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ANALYSIS OF THE CURRENT RANGE OF *PYRUS REGELII* REHDER IN KAZAKHSTAN AND CENTRAL ASIA

Annotation. Herbarium holdings of botanical organizations dated 1880-2022 were analyzed in order to identify the current range of *P. regelii* species and map its distribution. Materials of herbarium fund of RSE “Institute of Botany and Phytointroduction” (AA) - 133 herbarium sheets, V.L. Komarov Botanical Institute of RAS (LE) - 153 herbarium sheets, Republic of Uzbekistan (TASH) - 90 herbarium sheets were processed and analyzed, points of distribution on sites Plantarium and GBIF were viewed. As a result of the analysis 56 points of *P. regelii* distribution in Karatau, Western Tien Shan and Kyrgyz Alatau were identified and mapped, 28 points were marked from the territory of Kyrgyzstan, 42 points from Uzbekistan and 8 points from the territory of Tajikistan. It was revealed that the form of *P. regelii f. simplicifolia* occurs much less frequently than the form of *P. regelii f. Koopmani*. Possible processes of intrageneric hybridization between Central Asian pears require further ecological-biological and molecular-genetic studies. A critical review of the ecological conditions of P. regelii revealed that the species is distributed along southern, eastern, southwestern, less often northern slopes of mountains at an angle of 34° in the belt of shrub vegetation, in Uzbekistan in the band of juniper. The soil of *P. regelii* is stony-fine-grained and rubbly, and populations are distributed on mountain slopes along rivers at altitudes from 613 to 2600 m above sea level, depending on the ecological conditions of the gorges.

Keywords. *Pyrus regelii;* herbarium; distribution map; ecology; flora; range; population; growing area; geographical points.

Introduction

At present, the decline in biodiversity, including the diversity of wild relatives of cultivated plants, is mainly due to anthropogenic factors, and is a threat to the global community. The study of a large number of potentially useful species taking into account their economic and social demand is highly relevant and timely for Kazakhstan [1,2]. In order to preserve unique and valuable wild forms of pear, genetic banks are created to conserve genetic material from abiotic and biotic stress factors [3].

Pyrus regelii is a donor of economically valuable biological traits. It is distinguished by bright foliage, unusual colors and unique adaptive properties to the environment, such characteristics are highly valued in landscape design [4]. Under the influence of anthropogenic factors there is a reduction in natural populations of the species under study. At present, *P. regelii* is insufficiently studied from the geobotanical side, there is not enough information on the floristic composition of populations. The species is of great value as a carrier of genetic

properties in the selection of cultivated varieties, introduction into culture in the south of the country in the afforestation of arid areas.

P. regelii grows on dry stony slopes and in mountain river valleys [5]. A relict of Central Asian subtropical savannas of the Paleogene epoch [6]. According to the Flora of Kazakhstan, the *P. regelii* is variable in the shape of leaves, which are sometimes deeply dissected into narrow lobes, which is especially characteristic of specimens growing on rocks (*P. regelii f. Koopmani* Spath); sometimes in trees growing on wetter sites and reaching larger sizes here, most leaves are entire (*P. regelii f. simplicifolia* M. Popov) [7;401]. S.S. Kalmykov attributes this species to the Arys forests of the Western Tien Shan, where it occurs in pure stands or in communities with pistachio and *Crataegus pontica* K. Koch [8].

The species belongs to the genus *Pyrus* L., family *Rosaceae* Juss. Pear as a fruit crop has been known since ancient times, now various species and varieties of pear grow in different regions of the world. According to some data, the genus *Pyrus* includes about 60 species [9]. According to Flora of Kazakhstan there are 2 species in Kazakhstan: *Pyrus communis* L. and *Pyrus regelii*. According to M.S. Baitenov, 3 species grow on the territory of Kazakhstan and about 30 species in the genus itself [10].

P. regelii is endemic of the Western Tien Shan and Pamir-Alai, in Kazakhstan it is found in the southern regions of the country, in the mountains: Chu-Ili, Kyrgyz Alatau, Karatau and Western Tien Shan. In the western part of its range it grows in Turkmenistan (Kugitang Ridge). Further to the northeast, it grows in Tajikistan in the Kuramin and Zeravshan ranges. In the north, in the Western Tien Shan, it is noted in the Chatkal, Chandalash, and Ugam ranges [11].

P. regelii was included in the Red List of the International Union for Conservation of Nature (IUCN) in the Least Concern (LC) category in 2020 and the Red Data Book of Turkmenistan in 2024 [12]. In Kazakhstan it is included in the regional Red Data Book of Zhambyl region as a rare species with status 1 (E), the limiting factor of which is economic activity and logging, the reserves of the species are very small and it is found in single specimens [13].

The purpose of our work is to identify the current range of *P. regelii* and map its distribution within Kazakhstan and Central Asia. In this regard, we set the following objectives: critical analysis of herbarium specimens presented in leading botanical organizations of Uzbekistan (TASH), Russia (LE), Kazakhstan (AA); identification of distribution points and development of an area map of *P. regelii*; study of the ecological habitat of the species.

