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CONSERVATION OF THE GENE POOL OF RANUNCULACEAE AND RELATED FAMILIES (Paeoniaceae, Berberidaceae) IN THE NATIONAL PARKS OF THE NORTHERN TIEN SHAN

The article provides data on the number of species of three families of the Zailiysky Kungei Alatau floristic area: Ranunculaceae, Paeoniaceae and Berberidaceae recorded in two protected areas, Ile Alatau State National Nature Park (IA SNNP) and the State National Nature Park (SNNP) "Kolsai Koldery". In total, there were 82 species from 26 genera, or 97.6% of the flora of the Trans-Ili Kungei Alatau floristic region. Of those, 38 species from 17 genera were found in both protected areas. The largest genus, *Ranunculus*, had 26 species, of which 10 grew in both protected areas. Among these plants there were abundant, widespread, endemic, and rare species listed in the Red Book of Kazakhstan. There were two endemic and five rare species. *Ranunculus dilatatus* was an endemic of the Northern Tien Shan, and *Anemone almaatensis* was an endemic of Zailiysky Alatau. Both were found only in IA SNNP. Rare species listed in the Red Book of Kazakhstan were *Hepatica falconeri*, *Gymnospermium altaicum*, *Adonis chrysocyathus*, *A. tianschanicus*, and *Berberis iliensis*. Of those, only *Adonis chrysocyathus* and *A. tianschanicus* were found in both protected areas. The presence of *Gymnospermium altaicum* in the SNNP "Kolsai Koldery" requires verification. Most species of the families Ranunculaceae, Paeoniaceae and Berberidaceae have different beneficial properties, including decorative and medicinal; some species are poisonous. Several species are weeds, the number of which increases sharply with grazing. One example is *Aconitum leucostomum*, which forms a special formation. In terms of life forms, grassy perennials predominate, and in terms of ecological and cenotic groups, meadow, forest-meadow and forest elements predominate. This is unsurprising given a boreal origin of the family Ranunculaceae.

Key words: endemics, rare species, weeds, Zailiysky Alatau, Kungei Alatau.

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Солтүстік Тянь-Шань ұлттық парктарындағы Ranunculaceae және онымен туыс тұқымдастардың (Paeoniaceae, Berberidaceae) генофондын сақтау

Мақалада флоралық ауданның Іле Күңгей Алатауының үш тұқымдасы: Ranunculaceae, Paeoniaceae және Berberidaceae, екі ЕҚТА – Іле Алатауы мемлекеттік ұлттық табиғи паркінің (IA МҰТП) және «Көлсай көлдері» мемлекеттік ұлттық табиғи паркінің аумақтарында белгіленген түрлері бойынша деректер келтіріледі. Мұнда барлығы 26 тұқымдастың 82 түрі бар, бұл – Іле Күңгей Алатауы флоралық ауданы флорасының 97,6%-ы. Оның ішінде 17 тұқымдастың 38 түрі екі аумақта да кездеседі. Ең үлкен туыс *Ranunculus* ішінде 26 түрі бар, олардың 10-ы екі ЕҚТА өседі. Аталған өсімдіктердің ішінде Қазақстанның Қызыл кітабына енген, кең таралған, эндем және сирек кездесетін өсімдіктерде келтірілген. Соңғы екеуіне 7 түр жатады, олардың екеуі эндем, қалғандары сирек кездеседі. Солтүстік Тянь-Шань эндемдеріне *Ranunculus dilatatus*, Іле Алатауына *Anemone almaatensis* жатады. Екеуі де Іле Алатау МҰТП ғана кездеседі. Қазақстанның Қызыл кітабына енгізілген сирек кездесетін түрлер – *Hepatica falconeri*, *Gymnospermium altaicum*, *Adonis chrysocyathus*, *A. tianschanicus* және *Berberis iliensis*. Олардың ішінде екі аумақта да болу тек *Adonis chrysocyathus* және *A. tianschanicus* арқылы расталады. «Көлсай Көлдері» МҰТП *Gymnospermium altaicum* болуы дәлелдемелерді талап етеді. Ranunculaceae, Paeoniaceae және Berberidaceae тұқымдасының аталған түрлерінің көпшілігі әртүрлі пайдалы қасиеттерге ие –

сәндік, дәрілік, кейбіреулері улы, арамшөптер бар, олардың саны мал жаю кезінде күрт артады, мысалы, *Aconitum leucostomum* арнайы формацияны құрайды. Тіршілік формаларында шөпті көпжылдықтар басым, экологиялық-ценотикалық топтарда – шабындық, орман-шабындық және орман элементтері, бұл бореальды шыққан Ranunculaceae тұқымдасына түсінікті.

Түйін сөздер: эндемдер, сирек, арамшөп түрлері, Іле Алатауы, Күнгей Алатауы.

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Сохранение генофонда Ranunculaceae и родственных семейств (Paeoniaceae, Berberidaceae) в национальных парках Северного Тянь-Шаня

В статье приводятся данные по количеству видов трех семейств Заилийский Кунгей Алатау флористического района: Ranunculaceae, Paeoniaceae и Berberidaceae, отмеченных на территориях двух ООПТ – Иле Алатауского государственного национального природного парка (ИА ГНПП) и государственного национального природного парка «Көлсай Көлдері». Всего здесь насчитывается 82 вида из 26 родов представленных семейств, что составляет 97,6% флоры флористического района Заилийский Кунгей Алатау. Из них 38 видов из 17 родов встречаются на обеих территориях. Самый крупный род *Ranunculus* насчитывает 26 видов, из которых 10 произрастают в обоих ООПТ. Среди приведенных растений есть массовые, широко распространенные, эндемичные и редкие, занесенные в Красную книгу Казахстана. К последним двум относятся 7 видов, из них два эндемика, остальные редкие виды. К эндемикам Северного Тянь-Шаня относится *Ranunculus dilatatus*, Заилийского Алатау – *Anemone almaatensis*. Оба встречаются только в Иле Алатауском ГНПП. Редкими видами, внесенными в Красную книгу Казахстана, являются *Hepatica falconeri*, *Gymnospermium altaicum*, *Adonis chrysocyathus*, *A. tianschanicus* и *Berberis iliensis*. Из них нахождение на обеих территориях подтверждено только у *Adonis chrysocyathus* и *A. tianschanicus*. Наличие *Gymnospermium altaicum* в ГНПП «Көлсай Көлдері» требует доказательств. Большинство указанных видов семейств Ranunculaceae, Paeoniaceae и Berberidaceae обладают разными полезными свойствами – декоративными, лекарственными, некоторые являются ядовитыми, есть сорные и сорничающие, количество которых резко увеличивается при выпасе скота, как например, *Aconitum leucostomum*, образующий особую формацию. По жизненным формам преобладают травянистые многолетники, по эколого-ценотическим группам – луговые, лесо-луговые и лесные элементы, что вполне объяснимо для семейства *Ranunculaceae*, имеющего бореальное происхождение.

