- 6 Kubentayev, S.A., Alibekov, D.T., Perezhogin, Y.V., Lazkov, G.A., Kupriyanov, A.N., Ebel, A.L., Izbastina, K., Borodulina, O., & Kubentayeva, B.B. (2024). Revised checklist of endemic vascular plants of Kazakhstan. *PhytoKeys*, 238, 241–279. <https://doi.org/10.3897/phytokeys.238.114475>.
- 7 Turdumatova, N.K. (2022). Rod luk (*Allium* L.) v Kyrgyzstane (voprosy sistematiki, geografiia i perspektivy ispolzovaniia) [Genus *Allium* L. in Kyrgyzstan (questions of systematics, geography, and prospects of use)]. *Extended abstract of candidate's thesis*. Bishkek [in Russian].
- 8 (2014). *Krasnaya kniga Kazakhstana* [Red Book of Kazakhstan]. Vol. 2. Part 1. Rasteniia — Plants (2d ed.). Astana: TOO «ArtPrintXX1» [in Russian].
- 9 Permitina, V.N., Dimeyeva, L.A., & Imanolinova, A.I. (2024). Vysotnaia priurochennost vidov roda *Allium* L. (Liliaceae) gor Zhetysuskogo Alatau [Altitudinal distribution of species of the genus *Allium* L. (Liliaceae) in the Zhetysu Alatau Mountains]. *Problemy botaniki Yuzhnoi Sibiri i Mongolii — Problems of Botany of Southern Siberia and Mongolia*, 23(2), 308–312. Retrieved from <https://journal.asu.ru/bpssm/article/view/pbssm.2024110> [in Russian].
- 10 Kotukhov, Y.A., Danilova, A.N., Sumbembayev, A.A., & Anufriyeva, O.A. (2025). *Konspekt lukov Vostochnogo Kazakhstana* [Synopsis of onions of Eastern Kazakhstan]. Ridder: Print Center [in Russian].
- 11 Abdildanov, D.Sh., Vesselova, P.V., & Kudabayeva, G.M. (2023). Raznoobrazie vidov roda *Allium* flory Aralo-Balkhashskogo regiona [Species diversity of the genus *Allium* in the flora of the Aral Balkhash region]. *Problemy botaniki Yuzhnoi Sibiri i Mongolii — Problems of Botany of Southern Siberia and Mongolia*, 22(1), 6–11. <https://doi.org/10.14258/pbssm.2023001> [in Russian].
- 12 Rachkovskaya, E.I. (2003). Printsipy i osnovnye edynitsy raionirovaniia [Principles and main units of regionalization]. *Botanicheskaya geografiya Kazakhstana i Srednei Azii (v predelakh pustynnoi oblasti) — Botanical geography of Kazakhstan and Central Asia (within the desert region)* (pp. 172–195). Saint Petersburg [in Russian].
- 13 Pavlov, N.V. (Ed.). (1956–1966). *Flora Kazakhstana* [Flora of Kazakhstan] (Vols. 1–9). Alma-Ata: Izdatelstvo Akademii Nauk Kazakhskoi SSR [in Russian].
- 14 Goloskokov, V.P. (Ed.). (1969–1972). *Illustrirovannyi opredelitel rastenii Kazakhstana* [Illustrated guide to plants of Kazakhstan]. (Vols. 1–2). Alma-Ata: Nauka [in Russian].
- 15 (2007–2026). Plantarium: otkrytyi onlain atlas-opredelitel rastenii i lishainikov Rossii i sopredelnykh stran [Plantarium: Open online atlas and identification guide of plants and lichens of Russia and neighboring countries]. www.plantarium.ru. Retrieved from <http://www.plantarium.ru>.
- 16 (2026). *Plants of the World Online*. Royal Botanic Gardens, Kew. Retrieved from <https://powo.science.kew.org>.
- 17 Bykov, B.A. (1978). *Geobotanika* [Geobotany]. Alma-Ata: Nauka [in Russian].
- 18 Nelina, N.V., Kudabayeva, G.M., Mukhtubayeva, S.K., & Bilibayeva, B.K. (2016). K vidovomu sostavu flory ushchelii Merke i Karakystak zapadnoi chasti Kirgizskogo Alatau [The species composition of the flora of the Merke and Karakystak gorges

of the western part of the Kyrgyz Alatau]. *Problemy botaniki Yuzhnoi Sibiri i Mongolii. Sbornik nauchnykh statei po materialam XV mezhdunarodnoi nauchno-prakticheskoi konferentsii — Problems of Botany of Southern Siberia and Mongolia: collection of scientific articles based on the materials of the XV International Scientific and Practical Conference* (pp. 392–398). Barnaul [in Russian].

19 Islamkulova, A.F., Zverev, N.E., & Kalybayev, K.R. (2017). Redkolesia fistashnikov v Kirgizskom Alatau [Pistachio open woodlands in the Kyrgyz Alatau]. *Perspektivy i puti razvitiia promyshlennogo orekhovodstva na yuge Kazakhstana: sbornik materialov mezhdunarodnoi nauchno-prakticheskoi konferentsii — Prospects and ways of development of industrial nut farming in the south of Kazakhstan: collection of materials of the International Scientific and practical Conference* (pp. 30–38). Shymkent [in Russian].

Information about the authors

Gemejyeva Nadezhda Gennadievna — Doctor of Biological Sciences (D.Sc.), Professor, Head of Plant Resource Laboratory, RSE REM “Institute of Botany and Phytointroduction” FWC MEGNR RK, Timiryazev street, 36 “D”, 050040, Almaty, Kazakhstan; e-mail: ngemed58@mail.ru; ORCID: 0000-0002-7317-2685

Dimeyeva Liliya Aminovna — Doctor of Biological Sciences (D.Sc.), Professor, Head of Geobotany Laboratory, RSE REM “Institute of Botany and Phytointroduction” FWC MENR RK, Timiryazev street, 36 “D”, 050040, Almaty, Kazakhstan; e-mail: kgm_anita@mail.ru; ORCID: 0000-0002-9101-0460

Abdildanov Daulet Sharipkhanovich — PhD doctoral student, Department of Botany and Agroecology, Al-Farabi Kazakh National University, Timiryazeva 71, 050040, Almaty, Kazakhstan; Researcher at the Laboratory of Higher Plant Flora, RSE REM “Institute of Botany and Phytointroduction” FWC MENR RK, Timiryazev street, 36 “D”, 050040, Almaty, Kazakhstan; e-mail: abdildanov00@mail.ru; ORCID: 0000-0002-0681-5468

Friesen Nikolay Valterovich — Doctor of Biological Sciences (D.Sc.), Professor, Botanical Garden, University of Osnabrück, Albrechtstrasse 29, 49076, Osnabrück, Germany; e-mail: nfriesen@uni-osnabrueck.de. ORCID: 0000-0003-3547-3257