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Study of the distribution range of species of the genus *Adonis* L.

In the article data on the distribution of species of the genus *Adonis* L. in Kazakhstan were presented. In order to further clarify the places of distribution and inventory of modern growth of species of the genus Adonis, the main herbarium fund of botanical organizations was studied. The conducted analyses show that the highest occurrence of species is noted in Almaty region. To clarify the distribution in Kazakhstan and to compile the points of occurrence of species of the genus Adonis, 148 herbarium sheets (1843–2021) from Al-Farabi KazNU, Institute of Botany (AA), DAPO and KIR and digital herbarium of Moscow State University (MW) were reviewed and processed. Collections from 1843 are presented. The largest number of collections is from 1940–1972, and the main collectors are S.A. Arystangaliev, B. Bykov, N.V. Pavlov, and A.A. Ivashchenko. 148 actual places of growth for 8 Adonis species from the flora of Kazakhstan were identified: *Adonis aestivalis* L., *Adonis apennina* L. (*Adonis sibirica* Patr.ex Ledeb.), *Adonis chrysocyathus* Hook.f. & Thomson., *Adonis parviflora* Fisch., *Adonis tianschanica (*Adolf.*)* Lipsch., *Adonis vernalis* L., *Adonis villosa* Ledeb., *Adonis volgensis* Steven ex DC. Species diversity of *Adonis* L. is established in Dzungarian Alatau, Western Altai, Tarbagatai and Ile-Kungei Alatau, which are classified as rare and whose numbers are decreasing. Geographically, the most common are Adonis *Adonis aestivalis* L., *Adonis parviflora* Fisch. & *Adonis tianschanica (*Adolf.*)* Lipsch. The conducted research allowed systematizing, clarifying and supplementing information about species diversity and distribution of genus *Adonis* in the flora of Kazakhstan.

Keywords: distribution, herbarium, floristic regions, inventory, Kazakhstan.

Introduction

The genus *Adonis* L. includes 20 species growing in Europe and Asia. In Kazakhstan 8 species grows and [1] all of them are noted for the flora of Kazakhstan.

Adonis tianschanica (Adolf) Lipsch. is a rare species with decreasing abundance in the north-central Tianshan range [2, 3]. The species is included in the Red Data Book of Kazakhstan (1981) [4] and the List of Rare Species (2006) [5]. The above-ground part of the plant contains alkaloids, cardeonolides, saponins, nitrogen-containing compounds, flavonoids, vitamins. It is used as a cardiotonic agent (Grudzinskaya et al., 2014) [6]. *A. tianschanica* is a rhizomatous herbaceous perennial. By the time of flowering it reaches up to 35 cm in height. The number of stems is from 1–5. The stems are branched from the base, covered with many curly hairs. Leaves are scaly, twice pinnately divided into lanceolate lobes. At the beginning of vegetation, shoots and leaves are strongly curly-hairy; by fruiting, they are almost glabrous. Flowers are solitary, 3.5–5 cm in diameter, located at the ends of shoots. Petals are lemon-yellow, slightly irregular. The root system is represented by a shortened vertical rhizome up to 6 cm long with numerous straight cord-like roots of dark brown color up to 30 cm long. Lateral roots of the 2nd order are not numerous. In August, during the fruiting period, buds of renewal of next year's shoots are formed at the base of the rhizome. The number of buds depends on the size and age of the plant — from 1 to 5 (6) pieces. The fruit is a polycarp. Seeds are 3-4 mm long and 2-3 mm wide, finely wrinkled, scattered-hairy with a small, hook-shaped downward bent spout. The weight of 1000 seeds is 4.405 g [7].

Adonis apennina L. *(=Adonis sibirica* Patr. ex Ledeb.*)* — perennials. 20–30 cm tall, with fruits up to 60 cm; naked, with short, thick rhizome; stem smooth, simple or with short, slightly inclined branches; root and lower stem leaves scaly. sessile, middle and upper sessile, large, grayish underneath, twice or thrice pinnately divided, oval or triangular in outline, glabrous, terminal lobes linear-lanceolate, up to 12 mm long and 1 mm wide; flowers large, bright yellow, 4–6 cm. in dia. sepals yellow-tomato-greenish, glabrous, roundish-ovate, narrowed at the end, 10–15 mm long and 8–10 mm wide; petals oval, overlapping edges, 20–30

mm long and 10–15 mm wide; fruits shortly and sparsely pubescent, 4.5 mm long and 4 mm wide, their spout is short, bent downwards. Blossoms V-VI. Grows in dry meadows, forest edges, glades and light forests [1, 8].