Ключевые слова: эндемики, редкие, сорные виды, Заилийский Алатау, Кунгей Алатау.

Introduction

In the Northern Tien Shan, there are two well-known in Kazakhstan large state national natural parks, the Ile-Alatau (hereinafter **No.1**) and “Kolsai Koldery” (hereinafter **No.2**). The Ile-Alatau national park was established by the Decree of the Government of the Republic of Kazakhstan No.228 of February 22, 1996. It has an area of about 200 thousand hectares in the central part of the northern slope of the Trans-Ili Alatau. “Kolsai Koldey” was established by the Decree of the Government of the Republic of Kazakhstan No.88 of February 7, 2007, and occupies an area of just over 161 thousand hectares, mainly on the northern slope of the Kungei Alatau and partially on the southern slope of the Trans-Ili Alatau. Within the territories of the two parks there are various ecosystems representing all elevation belts, from the foothills to the alpine and nival (Fig.1).

In specially protected areas, the main area of scientific research is comprehensive monitoring. Following the classification of V. D. Utekhin [1], it includes four types of observation: inventory, retrospective, regime and methodological.

The most relevant for both protected areas are the inventory observations, since the studies of biological diversity in IA SNNP, including that of the higher plants, have been rather fragmentary until recently, although started a century and a half ago [2]. The biodiversity of SNNP “Kolsai Koldery”, as presented in the monograph of S.K. Mukhtabayeva [3], requires further verification and addition. Without comprehensive floristic inventory, it is impossible to carry out monitoring of natural phenomena and organize protection and rational use of biological diversity, in particular, for the purposes of environmental education and tourism.



Figure 1 – Location of IA SNNP (№1) and SNNP “Kolsai Koldery” (№2)
https://www.oopt.kz/categories/view/ile-atalay_gnpp/

Materials and Methods

The object of our study was the family Ranunculaceae, which occupies the sixth and seventh places on the list of the top ten most diverse families of the two protected areas, as well as two other closely related families [4,5].

The study of the floristic composition was carried out by the method of route-reconnaissance, and by stationary and semi-stationary surveys of the protected areas and the adjacent Almaty State Complex Nature Reserve (ASCNR). At the same time, traditional methods were used, including compiling lists of known species recorded on specific routes, points, sites and ecosystems, as well as herbarium collection and subsequent identification following various floristic summaries [6-11], and taking into account the taxonomic revisions of S.K. Cherepanov [12] and S.A. Abdulina [13] with additions [14]. In addition, materials of the herbariums of the Department of Science and Monitoring of SNNP “Kolsay koldery”, Al-Farabi KazNU, and the Institute of Botany and

Phytointroduction were studied.

To describe species distributions, materials from personal diaries for all years of observations, as well as geobotanical descriptions of monitoring sites and cenopopulations of rare species were used. In addition, data from literary sources [15-23], materials of herbarium collections stored at the Institute of Botany and Phytointroduction of the Ministry of Education and Science of the Republic of Kazakhstan (Almaty) and the Al-Farabi Kazakh National University were used. In 2010-2013, at our request, Dr Grachev, an employee of the Institute of Zoology, collected a herbarium on the territory of IA SNNP, for which we are sincerely grateful to him. Several herbarium specimens were provided by employees of IA SNNP: V.V. Vasilyev, G. Bagasharov, and M. Agibaev.

Habitat typology was according to V.P. Goloskokov [24], or in some cases, according to M.S. Baitenov [21]; ecological and cenotic groups, according to I.I. Roldugin [25]; the order of taxonomic groups, according to the A. Engler’s system adopted in the Flora of Kazakhstan [6];

and the species nomenclature, according to S.A. Abdulin's summary with additions [13,14]. Endemic species, as well as species listed in the Red Book of Kazakhstan are marked with an asterisk (*).

Results and Discussion

Summary of the families Paeoniaceae, Ranunculaceae, and Berberidaceae

Family Paeoniaceae Rudolphi

Paeonia intermedia C.A. Mey. (*P. anomala* var. *intermedia*) is a mountain Central Asian-South Siberian perennial forest-meadow species (№1, 2). It occurs sporadically on the steppe slopes of foothills and open rocky slopes of the lower belt, up to the lower boundary of the spruce belt (1800 m).

№1. We are aware of the following localities: the valley of the Kaskelen River (including the Kassymbek Gorge), the Ozhaylau Gorge, the B. Almaty and M. Almaty gorges (including the Medeu Gorge), valleys of the Kotyrbulak and Talgar rivers, and the Soldatsai Gorge. It grows in apple forests, on meadow slopes, and among shrubs. The species is common, not abundant; the numbers are diminishing due to the collection by vacationers for bouquets [26].

№2. So far, only one micropopulation consisting of a dozen generative individuals has been found in the spruce belt (2630 m above sea level) on the slope of the Karasay Gorge [27].

Family Ranunculaceae Juss.

Aconitum karakolicum Rapaics is a Dzhungar-Tian Shan forest-meadow perennial species. It grows on meadow slopes in the forest and alpine belt, in spruce forests, in openings and forest edges.

№2. It is found in the Zap. Karabulak Gorge, Kuturga.

A. leucostomum Worosch. is an Altai-Tian Shan forest-meadow perennial species (№1, 2), the most abundant representative of the genus in the surveyed territory. It is quite common in the subalpine and alpine belts; grows in mixed grass meadows, rocky-crushed stone slopes, on pebbles, river banks, and in the openings and forests edges.

№1. It is found everywhere, from the lowlands (1200 m) to the upper part of the spruce forest (2700 m, Mramornyi Ruchej). It is common, sometimes abundant, and forms thickets, being a subdominant in deciduous forests.

№2. It was found in the Zap. Karabulak, Kuturga, Kolsai, and Taldy gorges, and on the left bank of the Saty Gorge.