Materials and methods of research

The article used traditional botanical methods in the processing of materials from the herbarium funds of the “Institute of Botany and Phytointroduction” (AA), the herbarium fund of the V.L. Komarov Botanical Institute of the Russian Academy of Sciences (LE), the herbarium fund of the Republic of Uzbekistan (TASH) and the digital herbarium of MSU – «Noah's Ark» National Depository Bank of Live Systems (MW) [14]. To clarify the range of *P. regelii*, herbarium sheets of the above-mentioned botanical organizations were studied and analyzed. Additionally, data from the Plantarium website and GBIF [15,16] were used to clarify the places of growth. The map was made using GPS coordinates with further processing by QGIS. In the process of study, the data of the following literature sources were used: “Flora of Kazakhstan” and works of authors studying the genus *Pyrus L*. The names of plant species were given according to the Plant of the World online site [18]. Data of herbarium specimens in the article are presented in the form of a table. Since among the analyzed material there were repetitions of herbarium sheets from certain geographical locations, the table indicates in which herbarium collections there is a repetition. Labels of specimens are indicated only from the territories of Kazakhstan. Also, the authors' data on the results of field studies for 2022 within the Kyrgyz Alatau and Syrdarya Karatau ranges are presented in the paper.

Results and Discussion

As a result of field studies, as well as the analysis of herbarium materials, the areal of *P. regelii* has been established within South Kazakhstan and in the countries of Central Asia. The first collections of herbarium materials of *P. regelii* begin in 1880 of the XIX century, described by A.E. Regel presumably from the Mynzhilki gorge, belonging to the Syrdarya Karatau, the type sheet is in the herbarium collection of the V.L. Komarov Botanical Institute in St. Petersburg. The first scientific studies of *P. regelii* population were conducted by scientists Z.A. f. Minkwitz and O.E. f. Knorring in 1908 in the gorges of Syrdarya Karatau, the results of which are reflected in the preliminary report of botanical research in Siberia and Turkestan [19]. The vegetation of Karatau was further studied by V.V. Nikolskii, M.V. Kultiasov, E.A. Moheeva, M.M. Sovetkina, and B.A. Fedchenko from 1911 to 1930.

Botanical studies of the Karatau region were carried out to the fullest extent in 1930-1931, due to the fact that the best rubber-bearing plant of temperate floras, Tau sagyz, was found here. N.V. Pavlov and S.Y. Lipshits are considered pioneers in the study of the Karatau flora. As a result of studying the flora of the Syrdarya Karatau and collections of N.V. Pavlov, as well as other authors (Lipshits S.Y., Gomolitsky P.A., Pyataeva A.D., Mikeshin G.V., Tekutyev G.V., Chilikina L.N., Polyakov P.P., Bykov B.A.) have published many works [19].

To identify the range of *P. regelii* in Central Karatau, we analyzed 65 herbarium specimens stored in leading botanical centers.

In Syrdarya Karatau *P. regelii* is widespread enough (Table 1). It can be stated that Karatau is the main area of the species' growth. Growing points along the Karatau ridge were recorded in the gorges of the southwestern macro-slope: Biresik, Boyaldyr, in the basin of the Ushozen River, the gorge of the Koksarai River, the vicinity of the Baizhansai settlement and dry slopes of the Khantagi Gorge [15]. V.V. Nikolskii in 1911 and again in 1929, the places of *P. regelii* growth was recorded in the vicinity of Taldysu village, along the Besaryk River, belonging to the Central Karatau. The species is widespread throughout the Boraldaitau Range, in the Kokbulak River basin in the Boztorgai Gorge, southwestern slopes of the Kulantau Gorge, Bastarchai Gorge. R.G. Zaripov notes *P. regelii* on slopes of northern exposure in the valleys of the Kulan, Sayasu, Abyshsai rivers and in the Kokbulak River basin (Nurbaisai, Boztorgai, Bekesai, Arshalysai) [20]. The distribution of the species in the gorges of the Kokbulak, Boztorgai, Hantagi, Kenozen rivers, along the Boraldai tau ridge in the Nurbai Mountains is also confirmed on the Plantarium site. Growing points were noted in Kentau, Baidibek district on the southwestern slope of the Karatau ridge and in Zhualin district [16].

Table 1 – List of analyzed herbarium sheets from the territory of Kazakhstan.

Distribution Region and Ecology	**Herbarium Acronym**	**Collection Date**	**Collectors**
1	2	3	4
Mont. Min-dschilke prope fraj. Kendyr-aus.	LE	20.05.1880	A. Regel
Syrdarya region, Chymkent district, Beresek, Dzhantakty tract, Floodplain forests	LE	13.06.1908	B.A. Fedchenko
Syrdarya region, Chymkent district, Birsek River gorge, Dzhantak tract	TASH, LE	14.06.1908	Z.A. Minkvitz

Continuation of table 1

1	2	3	4
Syrdarya region, Chymkent district, near Kelen-Kurgan wintering, mountains in the Kuzak gorge	LE	29.06.1908	Akhmetov, Yakubov
Syrdarya region, Chymkent district, Kelen-Kurgan wintering	TASH	30.06.1908	O.E. Knorring
Syrdarya region, Chymkent district, Boztorgay gorge	LE	30.07.1908	S.S. Neustruev, G.I. Dolenko
Syrdarya region, Aulie-Ata district, Ulkun-sai-asu gorge (Kunek mountains)	LE	1909	Z.A. Minkvitz
Syrdarya region, Aulie-Ata district, Berkara gorge. Gorge bottom along the river, on the mountain slope	LE	23.05.1909	Z.A. Minkvitz, O.E. Knorring
Syrdarya region, Perovsky district, Karatau, Taldysu headwaters	LE	23.05.1911	V. Nikolsky
Syrdarya region, Tashkent district, Ugam River valley	TASH	06.1921	Baranova
Syrdarya region, Aulie-Ata district, Karatau mountains, turf-covered slopes near Berkara River	TASH	30.05.1922	V.P. Drobov
Syrdarya region, Tashkent district, Bogucholpak	TASH	12.07.1922	O.A. Simonova
Syrdarya region, Chymkent district, Karatau mountains, near Kokbulak River	LE	22.07.1922	M. Kultiassov
Syrdarya region, Chymkent district, rocky slopes of Duana-Tau mountains	TASH	24.07.1922	M. Kultiassov
Syrdarya region, Chymkent district, Karatau mountains. Road from Mynzhylky to Bayaldyr gorge, rocky slopes	TASH, MW	05.07.1923	E.A. Mokheeva
Syrdarya region, Chymkent district, Daubaba River valley, upstream from Daua Baba's tomb	TASH	31.06.1924	M. Sovetkina