A. nemorum M. Pop. is a Tian Shan forest perennial species (№1, 2). It occurs sporadically in the forest and subalpine belts in sparse fir forests, meadows, archevniks, in the rock shade, sometimes along streams, and less often on sazes. The territory of IA SNNP is a "locus classicus" for this species, which has been described from the vicinity of Almaty [7].

№1. It is found in the upper reaches of the B. Almaty Gorge (below the lake, 2300 m), in the valleys of the Turgen and Talgar rivers, including the Left Talgar and M. Almatinka. It is not numerous; of the 16 monitoring sites, it was found in only one, No.8 (Chinturgen).

№2. It is more common in the gorge and on the Kurmekty pass, in the upper reaches of Saty, in the Zap. Karabulak Gorge, Kaindy.

A. rotundifolium Kar. et Kir. is a mountain Central Asian perennial meadow species widely distributed throughout the surveyed territory (№1, 2). It grows on dry grassy and rocky slopes of the subalpine and alpine belts, on pebbles, river banks, and moraines.

№1. The species is common throughout the territory in suitable habitats.

№2. It was found in the Zap. Karabulak Gorge, on the Kurmekty pass, and in one of the monitoring sites, Kolsai-3.

A. soongoricum Stapf. is a Tian Shan-Himalayan perennial forest-meadow species (№1, 2). It grows sporadically in meadows, near streams and in forest openings, from the forest belt (1600 m) up to the alpine belt.

№1. We found small isolated populations in the upper reaches of the rivers Kazachka, B. Almatinka, Kaskelen, and Kirgauldy, in the Ozhaylau Gorge; M.S. Baitenov et al. [23] described it in the Left Talgar, and V.P. Goloskokov [15], in the upper Tau-Chilik and M. Almatinka.

№2. It was found in the subalpine belt in one gorge, Karabulak [28].

Adonis aestivalis L. is an annual eastern ancient Mediterranean steppe species (№1,2). According to M.G. Popov [17], it is common in the foothills and dry lowlands.

№1. We found it in the lower part of the valleys of the rivers B. Almatinka and Kaskelen, and in the middle part of the Kotyrbulak River valley (1100-1600 m). It is not abundant, sometimes grows in weedy places.

№2. It was found in 2015 on the meadow terrace of the left bank of the Saty Gorge by S.K. Mukhtubayeva, A.A. Shormanova and M.P. Danilov [3].

**A. chrysocyathus* Hook. fil. et Thoms. is a disjunctive, mountain Central Asian-Himalayan forest-meadow species, a rhizome perennial (No.1, 2). It grows in fine-grained areas of stony slopes, in mixed grass. Being a rare species throughout the Northern Tien Shan listed in the Red Book of Kazakhstan, it is found growing sporadically in the upper part of the spruce belt and in the subalpine belt of the Talgar and Issyk river basins [17].

№1. To date, two small isolated populations have been found, numbering no more than 100 individuals each. The first population was found in June 1998 by V.G. Epiktetov (oral report) on the northern slope of the upper Kirgauldy River (2800 m), and the second, on 16.07.2000 by one of the authors of the publication, A.A. Ivashchenko, on the north-western slope of the left bank of the Ozernaya River (a steep slope with meadow grass and isolated bushes of *Juniperus pseudosabina* Fisch. & C.A. Mey., 2800 m). Herbarium collections of other authors: the interfluvium of Kirgauldy (Aksay-Kaskelen), 5.07.1936 (B.A. Bykov); Issyk, on the pass to Teskensu, the upper reaches of the eastern sairs, grassy slopes, 17.07.1937 (M.G. Popov); Pryamaya Schel, upper reaches, 30.06.1936 (V.P. Goloskokov).

№2. It was found in 1998 above the confluence of the Kaindy River by S.K. Mukhtubayeva [3]. After a dedicated search, we could not find it.

A. parviflora Fisch. ex DC. is a Palearctic annual meadow species found on deposits, saline and wet meadows, in shady places, on rocks, and in bushes.

№2. It is known only from the Kurmekty Gorge, where it was collected in 1964 by I.I. Roldugin [3].

**A. tianschanicus* (Adolf) Lipsch. is a Tien Shan perennial meadow species (№1, 2). It grows in subalpine meadows, on stony-crushed stone slopes, and in shrub thickets. The species is listed in the Red Book of Kazakhstan [49].

№1. It has been found in the highlands of Talgar [23]. There are no other data from the surveyed area.

№2. In 1942, it was collected in the Kurmekty Gorge by A.S. Lazarenko [3]. By now, several other localities have been found: the Kurgoby Gorge [30], Kurgoby and Zhamanbulak gorges (2020, R.E. Kaparbay, B.B. Arynov).

Anemone almaatensis Juz. is an endemic meadow-steppe perennial species of the Zailiysky Alatau described by S.V. Yuzepchuk [7] from the vicinity of Almaty. However, neither M.G. Popov [17] nor M.S. Baitenov et al. [29] put it on the list of flora of the area studied.

№1. We have repeatedly found it on the dry slopes of the right bank of the Kotyrbulak River and in the Kirgauldy Gorge (1300 m); I.I. Kokoreva [33] found it in the Pryamaya Schel.

A. protracta (Ulbr.) Juz. is a Pamir-Alai-Tian Shan forest-meadow species, perennial (No.1, 2). It grows in subalpine and alpine belts, in meadows, along forest edges and clearings, in archevniks, and less often on stony slopes.

№1. It is common, sometimes plentiful.

№2. It is common in the gorge and on the Kurmekty pass, in the basins of the Kolsai and Taldy rivers. Not so long ago it was found in the Malye Urjukty [28].

Aquilegia atrovinosa M.Pop. ex Gamajun. is a Pamir-Alai-Tian Shan forest, forest-meadow perennial species (No.1, 2). It occurs sporadically throughout the study area in meadows, in archevniks, along forest edges and clearings, sometimes along pebbles, from the forest to alpine belts.

№1. It is found in the valleys of the rivers B. and M. Almatinka, Talgar, Chinturgen, and Aksai, on monitoring sites in apple forests (Soldatsay) and spruce forests (Almaarasan, near the Lake B. Almaty, Chimbulak).

№2. It is found in the Kurmekty and Zap. Karabulak River. It was found in the Taldy Gorge by I.G. Otradnykh and I.A. Syedina in 2016.

A. glandulosa Fisch. ex Link is a Dzhungaromountain-Siberia perennial species (No.1). M.S. Baitenov et al. [23] found it on stony slopes near streams of the alpine belt, in the valleys of the Left and Middle Talgar rivers. This fact needs to be verified, since in one of the previous works M.S. Baitenov [21] described it only for the Dzhungar Alatau.

A. karelinii (Baker) O. et B. Fedtsch. is a Tarbagatai-Tian Shan forest, forest-meadow perennial species (No.1, 2).

№1. M.G. Popov [17] found it only in the middle part of the Chilik River valley; M.S. Baitenov et al. [23], near the Talgar River.

№2. It is likely to grow here, since it was found by S.K. Mukhtubayeva [3] in the Kensu Gorge.

Atragene sibirica L. is a Pamir-Alae-Tian Shan-Siberian forest species (No.1, 2). This is a shrubliana, growing in coniferous forests, archevniks, among shrubs, and sometimes on stony slopes.

№1. It is distributed throughout the study area, and is particularly abundant in the valley of the B. Almatinka River (2300-2800 m). Occasionally, individuals with white sepals are found, differing in the shape of the petals, which are similar to those of *A. tianschanica* described by N.V. Pavlov

in 1954 [6], but then promoted to a synonym of the main species [12,13]. We collected such individuals on June 18, 2009 in the valley of the Kazachka River, near the river, above the upper barrier (1850 m). It is noteworthy that in this spruce forest there were also typical individuals with yellow sepals and petals, which indicates the need for further study of the polymorphism of this species and determination of the taxonomic affiliation of such forms. It is possible that N.V. Pavlov's species was "closed down" without sufficient grounds.

№2. It grows in the Kurmekty Gorge, Kolsay. In the Saty Gorge, on the meadow terrace of the left bank it was found in 2015 (M.P. Danilov, A.A. Shormanova, B.K. Bilibayeva). In 2020, one of the authors of this article, R.E. Kaparbay, found it in the Taldybulak Gorge.

***Batrachium divaricatum* (Schrenk) Wimm.** is a Holarctic aquatic species, a perennial growing in stagnant and weakly flowing waters, often on wet mud of drying water bodies.

№1. In such conditions, we collected it on 12.08.2010 on the swampy soils of the dried-up channel near the left bank of the Lake Issyk (1750-1800 m). V.P. Goloskokov [15] described this species as rare, growing in drying closed reservoirs of the Ulken-Turgen River valley (2950 m). It should be emphasized that it was thanks to the research of V.P. Goloskokov that representatives of this genus were first found in the surveyed territory.

***B. mongolicum* (Kryl.) V. Krecz.** is a Siberian-Mongolian aquatic species, perennial.

№1. Here it is known only from the upper Turgen River [9]. The Flora of Kazakhstan [6] also provides information about the collections of this species by V.P. Goloskokov from the reservoirs of the Kairakty Gorge (2900-3200 m).

***B. pachycaulon* Nevski** is a mountainous Central Asian-Iranian aquatic species, perennial.

1. It was found in the vicinity of Almaty [9].

***Callianthemum alatavicum* Freyn.** is a mountain Central Asian-Altai perennial meadow species (**№1, 2**). It is found in the subalpine belt, on alpine lawns and steppe slopes, and in crushed stone areas and moraines. It grows along the rock cracks and on stream banks.

№1. The species is common, not numerous, found from the lower boundary of the subalpine belt (2800 m) to the upper limit of vegetation (3450 m, upper Kirgauldy, 18.06.2015, V. Vasilyev).

№2. It was found on the pass and in the upper reaches of the Kurmekty River, at the source of the Kolsai River, and in the Kuturga Gorge.

***Ceratocephalus testiculatus* (Grantz) Bess.** is a Palearctic, annual meadow-steppe species.

№1. It is common in the foothills [15], but not found in the Almaty reserve [23]. We first registered it on 25.05.1989 while recording *Tulipa ostrowskiana* on the dry slope of the right bank of the Talgar River (1700 m). Later (1.05.2015 and 7.05.2015), it was found in similar conditions on the left bank of the Kaskelen River (1200 m) and in the lower part of the Kazachka River valley (1300 m). The species is not plentiful, weedy. Of particular interest are our findings (20.06.2015) of this species in the highlands: near a road on the right bank of the Turgen River (2175 m) and in the upper reaches of the Assy River (2710 m).

***Clematis asplenifolia* Schrank.** is a mountainous Central Asian meadow-steppe semi-shrub.

№2. It grows on rocky mountain slopes and foothills in lower and middle mountain belts. It is found in the village of Saty and in the Kuturga Gorge [3].

***C. glauca* Willd.** is a Tian Shan-Siberian forest species, shrub-liana (**№1, 2**). It occasionally occurs in floodplain forests, near springs, and in the lower part of gorges, in shrub thickets.

№1. We recorded it in the valley of the Kaskelen River; M.S. Baitenov et al. [23] recorded it in the valley of the Talgar River, where he described two following species. M.G. Popov [17] points to its distribution in the valley of the Turgen River.

№2. It was found in the Kurmekty and Kaindy gorges.

***C. orientalis* L.** is a forest shrub-liana, more common in the territory of the IA SNNP, and occurs in the same conditions as the previous species.

№1. According to our data, it is not numerous in the valleys of the Aksai (1300-1400 m) and B. Almatinka rivers, in the vicinity of the Lake Issyk (1700 m).

***C. songarica* Bunge** is a Tian Shan-Altai meadow-steppe shrub (**№1, 2**). It grows on dry scree in the lower parts of valleys, on saline clay residues, in meadows and near streams, in low mountains and the lower mountain belt.

№1. The species is quite rare, found by us in the lower reaches of the Aksai River (1200-1300 m).

№2. It is found in the floodplain of the Saty River, near the village of Saty, in the Kurmekty and Taldy-su river gorges.

***Delphinium biternatum* Huth** is a mountainous Central Asian perennial steppe species (**№1, 2**). It occasionally occurs on dry slopes of the foothills, and less often in the lower mountain belt, on the foothill plains, on the ravine

slopes and crushed stone slopes in shrubs, and sometimes on deposits.

№1. M.G. Popov [17] described it on the foothills “from Almaty to Syugaty”, and M.S. Baitenov et al. [23], in the Right Talgar. We found two small populations on a shrub slope of the left bank of the B. Almatinka River, near the dam (1250 m) and near the highway in front of the village Turgen.

№2. It is found in the Saty Gorge, Aliman Gorge, and on the left bank of the Saty River.