Continuation of table 1

1	2	3	4
Syrdarya region, Aulie-Ata district, Karatau mountains, Asy River basin. Siyasi gorge cliffs	TASH	08.05.1925	M. Sovetkina
(*f. simplicifolia* M. Popov). Western Tien Shan, vicinity of Chimghan Botanical Station. Bank of Chimghan River, half a mile from the resort area, upstream	AA	28.08.1928	P. Gomolitsky
Syrdarya region, Perovsky district, Karatau, Taldysu gorge	LE	29.05.1929	V. Nikolsky
Kazakhstan, Western Tien Shan, mountains in the upper reaches of the Badama River, downstream of Dorofeevka River	LE	09. 1929	B.A. Fedchenko
Turkestan district, foothills of Karatau beyond Baba-Kurgan kishlak. Gravelly slopes of mountains	MW, TASH, LE	21.04.1930	S.Yu. Lipschits
Turkestan district, Karatau mountains, Ush-Ozen gorge. Gravelly slopes of mountains	TASH, MW	28.04.1930	S.Yu. Lipschits
Western Tien Shan, Karatau mountains, Turkestan Birisek valley	TASH	18.08.1930	P. Gomolitsky
Western Tien Shan, Karatau mountains, upper reaches of Zhilagan Ata gorge, left tributary	TASH, LE	27.08.1930	P. Gomolitsky
Karatau mountains, rocky slopes in Berkara gorge near Lake Bilikol	AA	03.05.1931	N.V. Pavlov
Karatau mountains, meadow slope under Bukuy-Tau pass	MW	29.06.1931	N.V. Pavlov
Western Tien Shan, Karatau mountains, rocky-fine soil habitat	LE	25.07.1934	A.D. Pyataeva
Talas-Alatau mountains, southern rocky slopes along the Daubaba River (1400 m)	LE, MW	29.07.1931	N.V. Pavlov
South Kazakhstan region, Bostandyq district, Karan-Kul gorge, southern slope at the gorge's summit, rocky places	AA	25.08.1933	P. Chaban

Continuation of table 1

1	2	3	4
Western Tien Shan, Karatau mountains, gravelly northwest slope of Karasai tract	TASH	25.05.1934	A. Pyataeva
Karatau range, Akchek-Tau mountain near Mikhailovka village. Rocky slope	MW	29.05.1934	L.N. Chilikina
Karatau region, Kainar-Bastau district, Great Aktau	MW	18.07.1934	G.V. Mikeshin
Syrdarya Karatau, eastern slope of Mashat mountains near Tulku Bas station	AA, MW	26.07.1934	N.V. Pavlov
Western Tien Shan and Karatau, northern side gorges of Derbaz-Keptal, Great Aktau, rocky slopes	MW	02.08.1934	G. Mikeshin
Western Tien Shan, Karatau mountains, gravelly northwest slope of Karasai tract	LE	29.08.1934	A. Pyataeva
Syrdarya region, vicinity at the top of the Mashat mountains gorge near Daubaba pass	MW, AA	12.09.1934	N.V. Pavlov
Karatau foothills, Kainar district, Great Aktau range, southern rocky slope	MW	30.05.1935	A. Nikolaev
Karatau range, Turkestan district, Ush-Ozen River gorge, west gentle slope, fine soil with gravel, sagebrush steppe with shrubs	MW	05.07.1935	G.V. Tekutyev
Western Tien Shan, Karatau mountains, gravelly fine-soil southwest slope of Agayuk-Sai	TASH	04.06.1936	A. Pyataeva
Western Tien Shan, eastern part of Karatau range, Kuyuk mountains, Arbatas tract, Talbulak gorge	MW	12.06.1936	L.N. Chilikina
Western Tien Shan, Ugam range, upper reaches of Karatash gorge	LE, AA	07.07.1936	A. Dmitrieva
Karatau mountains, Berkara gorge near Lake Bilikol, rocky slopes	MW	03.05.1939	N.V. Pavlov
South Kazakhstan region, Tyulkubas district, upper reaches of Kokbulak gorge near cordon, northern slope with apple and	LE	22.07.1939	A.V. and V.A. Yarmolenko