***D. confusum* Popov** is a Pamir-Alai-Tian Shan meadow perennial species. It grows mainly on rocky slopes of the subalpine belt, in mixed grass meadows, and on river pebbles.

№2. It was found in Tau-Chilik, near the village of Saty, in the Taldy Gorge [3].

***D. dictyocarpum* DC.** is a Panno-Kazakhstan perennial species.

№1. We cite it according to M.G. Pakhomova [9], who described this species in the vicinity of Almaty.

***D. iliense* Huth** is a north-central Tian Shan meadow perennial species (**No.1, 2**). This is a common member of the family in the study area. It is found in subalpine and alpine belts in mixed grass meadows, shrubby thickets, raw cobresia meadows, on river pebbles, and moraines.

№1. It is common everywhere in the forest belt: in clearings and forest edges, and along meadow slopes in the altitude range of 1400–2700 m.

№2. It is found in Tau-Chilik, at the village of Saty, 15.07.1937; the Kurmekty pass, 27.08.1937, Mikhailova V.P.; the Kurmekty Gorge, 24.07.1937, Gorbunova E.P.; the Kurmekty Gorge, 29.07.1953, 31.07.1953; the Kaindy Gorge, 08.08.1964, Roldugin I.I.

***D. oreophilum* Huth** is a Pamir-Alai-Tian Shan meadow perennial species found growing sporadically, mainly in the alpine belt, in meadows, rocky scree, sometimes near snowfields.

№1. V.P. Goloskokov [15] considered it common, and M.S. Baitenov et al. [23] pointed to the distribution in the Talgar valley.

***D. poltoratzkii* Rupr.** is a Pamir-Alai-Tian Shan perennial meadow species.

№1. It inhabits rocky slopes of the subalpine and alpine belts of the Left Talgar River valley [23]. Data on the distribution of this and the previous species need to be clarified, since M.G. Pakhomova [9] mentioned only the Trans-Ili Alatau as the distribution area of *D. poltoratzkii*, and the Western Tien Shan as the distribution area of the previous species.

***Ficaria verna* Huds.** is a European-Volga perennial forest-meadow species.

№1. It was found in the vicinity of Almaty [6,9], and without a doubt was a cultivar.

***Halerpestes salsuginosa* (Pall. ex Georgi) Greene** is a Holarctic perennial coastal-water species found in salt marshes and salty places, on damp pebbles, and at the exits of groundwater and springs.

№2. It grows in the Kurmektsy Gorge.

****Hepatica falconeri* (Thoms.) Steward.** is a disjunctive, Tian Shan-Himalayan perennial forest species. It occurs occasionally on rocky slopes and screes in the subalpine belt.

№2. It grows in the Taldy-su Gorge; in the Saty Gorge it was discovered in 2015 by S.K. Mukhtabayeva, M.P. Danilov, A.A. Shormanova and D.A. Akhataeva. In 2016, the presence of plants in the Taldy Gorge was confirmed by I.G. Otradnykh and I.A. Syedina. In 2020, a small population was found in the upper reaches of the Taldy Gorge (Tsarskie Vorota) by R.E. Kaparbay and B.B. Arynov.

***Nigella integrifolia* Regel** is an annual steppe species. It grows in dry crushed stone parts of foothills and lowlands.

№1. It is found growing sporadically on the territory of ASCNR, east of Almaty.

***Oxygraphis glacialis* (Fisch.) Bunge** is an Arctic-Alpine, mountainous Central Asian-Siberian perennial meadow species (**№1, 2**). This is an ordinary alpine species growing on cryophilic lawns, moraines, and among melting snow.

№1. It occurs sporadically only in the alpine belt, on lawns, wet crushed stone slopes, and near snowfields; not abundant.

№2. It is found in the basin of the Kolsay River.

***Paraquilegia anemonoides* (Willd.) Ulbr.** (*P. grandiflora* Fisch. ex DC.) is a mountain-central Asian petrophilic species, turf perennial (**№1, 2**). It grows on rocky slopes in the upper belt of the mountains in the subalpine and alpine belts.

№1. It is found quite often in the subalpine and alpine belts. It is common, sometimes quite abundant and grows in rock cracks.

№2. It is found on the pass and in the upper Kurmekty, and in the Zap. Karabulak Gorge, Kuturga.

***P. caespitosa* (Boiss. et Hohen.) Drum. et Hutsch.** is an east-Palaearctic petrophilic perennial species.

№1. V.P. Goloskokov [15] described it only in the M. Almatinka (based on the collections of B.K. Shishkin), and M.S. Baitenov et al. [23], in the Left Talgar.

***Paropyrum anemonoides* (Kar. et Kir.) Ulbr.** is an Iran-Mountain-Central Asia-Himalayan petrophilic perennial species (No.1, 2). It grows in the subalpine and alpine belts on rocky outcrops, in rock cracks, damp lawns, in the shade of rocks, among archevniks, and less often on lawns, in cobrezia thickets, and on pebbles (2900 m).

№1. The species is common, not abundant.

№2. It is found in the upper course of the Saty River, and in the Zap. Karabulak Gorge.

***Pulsatilla campanella* Fisch. ex Regel et Til.** is a Pamir-Alai-Tian Shan-Siberian meadow-steppe perennial species (No.1, 2). It is found throughout the surveyed area in dry steppe and meadow-steppe, in archevniks, and on the rocky slopes of the subalpine and alpine belts. Sometimes it occurs down to the upper part of the forest belt.

№1. The species is common, not abundant.

№2. It has been found in the Zhamanbulak Gorge, Kolsay, and on the right bank of the Taldy River.

***Ranunculus alberti* Regel et Schmalh.** is a disjunctive, mountain-central Asian meadow perennial species (No.1, 2) found everywhere, in subalpine and alpine belts, in meadows, on rocky slopes, near snowfields, on river pebbles, damp lawns, and moraines

№1. The species is common, sometimes plentiful.

№2. It grows in the upper reaches of the Kurmekty River, and in the upper reaches of the Kolsay River.

***R. altaicus* Laxm.** is an Altai-Tian Shan meadow perennial species. It grows in the alpine belt on damp lawns, near moraines, and at the edge of melting snow.

№2. It grows on the Kurmekta pass, at the headwaters of the river of the same name, and at the headwaters of the Kolsai River.

***R. auricomus* L.** is a West Palearctic perennial species.

№1. In the study area, it has been found only in the Talgar valley [23]. This information needs verification, because according to other studies [6,9,12] it was found only in Europe and Siberia; in Kazakhstan it does not occur south of the Saur and the northern regions.

***R. borealis* Trautv.** is a mountainous Siberian-Tian Shan forest-meadow perennial species. The species was not recorded in the surveyed area by previous investigators.

№1. A few of its populations were found by us in two locations: in the apple-tree forest of the Aksai

River valley (1350 m) and in similar conditions in the Belchabdar River valley (1400 m).

***R. brotherusii* Treyn.** is a Central-Eastern Tian Shan perennial steppe species.

№1. According to V.P. Goloskokov [15], this is a rare species, found in the high mountain steppes and on the rocky slopes of the subalpine and alpine belts.

****R. dilatatus* Ovcz.** is a meadow species, perennial. It is an endemic of the Northern Tien Shan described by P.S. Ovchinnikov from the Trans-Ili Alatau [6].

№1. It grows on grassy slopes, near roads and in the river floodplains of the lower mountain belt, in particular, in the valleys of the Talgar and Turgen rivers [17,23].

***R. fraternus* Schrenk.** is a Dzhungar-Eastern-Tian Shan coastal and alkaline perennial species. It grows along river banks and wetlands of the subalpine and alpine belts.

№1. It is known from the valleys of the rivers Talgar and Issyk [23].

***R. gelidus* Kar. et Kir. (*R. karelinii* Czer.)** is a Dzhungar-Eastern-Tian Shan meadow perennial species.

№1. It is found quite often in the alpine and nival belts, on rocky slopes and crushed stone scree in the valleys of the rivers M. Almaty, Talgar, Issyk, and Turgen.

***R. grandifolius* C.A. Mey.** is a north-central-Tian Shan-Altai-Sayan forest-meadow, meadow perennial species (No.1, 2) found everywhere in the spruce belt, in meadows, clearings and edges, in meadows, and in shrub thickets in the altitudinal range of 1500-2700 m.

№1. It is often found in considerable abundance, forming aspect glades (B. Almaty, 2300-2400 m).

№2. It is common in the Zap. Karabulak, Kuturga, Kolsai, and Saty gorges.

***R. krylovii* Ovcz.** is a mountain Siberia-Tian Shan perennial species.

№2. It has been recorded at the Kolsai-2 monitoring site, Sairam Ogem [30].

***R. longicaulis* C.A. Mey.** is a Tian Shan-Altai-Sayan coastal-water-meadow perennial species (No.1, 2) found growing sporadically in damp meadows, highland swamps and sazes.

№1. M.G. Popov [17] did not find it in the surveyed territory, and M. S. Baitenov et al. [23] mentioned the Left Talgar as a collection locality. We know this species from two localities: silted banks and bays at the stream above the Lake B. Almaty (2550 m), and the banks of the stream on the left bank of the Mramornoe, in the vicinity of ASCNR (2700 m).

№2. It is found in the Saty Gorge.

***R. monophyllus* Ovcz.** is an east-palaearctic forest-meadow, meadow species, perennial. It grows in grassy swamps, damp meadows and deciduous forests.

№1. There are data from the Talgar River valley [23], as well as from apple and spruce forests of the M. Almatinka and Turgen river valleys [17].

***R. natans* C.A. Mey.** is a mountainous Siberian and Central Asian aquatic species, perennial. It is found growing sporadically in streams and swamps of the highlands.

№1. It has been recorded in Talgar, Zhenishke and Upper Chilik [17,23]. We found only two locations: the upper part of the Assy River, below the observatory (2600 m); and the upper part of the Ozernaya River, below the hydrometeorological station (2600 m).

***R. pedatifidus* Smith** is an Altai-Tian Shan meadow perennial species.

№1. It is very rare. M.G. Popov [17] mentioned its occurrence under the name of *R. affinis* R.Br. in the alpine belt of the Chinturgen River valley, and M.S. Baitenov et al. [23], in the subalpine belt of the Talgar River valley.

***R. polyanthemus* L.** is a West Palearctic meadow perennial species (**№1, 2**) found throughout the study area in dry and steppe meadows, among shrubs, along forest edges and river banks; common, not abundant.

№1. It was recorded at five monitoring sites, from the foothills to the lower border of the spruce forests (1730 m, Alma-Arasan).

№2. It grows in the Taldy River valley, in the Kurmekty, and Zap. Karabulak Gorge.

***R. polyrhizus* Steph.** is a Palearctic meadow-steppe perennial species.

№1. M.G. Popov [17] mentioned this species occurring on the steppe slopes of the Syugatinsky Mountains and in the Talgar Gorge. The last locality is also on the list of M.S. Baitenov et al. [23] We found it in low abundance on May 12, 2012 in a meadow of the left bank of the Aksai River (1350-1450 m), as well as in the valley of the Ayusai stream (1700 m).

***R. popovii* Ovcz.** is a north-central Tian Shan perennial species (**№1, 2**) found on stony slopes, scree and alpine lawns of highlands, and on stream pebbles.

№1. V.P. Goloskokov [15] described it as a rare species from the eastern part of the ridge, and M.S. Baitenov et al. [23], from the valleys of the Talgar and Issyk rivers. We found it quite common in the archevniks of the Mramornyi Ruchei (2750-2800 m) in the vicinity of Gaish.

№2. It is found in the Taldy Gorge.

***R. pseudohirculus* Schrenk** is a mountain Central Asian coastal-water meadow perennial species.

№1. It is quite common in the subalpine and alpine belts, where it grows in meadows and along streams.

***R. pulchellus* C.A.Mey.** is a Pamir-Alai-Tian Shan-mountain-Siberian coastal-water-meadow species, perennial, similar to the previous species and to *R. longicaulis* C.A.Mey. (**№1,2**). Some systematics [22] even combine them into one. This is a species with an eastern-Palearctic range type growing along meadows in the upper part of the forest and subalpine belts.

№1. It is known from the valleys of the Talgar River and east of Turgen [17].

№2. It grows on the pass and in the upper Kurmekta.

***R. regelianus* L.** is a mountain Central Asian steppe species, perennial (**№1, 2**). It grows on dry crushed stone slopes and among shrubs in the lower mountain belt, sometimes up to the lower border of spruce forests.

№1. We found it in the valleys of the Kaskelen and Talgar rivers, as well as in the territory of the ASCNR (Karaturuk, Kokbeksai, Aksheshkek).

№2. It grows in the Saty Gorge, Kuturga.