pear thickets			
Continuation of table 1			
1	2	3	4
Western Tien Shan, Karzhantau range, Bogucholpak tract, on gravelly slopes, in woody-shrub zone	AA	04.06.1940	V.U. Makarchuk
On the northern gravelly slope of Mashattau opposite Tulku Bas station	AA	05.08.1946	P. Polyakov
Karatau, Boraldaitau, Sayasu gorge	AA	07.08.1946	P. Polyakov
Karatau, Berkara gorge	AA	15.06.1947	B. Bykov
Kyrgyz Range, Merke River gorge, western rocky slope (1200 m)	AA	19.07.1947	N.I. Rubtsov
(*f. simplicifolia*) South Kazakhstan region, Karatau, rocky slope in Kokbulak gorge	AA, MW	12.08.1949	N.V. Pavlov
(*f. simplicifolia*) South Kazakhstan region, Karatau, steppe slope in Bozturgai gorge	AA, MW	13.08.1949	N.V. Pavlov
Southern Karatau, upper reaches of Boztorgai gorge, rocky terrace	LE	19.07.1950	I. Vasilchenko
Karatau, Sandidas Mountain, eastern slope near borehole tunnel, rocky gravel slope with shrub thickets	MW	30.05.1952	N. Parfentieva
Karatau Mountains, Biresik Valley, southwest slope, 34° angle, elymus-feraula association with shrubs	MW	05.08.1953	N. Parfentieva
South Kazakhstan region, Bostandyq, Pskem River valley 2 km above Uzun village, gravelly slope	MW	25.08.1953	V. Pavlov
Western Tien Shan, Karatau range, Koksaray River gorge, on the slope	LE	02.06.1958	O. Neustroeva et al.
South Kazakhstan, between Orlovka and Baidzhansai mine, Kattybugun River valley, dry gravelly steep slopes	LE	17.06.1959	V.P.Bochantsev, A. Pyataeva
Western Tien Shan, SW part of Lake Biylikol, Karatau's Sayasu side gorge	LE	19.06.1959	A. Pyataeva
Kyrgyz Alatau, Botamoynak gorge, eastern	AA	20.05.1961	A. Gamayunova

slope ridge			
Continuation of table 1			
1	2	3	4
Karzhantau Ridge, Kasbasay River Valley, near Turbat village	AA	22.05.1961	N. Karmysheva
Kyrgyz Alatau, gorge west of Almalysai, rocky cliffs near the summit	AA	25.05.1961	V.V. Fisun
Syrdarya Karatau, Berkara gorge (Biylikul Lake basin), southern rocky slopes	LE, AA	24.05.1963	V. Goloskokov
Southwestern end of Kyrgyz range, Almalysai gorge, rocky slopes	LE, AA	01.06.1963	V. Goloskokov
Syrdarya Karatau, Berkara gorge slopes, lower and middle part	LE	27.08.1969	R. Kamelin
Karatau Ridge, Baydzansai gorge, 6 km from Baydzansai village	AA	1969	B. Winterholler
Syrdarya Karatau, Berkara gorge, middle part, shrub thickets	LE	18.07.1970	R. Kamelin
Syrdarya Karatau, Aygyzhal ridge, northern rocky slope	AA	04.06.1972	P. Myrzakulov
Syrdarya Karatau, southern slope at 1720 m above sea level	AA	19.06.1972	P. Myrzakulov
Western Talas Alatau, upper Daubaba valley, northern slope	AA	25.06.1973	N. Karmysheva
Syrdarya Karatau ridge, Biresik, 3 km above Mangytai	MW	04.07.1973	M.E. Pimenova
South Kazakhstan, Syrdarya Karatau, Khantagi gorge, dry slopes with shrub woodlands	LE	03.07.1974	R. Kamelin
Karatau Mountains, Koshkarata River basin, Bas-Sungu creek mouth, eastern slope	AA	1977	N.V. Lyashenko
(*f. simplicifolia*) Boraldaitau, Kokbulak gorge, southern slopes	AA	20.06.1979	Zaripov
Boraldaitau, Kulantau gorge, southwestern slopes	AA	21.05.1980	-

Continuation of table 1

1	2	3	4
Talas Alatau, Daubaba gorge, river floodplain above cordon	AA	1980	L. Grudzinskaya
Boraldaitau, Kulantau gorge, southwestern slopes	AA	21.05.1980	-
Karzhantau Ridge, Arkabay gorge, dry ridges	AA	17.07.1981	V.A. Samoylova
Kyrgyz Alatau, Kaindy River Valley, southern slope	AA	31.07.1981	N. Karmysheva
Karatau ridge, near Kitaevka village	AA	04.08.1981	V.A. Samoylova
Shymkent region, Karatau Mountains, Baji Pass	AA	20.06.1982	N.V. Lyashenko
Kyrgyz Alatau, Kaindy River Gorge, middle course, eastern slope	AA	19.07.1982	N. Karmysheva, N.V. Nelina
South Kazakhstan, Syrdarya Karatau, Boralday ridge, Bastarchay gorge	MW	10.08.1982	M.G. Pimenov
Karatau Ridge, southern slope above Abai village, eastern exposure	AA	09.06.1983	V.A. Samoylova
Western part of Kyrgyz Alatau, Merke River gorge, western herbaceous slope near GES-2	AA	26.06.1983	N.V. Nelina
Western end of Kyrgyz Alatau, Kaindy River Valley, western rocky gorge near the bridge, scree	AA	19.05.1984	N.V. Nelina
Central Karatau, Khantagi Gorge, 23 km from Khantagi village, left side of the river, rocky-gravel slope	AA	09.05.1985	P. Myrzakulov, V.A. Samoylova
Kazakhstan, Shymkent region, Karatau (north), western slope of Belbulak gorge (Aktobe), north of Mynzhylky	MW	17.05.1985	M.G. Pimenov
(*f. simplicifolia*) Kyrg yz Alatau, northern macroslope, Molaly gorge, eastern foothill slopes	AA	10.07.1986	N.V. Nelina

Continuation of table 1

1	2	3	4
Shymkent region, 16-20 km northeast of Kentau city, Karatau ridge, SW macroslope, Khantagi gorge (750 m)	MW	02.06.1989	I.I. Rusanovich
Karzhantau Ridge, southern spurs, Ugam River floodplain, rocky slope	AA	25.08.1992	M.S. Baytenov
Karatau Mountains, Ushozen tract	MW	18.06.	Sheglova
Zhambyl region, Kyrgyz Alatau, Kaindy Valley (42°52'45.6"N; 71°54'33.09"E), 1056 m, shale rock outcrops	AA	23.06.2011	M.P. Danilov et al.
Karatau Reserve, Biresik gorge, southern slope (43°38'054"N; 63°37'38.0"E), 693 m, Turkestan region	AA	10.05.2019	G.T. Sitpaeva et al.
Karatau, Boraldaitau, Kulan River valley, hawthorn sparse forest	AA	01.06.2000	G. Kudabaeva
South Kazakhstan, Tulkubas district, Sayram-Ugam National Park, Boraldaitau Mountains, Kokbulak gorge and cordon (800-850 m)	AA	19.05.2013	B. Bilibaeva et al.
Karatau, Molaly gorge along Ikan-su road, undulating mountain plain, mountain serozems	AA	14.06.2013	A. Kurmantaeva
Kyrgyz Alatau, Zhambyl region, Botamoynak locality, Almalysai gorge (42°49'44"N; 71°43'25"E), rocky slope at 1150 m	AA	27.06.2022	P.V. Veselova et al.
Kyrgyz Alatau, Zhambyl region, Merke Gorge, eastern slope, right bank of the Merke River. Shrub-grass community (N 42°46'11 E 73°13'39) H-1010 m	AA	29.04.2023	A.Abdukhadyr, G.T. Sitpaeva
Kyrgyz Alatau, Zhambyl region, Almalysai Gorge, south slope (N 42°49'42.443" E 71°43'23.913") H-1146 m	AA	29.04.2023	A.Abdukhadyr, G.T. Sitpaeva
Kyrgyz Alatau, Kaindy Gorge, western slope (N 42°53'14.048" E 71°54'52.697")	AA	30.04.2023	A.Abdukhadyr, G.T. Sitpaeva

H-1002 m			
Continuation of table 1			
1	2	3	4
Karatau, Berkara gorge, southeast slope (N 42°55'34.2" E 70°38'31.3') H-613 m	AA	17.07.2023	A.Abdukhadyr, N. Zverev
Karatau, Sayasu Gorge, left bank of the river, southern slope (N 42°53'48.446" E 70°43'07.182") H-621 m	AA	17.07.2023	A.Abdukhadyr, N. Zverev
Acronym of the herbarium: (AA) - Herbarium Fund of the "Institute of Botany and Phytointroduction". (MW) - «Noah's Ark» National Depository Bank of Live Systems. (LE) - Herbarium fund of the V.L. Komarov Botanical Institute of the Russian Academy of Sciences. (TASH) - herbarium fund of the Republic of Uzbekistan.			

In the Lesser Karatau, finds have been recorded in the Sayasu and Berkara gorges, which is confirmed by our expeditionary research undertaken in 2022. According to collections by Pyataeva (1934), a collection point was noted on the northwestern slope of the Karasai tract (Karasai Rift). Populations of *P. regelii* in Sayasu and Berkara gorges are marked on the Plantarium site with location coordinates, as well as individual trees were recorded in Eliksai gorge, which is located in the southeastern part of the Syrdarya Karatau between Tutsai and Ayirsai gorges, in the valley of the Ulken-Bugun River. According to the biodiversity assessment report of the Karatau Range, the northernmost location point of the study site was recorded in the Karagur River basin on the northeastern slope of Karatau [11; 286].

The growing ecology of *P. regelii* is diverse. Having analyzed the actual data collected from the whole Karatau Range, we concluded that mainly populations of the species are confined to the southern, eastern, southwestern, less often to the western and northern exposures of dry mountain slopes at an angle of 34°. Soils in P. regelii habitats are sodden clayey-stony, stony-fine-grained, stony-rubble or stony terraces with slate rock outcrops. The Karatau population of *P. regelii* is most often confined to slopes along rivers in the lower and middle part of hills at an altitude of 693 to 1720 m above sea level. According to our data, in the Berkara Gorge it grows at an altitude of 613 m above sea level.

P. regelii is a characteristic dominant of the florocenotype shibliak and is confined to shrub-shallow forest cenoses with floodplain forest elements of sparse woodland with participation of *Malus sieversii* (Ledeb.) M.Roem., *Crataegus turkestanica* Pojark. and *Acer tataricum subsp. semenovii* (Regel & Herder) A.E.Murray et al. According to R.V. Kamelin, shibliak is a mediterranean vegetation type consisting of deciduous, often drought-tolerant shrubs and low-growing trees of about 3-4 meters in height. *P. regelii* grows in association with *Acer tataricum subsp. semenovii*, of the shrubs the most common are *Prunus griffithii var. tianshanica* (Pojark.) Ingram, *Prunus erythrocarpa* (Nevski) Gilli, species *Rosa* L., *Atraphaxis* L., *Rhamnus songorica* Gontsch., *Prunus spinosissima* (Bunge) Franch., *Lonicera nummulariifolia* Jaub. & Spach, *Spiraea hypericifolia* L.