***R. repens* L.** is a Palearctic coastal-water-meadow species, perennial (**№1, 2**). It is found growing sporadically throughout the study area along the banks of streams, in wet meadows and high-mountain swamps.

№1. We found it in the B. and M. Almatinka river valleys (the vicinity of the Lake B. Almaty and Gaysh, the left bank of the Sarysay River, Kazachka), in the vicinity of the cordons Tastibulak and Oizhailau, and in the Soldatsay (below the monitoring site No.2) in the altitudinal range of 1500-2700 m.

№2. It is found in the Kurmekta Gorge, on the left bank of Saty.

***R. rubrocalyx* Regel ex Kom.** is a Pamir-Alae-Tian Shan meadow perennial species. It is found growing sporadically on rocky scree, and in rocky areas of the alpine belt.

№1. It is known from the Talgar and Issyk river valleys [23].

***R. sceleratus* L.** is a holarctic coastal-water-meadow species, annual-biannual (**№1, 2**). It grows near streams and ditches in the foothills.

№1. The species was not found in the Almaty Reserve in its current borders [17,23]. We found it in two locations: a swamp near the Turgen River

bed (1300 m); and a drying swamp in the Kaskelen River valley and along the aryks (1600 m).

№2. It has been found in the Kurmekty and Karabulak gorges.

R. songoricus Schrenk is a Pamir-Alai-Tian Shan-Tarbagatai meadow species, perennial (**No.1, 2**) found throughout the surveyed territory in the forest and subalpine belts, in meadows, along river banks and stony slopes.

№1. The species is common, not abundant.

№2. It has been found in the Kurmekty Gorge.

R. transiliensis M.Pop. ex Ovcz. is a Dzhungaro-Eastern Tian Shan meadow species, perennial. It has been described in the surveyed territory [6]. It occurs sporadically in the upper mountain belt, on lawns and moraines, and around snowfields.

№1. The author of the first description of the species, M.G. Popov [17], described it growing in the valleys of the rivers M. Almatinka and Turgen, and M.S. Baitenov et al. [23], in the Talgar and Issyk river valleys. We collected it on 07.06.2008 on rocky slopes of a pit in the Chimbulak Gorge, near the second lift station at the Talgar Pass (2850 m).

R. trautvetteranus Regel ex Kom. is a Pamir-Alai-Tian Shan meadow species, perennial. This species is identified by some authors [24] with *R. songoricus*.

№1. It grows on wet slopes and lawns of the alpine belt: in the upper reaches of the rivers Turgen and Teskensu [15], and in the valleys of the Talgar and Issyk rivers [23].

Shibatheranthis longistipitata (Regel) Nakai is an Iranian-Mountainous-Asian meadow-steppe species, perennial. It is rare in the surveyed area. It occurs sporadically in small isolated populations on the dry slopes of lowlands,

№1. M.S. Baitenov et al. [23] mentioned that in the valley of the Left Talgar River it grows up to the alpine belt. We found it in the middle part of the Kotyrbulak River valley (dry slope with shrubs and single trees of Dzhungar hawthorn, 1300 m) and in the same conditions in the valley of the Kirgaulda River (oral communication by V. Epiktetov).

Thalictrum alpinum L. is an Arcto-Alpine, Holarctic meadow species, a miniature perennial plant (**№1, 2**). It is found everywhere in the alpine belt on lawns, crushed stone slopes, and moraines. Sometimes it descends to the upper part of the subalpine belt.

№1. The species is common, sometimes plentiful.

№2. It grows on the Kurmekty pass and in the upper reaches of the Kurmekty Gorge.

Th. collinum Wallr. is a Palearctic meadow, meadow-steppe species, perennial. It is found scattered throughout the surveyed area among shrubs, along dry meadows and steppe slopes, from the foothills to the lower part of the subalpine belt.

№1. The species is common, not abundant.

Th. flavum L. is a Palearctic forest-meadow species, perennial. It is found growing sporadically in a strip of deciduous forests in clearings and among shrubs, sometimes along river banks.

№1. We found it in the valleys of the rivers Aksai, Turgen, B. Almatinka (Alma-Arasan), and in the Oizhailau and Soldatsay gorges, not abundant.

Th. foetidum L. is a Palearctic meadow species, perennial (**No.1, 2**). It is found in the sub-alpine belt on rocky slopes, among various grasses, and in meadows.

№1. According to M.G. Popov [17], it sometimes grows in meadows of the spruce belt in the valley of the Turgen River, and according to M.S. Baitenov et al. [23], on rocky and crushed stone slopes of the upper mountain belt in the valley of the Talgar River.

№2. It has been found on the Kurmekty pass, in the Zap. Karabulak Gorge, and in the middle course of the Kaindy River.

Th. isopyroides C.A. Mey. is a Dzhungaro-Mediterranean steppe species, perennial. It is common on dry slopes of the desert lowlands.

№1. It was described by M.G. Popov [17] growing in the mountains of Shugata. It is likely to occur in the eastern part, in ASCNR.

Th. minus L. is a Palearctic forest-meadow species, perennial. It grows on stony-crushed slopes, in shrub thickets, and in mixed grass.

№2. It has been found in the Zap. Karabulak, Kolsai, Saty, and Zhamanbulak gorges.

Th. simplex L. is a Palearctic forest-meadow species, perennial (**No.1, 2**). It is found in the forest and subalpine belts in meadows, forest clearings and along river banks.

№1. M.G. Popov[17] described it growing in Chilik and Zhenishke, and M.S. Baitenov et al. [23], in Talgar. We found it growing sporadically in the valley of the Turgen River (2175 m) and in sparse spruce stands of M. Almatinka (1700 m).

№2. It is found on the Kurmekty pass, in the Kolsai and Saty gorges, on the left bank.

Trollius altaicus C.A. Mey. is a Tian Shan-Altai forest-meadow species, perennial (**No.1,2**). It is found in the subalpine belt, in herb meadows of spruce forests, archevniks, and in damp meadows.

№1. It is quite rare in the surveyed territory, and is not on the earlier lists [15,17,23]. We found it in

the valley of the Kotyrbulak River (Ivashchenko, 2007) [31] and on the left bank of the Almatinka River, above the Chimbulak Gorge (2400 m), not abundant.

№2. It grows in the Taldy, Kolsai, Saty gores on the left bank, the Aliman Gorge.

Trollius asiaticus L. is a North Tian Shan-Siberian meadow species, perennial. It grows in the sub-alpine belt in herb meadows, on damp lawns, pebbles, and near streams.