Phenotypic analysis of leaf plate shape of herbarium specimen of V. Pavlov (1949) in Kokbulak and Bozturgai gorges of Syrdarya Karatau revealed whole lanceolate leaves (*P. regelii f. simplicifolia*).

In the Western Tien-Shan *P. regelii* according to herbarium collections was recorded: in Karzhantau and Ugam ridge along the Ugam river, near the border with Uzbekistan; in the

upper reaches of the Karatash gorge; at Bogucholpak pass; in the Daubaba mountains (Taldybulak brook valley); in the canyon of the Mashat river; in the vicinity of the Chimganka river (P. Gomolitsky 1928); it is listed in the upper reaches of the Badam river (B.A. Fedchenko 1929). Mashat; in the vicinity of the Chimganka River (P. Gomolitsky 1928); listed in the upper reaches of the Badam River (B.A. Fedchenko 1929). Marked on dry ridges of the Arkabai Gorge (V.A. Samoylova 1981). In the work of N. Karmysheva noted collection sites in the Karakus, Alatau, and Aksu River canyon [21]. According to the Plantarium website, the points are marked in the gorge of the left unnamed tributary of the Ulken-Sarymsaksay (Daubaba) brook at an altitude of 1700 m above sea level.

P. regelii in the Western Tien Shan grows mainly on the northern stony and rubbly mountainside, on dry ridges in the tree and shrub belt, at an altitude of 800-1700 m above sea level. However, in the Aksu-Zhabagala reserve in the Zhusaly gorge it grows much higher than the usual altitudinal interval for it, on the Mynzhilki terrace it rises up to 2600 m above sea level, probably due to the specific microclimate of the southern slope of this gorge [11; 286]. Phenotepic analysis of leaf plate shape showed that *P. regelii f. simplicifolia* is found here only along the bank of the Chimganka River, in other gorges leaf plate has dissected leaf shape (*P. regelii f. Koopmani*).

In the Kyrgyz Alatau the distribution of *P. regelii* is confirmed by 10 herbarium sheets of the “Institute of Botany and Phytointroduction” (AA). Collections from the territories of the Kyrgyz Alatau date from 1961 (collector Gamayunova A.P.). V.V. Fisyun (1961) noted *P. regelii* in the Almalysai Gorge. In the gorge of the Kayyndy River, growing points were recorded by N. Karmysheva and N.V. Nelina (1981, 1982). In the Merke River Gorge and Molaly Gorge were noted by N.V. Nelina during her survey work [22]. Also, the growing points of *P. regelii* in the Merke Gorge, in the valley of the Kayyndy River and in the Almalysay Gorge were confirmed by our expedition research undertaken in 2022. During our research in the Merke and Kayindy Gorge, two leaf forms with pronounced variegation were identified, as shown in figure 1 (*P. regelii f. simplicifolia*, *P. regelii f. Koopmani*).

General view *Pyrus regelii* Rehder

P. regelii f. Koopmani Spath

P. regelii f. *simplicifolia* M. Popov

Figure 1 – Morphological features of *P. regelii* forms in the Kayindy Gorge

Near these populations in the lower part of the slope grow cultivated species of *Pyrus* L. A solid elongated form of leaf lamina (*P. regelii f. simplicifolia*) is represented in the herbarium specimen of collections by N.V. Nelina (1986) from the Molaly Gorge. In the Almalysai population, where cultivated pear does not occur, populations of *P. regelii* have pinnately dissected leaves (*f. Koopmani*). The process of pear shaping in Central Asia was noted as early as the beginning of the 19th century. The presence of interspecific double, triple hybrids (*R. regelii x R. communis x R. serotina*) was established by Rubtsov G.A. [23]. In general, spontaneous interspecific hybridization of the *Rosaceae* family is quite common in nature [24].

To determine the range of *P. regelii* on the territory of Kyrgyzstan, 49 herbarium sheets collected from 28 places of its growth were reviewed. The earliest references to finding *P. regelii* date back to 1899. Analysis of the examined specimens showed that the species within Kyrgyzstan is found in the Western Tien Shan: Chatkal, Pskem, Fergana, Kirghiz ridges, along the banks of the Namash, Kasan, Ters, Ermendy *(f. simplicifolia*), Kaljrsu, Abdyi, Chatkal, Chimbulak, Kara Archan gorges, Uzun-Bekhal, Kaljrsu, Abdyi, and Kara Archan gorges (*f. simplicifolia*), Nichkesai (*f. simplicifolia*), Kalzhrsu, Abdyi, Chatkal, Chimbulak, Kara Archa, Uzun-Bulak, Mailuu Suu gorges, Adyr tract, Kichik-Dzhol pass, Kyzyl-Alma mountains, Suzak (*f. simplicifolia*) and in Suzak district.

The studied species grows in Kyrgyzstan forming mixed deciduous forest on rocky northeastern, northern, eastern, southern slopes of mountains at an altitude of 900-1250 m above sea level. In Mailuu Suu in tract Zhurek the object of study was found at altitudes over 1545 m above sea level and in tract Khurmaidan 1806 m above sea level [25]. The species is confined to fine-grained, stony, clayey, reddish-sandstone, stony-coarse-rubble, less often sulfur soils.

In order to estimate the area of *P. regelii* growth in the territory of Uzbekistan, 80 herbarium sheets were reviewed in the herbarium collection and 42 growing points were identified. In the Chatkal Range *P. regelii* is distributed in the gorges of the Shavrez, Kasansai, Ters, Koksu, Shevas, Aksakata, Nurek-ata, Chatkal, Sandalash, Kyzylsai rivers. Marked points in Hadonlak-sai gorge and foothills around Shavaz-sai, near Kyzylsai pass. In Nurata range - in Koshrabat, Aktau, Koitash and Zargar mountains. Within the Zeravshan range in the vicinity of Shakhrisabz, Talbary, Amankutan, Yulsai, at the Takhtakaracha pass. In the Kugitang Mountains near Kempir-Tyube and Aktash villages. In the Gissar range between the Kashka and Dzhany-Darya rivers, the valley of the Sangardak and Gilon-Darya rivers, the vicinity of Guliob village. Within the Ugam range: in the valleys of the Ugam and Konsai rivers. In Turkestan range: Kulsai valley and Jenishke pass. In the Kuramin range: Altyn-Topkan, Kashkasai, Kara-kiya, Saraimardon, Angren and Abayazsai river valleys. In the Pskem range: Navoni-sai and Karabau, also in the Susyztau range. In the mountainous region of Samarkand region at coordinates 40.480936; 66.808007 (GBIF).

In Uzbekistan, the ecology of the species is confined to northern, southern, southwestern stony, rocky, rubbly, rubbly-fine-grained mountain slopes, in a strip of juniper and woody-shrub vegetation, in a wheatgrass community, at an altitude of 1000-2200 m above sea level. The leaf form of *P. regelii f. simplicifolia* in Uzbekistan is found only in Yulsai.

In Tajikistan, the range of *P. regelii* is represented on 6 herbarium sheets, collected within the Hissar, Pamir, Alai ranges and the Mogoltau Mountains. It is confined to stony soils on the eastern, northeastern slopes of the mountains at an altitude of 900-2200 m above sea level, growing among thickets of maple and pistachio. According to the data of herbarium specimen analysis it was revealed that in Tajikistan the whole form of leaves is found only in the Mogoltau Mountains.

Having analyzed the data of the presented herbarium collections, we have identified 134 points of distribution of *P. regelii* in Central Asia. As can be seen in Figure 2, all identified points are mapped and distributed in the countries of Kazakhstan, Tajikistan, Uzbekistan and Kyrgyzstan. From the territories of Turkmenistan data in herbarium organizations are absent and are not presented on the sites Plantarium and GBIF.

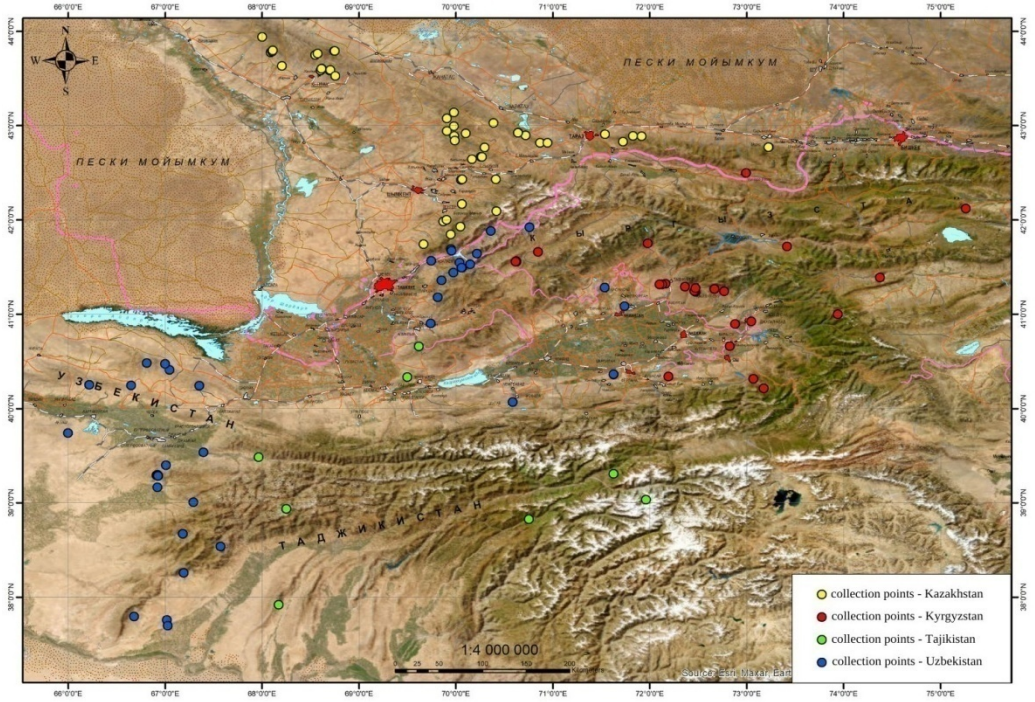

Figure 2 – Distribution map of Pyrus regelii Rehder

Conclusions

Thus, as a result of a critical review of herbarium specimens of leading botanical organizations, the exact locations of *P. regelii* species in Kazakhstan and Central Asia were determined. Also additional data on the range of *P. regelii* were presented with reference to the sites of Plantarium and GBIF.

For Kazakhstan, 56 points of distribution of *P. regelii* from the mountainous areas of the Kyrgyz Alatau, Karatau and Western Tien Shan were determined and recorded on the map. The occurrence of the species in the Chu-Ili Mountains, although given in the Flora of Kazakhstan and in I.I. Roldugin's outline of the Chu-Ili Mountains, is not confirmed by herbarium collections, as well as on the sites of Plantarium and GBIF.