№2. It has been found in the Zap. Karabulak Gorge.

T. dschungaricus Regel is a Dzhungaro-Pamir-Alai forest-meadow, meadow species, perennial (**No.1, 2**). This is a common species found throughout the study area in meadows, among archevniks, along forest glades and edges from the upper part of the forest belt to the alpine belt.

№1. The species is abundant in places.

№2. It is found on the pass and gorge Kurmekty, at the headwaters of the right tributaries of the Kolsai River, 14.07.1952; in the Kaindy Gorge, Zap. Karabulak, Kuturga, Kolsai, and Saty Gorges.

T. lilacinus Bunge is a Pamir-Alai-Tian Shan-Altai meadow species, perennial (**No.1, 2**). This is a typical inhabitant of the alpine belt. It grows sporadically on alpine lawns and on rocky slopes near snowfields, and in pits.

№1. The pretty rare.

№2. It grows on the Kurmekta pass, in the upper reaches of the Sata River, and at the sources of the Kolsai River.

Family Berberidaceae Juss.

**Berberis iliensis* M. Pop. is a forest shrub endemic to the Ili River valley; listed in the Red Book of Kazakhstan [29].

№1. It does not grow in the IA SNNP, but is found on the territory of the ASCNR, in tugai thickets along the Chilik River valley, below the Bartogay reservoir.

Berberis sibirica Pall. is a Dzhungaro-mountain-Siberia petrophilic-lithophytic shrub. It grows on stony rocks, rocky slopes and placers.

№2. It has been found in the Kolsai Gorge, in 2015, by S.K. Mukhtubayeva, M.P. Danilov, A.A. Shormanova, and B. Bilibayeva [3]. The species needs further investigation.

B. sphaerocarpa Kar. et Kir. (*B. heteropods* Schrenk) is an Altai-Tian Shan forest-meadow shrub (**No.1, 2**). This is a common species found throughout the territory in deciduous forests, along slopes and rivers, up to the upper boundary of the spruce forests.

№1. It has been recorded at all forest monitoring sites, from Aksai (1350 m) to the vicinity of the Lake B. Almaty (2550 m).

№2. It is found along the river in the Kurmety Gorge, in the Zap. Karabulak, Kaindy, Vost. Karabulak, and Saty gorges on the left bank.

Gymnospermium altaicum (Pall.) Spach is a Tian Shan-Altai forest perennial tuberous ephemeroïd, one of the most prominent primroses (after *Crocus alatavicus* Regel & Semenow and *Iridodictyum kolpakowskianum* (Regel) Rodion.). It grows mainly in apple forests, among shrubs, only in the lower belt of mountains (1000-1600 m).

№1. It occurs sporadically (Talgar, Kotyrbulak, Belbulak, Turgen, Remezovka), in places abundantly. The species is listed in the Red Book of Kazakhstan [48].

№2. There are no reliable data on this species in the protected area. It was recorded by S.K. Mukhtubayeva [3] in the Kungei Alatau without specific location.

Leontice ewersmannii Bunge is a Central Palearctic steppe perennial ephemeroïd found in clay plains and foothills.

№1. It was not previously recorded in the surveyed area; M.G. Popov [17] found it only in the foothills of Sugata (Pshuk-Nura). The only known population reported by V.G. Epiktetov was located in the lower part of a dry slope of the left bank of the Kirgaulda River (1200 m).

Conclusion

Thus, within the protected areas of the Northern Tien Shan (Ile Alatau State National Nature Park, Almaty Reserve and the “Kolsai Koldery” State National Nature Park), 82 species from 26 genera of the family Ranunculaceae and two related families, Paeoniaceae and Berberidaceae, are protected, which is 97.6% of the flora of this floristic area. There are abundant, widespread, endemic and rare, listed in the Red Book, species. There were two endemics and five rare species. Among the Red Book listed species, one, *Hepatica falconeri*, is the rarest and the only representative of the genus *Hepatica* in the flora of Kazakhstan; it occurs in a few locations in a single gorge of the Kungei Alatau. Another rare species is *Gymnospermium altaicum*, one of the early primroses of the Northern Tien Shan, which presence in the SNNP “Kolsai Koldery” requires confirmation. The above rare species, as well as *Adonis tianschanicus*, are the objects of a special study by a doctoral students of Al-Farabi KazNU.

In turn, all rare species should be subject to regular monitoring within the protected areas.

Most of the species of the families Ranunculaceae, Paeoniaceae and Berberidaceae have various beneficial properties including decorative and medicinal; some species are poisonous. Some species are weeds, the number of which increases sharply with grazing, for example *Aconitum leucostomum*. This species forms a special formation studied in detail by S.A. Arystangaliev [32]. In “Kolsai Koldery” it consists of three groups of associations: Aconite-Geranium, Chervils-Aconite and False Hellebore-Aconite, where the dominants and subdominants are *Geranium rectum* Trautv., *Anthriscus aemula* (Woronow) Schischk. and *Veratrum lobelianum* Bernh. The group of harmful weeds not eaten on pastures includes, in addition to aconites, other representatives of the family Ranunculaceae (*Thalictrum simplex*, *Th. foetidum*, *Ranunculus polyanthemus*, *R. grandifolius*). Especially abundant are their thickets in the Kungei Alatau, including in the territory of “Kolsai Koldery”, where grazing ceased not so long ago.

Some weeds grow abundantly in cattle sites, sometimes appearing in atypical habitats. For

example, on June 20, 2015 we recorded a typical inhabitant of the foothills, an annual *Ceratocephalus testiculatus* in the upper reaches of the Assy River at an altitude of 2710 m, as well as in the spruce belt near the road to the Turgen Gorge (2175 m).

Analysis of the study group by life form showed that the vast majority are herbaceous plants, mainly perennials (84.1%), with annuals comprising only 6.1%. Also, the share of shrubs is low (9.8%). With regard to the distribution of species by ecological and cenotic groups, since the family Ranunculaceae is of boreal origin, its representatives are mostly found in the forest, forest-meadow and meadow plant communities (59.7%). The proportion of meadow-steppe and steppe species is lower (19.5%), as well as that of the coastal-water-meadow and aquatic species (15.6%); a few species (*Paraquilegia anemonoides*, *P. caespitosa*, *Paropyrum anemonoides* and *Berberis sibirica*) belong to the group of petrolithophilic elements.

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