The growing ecology of *P. regelii* is confined mainly to southern and eastern, less often western and northern dry mountain slopes, at altitudes from 613 m above sea level (Berkara Gorge, Small Karatau) to 2600 m above sea level (Western Tien Shan). Places of growth are characterized by high air temperature and low precipitation in summer season, which shows xeromesophyticity of the species. The soil is stony and rubbly with rock outcrops.

Uncharacteristic solid leaf shape (*P. regelii f. simplicifolia*) occurs in the vicinity of cultivated pear orchards. This feature requires further molecular genetic studies to identify possible hybridization between these species, or more historical hybridization processes with other species of this genus.

In Central Asian countries, including Kyrgyzstan, 28 points of *P. regelii* occurrence have been identified, in Uzbekistan 42 and in Tajikistan 8 points, on the basis of which a distribution

map has been compiled. The ecology of *P. regelii* in Kyrgyzstan and Tajikistan is similar to Kazakhstan, where the species grows in mixed deciduous forest; in Uzbekistan it is found in the *Juniperus* L. belt, on dry stony, rubbly slopes at an altitude of 900 to 2200 m above sea level. The solid elongated leaf shape is also found in these regions, including in Armand and Vasilenko's 1945, 1953 collections of specimens redefined as the hybrid *Pyrus bucharica* Litw. *x P. regelii.*

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ҚАЗАҚСТАН МЕН ОРТА АЗИЯДАҒЫ PYRUS REGELII REHDER-ДІҢ ҚАЗІРГІ ТАРАЛАУЫН ТАЛДАу

Аңдатпа. *P. regelii* түрінің өсуінің қазіргі ауқымын анықтау және таралу картасын жасау мақсатында 1880-2022 жылдары жасақталған ботаникалық ұйымдардың гербарий қорларына талдау жүргізілді. В. Л. Комарова РҒА (LE) - 153 гербарий парағы, Өзбекстан Республикасы (TASH) – 90 гербарий парағы, Плантариум және GBIF сайттарында таралу нүктелері қаралды. Талдау нәтижесінде Қаратау, Батыс Тянь-Шань және Қырғыз Алатауында P. regelii таралуының 56 нүктесі анықтаып, картаға түсірілді, Қырғызстан аумағынан 28 нүкте, Өзбекстаннан 42 нүкте және Тәжікстан аумағынан 8 нүкте белгіленді. *P. regelii* f.*simplicifolia* формасы *P. regelii* f. Koopmani Spath. формасына қарағанда әлдеқайда сирек кездесетіні анықталды. Ортаазиялық алмұрт арасындағы туа біткен будандастырудың мүмкін процестері одан әрі экологиялық-биологиялық және молекулалық-генетикалық зерттеулерді қажет етеді. Экологиялық өсу жағдайларын сыни тұрғыдан қарау кезінде Өзбекстанда аршалар өскен белдеуінде *P. regelii* түрі оңтүстік, шығыс, оңтүстік-батыс, таулардың солтүстік беткейлерінде бұталы өсімдіктер белдеуінде 34° бұрышпен таралғаны анықталды. *P. regelii* өсіп келе жатқан топырақ жартасты-ұсақ

түйіршікті-қиыршық тасты, популяциялар шатқалдардың экологиялық жағдайына байланысты теңіз белдеуінен 613 м-ден 2600 м-ге дейінгі биіктікте өзендер бойындағы таулы беткейлерде таралған.

Кілт сөздер. *Pyrus regelii;* гербарий; таралу картасы; экология; флора; ареал; популяция; өсу аймағы; географиялық нүктелер.

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АНАЛИЗ СОВРЕМЕННОГО АРЕАЛА *PYRUS REGELII* REHDER В КАЗАХСТАНЕ И СРЕДНЕЙ АЗИИ

Аннотация. В целях выявления современного ареала и составления карты распространения вида *P. regelii* Rehder (Груша Регеля) был проведен анализ гербарных фондов ботанических организаций, датированных 1880-2022 гг. Обработаны и проанализированы материалы гербарного фонда РГП «Института ботаники и фитоинтродукции» КЛХЖМ МЭПР РК (AA) – 133 гербарных листа, Ботанического института им. В.Л. Комарова РАН (LE) - 153 гербарных листа, Республики Узбекистан (TASH) – 90 гербарных листов, просмотрены точки распространения на сайтах Плантариум и GBIF. В результате анализа выявлены и нанесены на карту 56 точек произрастания *P. regelii* в Каратау, Западном Тянь-Шане и Киргизском Алатау, с территории Кыргызстана выявлены 28 точек, Узбекистана - 42 точки и территории Таджикистана - 8 точек. Выявлено, что форма *P. regelii f. simplicifolia* встречается гораздо реже чем форма *P. regelii f. Koopmani*. Возможные процессы внутриродовой гибридизации между среднеазиатскими грушами требуют дальнейших эколого-биологических и молекулярно-генетических исследований. При критическом просмотре экологических условий произрастания *P. regelii* было установлено, что вид на территории Казахстана, Кыргызстана и Таджикистана распространен по южным, восточным, юго-западным, реже северным склонам гор под углом 34° в поясе кустарниковой растительности, в Узбекистане в сообществе с доминированием можжевельника. Почва произрастания *P. regelii* каменисто-мелкозернисто-щебнистая, популяции приурочены к горным склонам вдоль рек на высоте от 613 до 2600 м над уровнем моря в зависимости от экологических условий ущелий.

Ключевые слова. *Pyrus regelii;* гербарий; карта распространения; экология; флора; ареал; популяция; район произрастания; географические точки.