Adonis villosa Ledeb. — perennials, 5–25 cm tall, with fruits up to 45 cm; stems solitary, with spreading branches; entire plant scattered-hairy; lower leaves brown, scaly, subsequent stem leaves twice pinnate, sessile, with 2 shortened lobes at the base, ovate or triangular in outline, their terminal lobes lanceolate, acuminate, young leaves strongly pubescent, later becoming less pubescent; flowers from 2 to 5 cm. in diameter, on a hairy pedicel; calyx purplish, its lobes oval, acuminate, pubescent, much shorter than the length of petals; petals pale yellow, oblong, narrow, narrowed at the ends, sometimes slightly toothed, 1-1.5 cm long and 0.5-1 cm wide; sop-lodia globular or ovoid, sometimes drooping; fruits 3-4 mm long, ovate, slightly wrinkled, pubescent, spout small, hooked downwardly bent. Blossoms V-VI. Grows on the edges of birch forests and in mountain steppes [1, 9].

Adonis chrysocyathus Hook.f. & Thomson — perennials, 12–40 cm tall, with fruits higher; rhizomes dark brown; stems straight, often curved at the top, ovate, with large, brown, scaly leaves below, lower green leaves long petiolate, large, sometimes exceeding the height of the stem, petioles 2-3 times longer than the lamina, upper leaves are sessile, the laminae are thrice pinnately incised into lanceolate or ovate-robic, acuminate lobes at the apex, young leaves are covered with fine, curly hairs on the underside, in old leaves they are strongly reduced; flowers are solitary, up to 4 cm. in dia. sepals are 6–8, purplish, ovate, unequally toothed at the apex, hairy on the outside, 12–15 mm long; petals are 16–24, golden-yellow, 25–27 mm long, 5–8 mm wide, obovate-lanceolate, blunted; copulose globular, about 10 mm in dia.; fruit 5–7 mm long, glabrous, with a long, inwardly twisted spout, almost twice as short. Blossoms VI-VII, fl. VIII. Grows on fine-grained slopes of the alpine belt of mountains and meadows like snow patches [1, 10].

Adonis vernalis L. — perennials, 5–20 cm, with fruits up to 40 cm tall.; rhizome thick, short, brownish-black; stems 3-4 in number, smooth, erect or slightly deflected, usually low branched, with oppressed branches, brownish in the lower part, with brown scaly leaves, stem leaves sessile, ovate or rounded in outline, dissected into lobes: lower palmately divided, upper lobes twice palmately divided, terminal lobes linear, entire-edged, 1-2 cm long. and 0.5-1 mm wide, glabrous; flowers bright yellow, 4 4.5 cm. in dia.; sepals green, finely pubescent, blunted at the top, up to 2 cm. long and 1.2 mm. wide, petals 12–20, oblong-elliptic, slightly narrowed and finely serrate at the apex, 1.5–3.5 cm long and 0.5-1.2 cm wide; fruit ovoid, 3.5–5.5 mm long and 3 mm wide, wrinkled, hairy, with a short, hook-shaped spout wrapped downwards, collected in ovoid heads about 2 cm long and 1.2 cm wide. Blossoms IV-V. It grows in steppes, along the margins of steppe coniferous forests and in shrubs [1, 11].

Adonis volgensis Steven ex DC. — perennials, 15–30 cm tall, with fruits up to 35 cm; rhizome thick, short, brownish-black; stems solitary or several of them, sparsely branched, almost glabrous at the lower part, with brownish scaly leaves; stem leaves sessile, ovate in outline, twice palmately divided into broadly linear lobes, wrapped at the bottom, more than 1.5 mm wide, young leaves rather densely pubescent, pubescence becomes sparse at flowering; flowers pale yellow, 3.5 4.5 cm. in dia.; sepals purplish, slightly pubescent; petals 1.7-2 cm. long and 6-7 mm. wide; fruits numerous, rounded, densely assembled into a head, finely indistinctly wrinkled, sometimes smooth, hairy, up to 4 mm. wide, their spout bent downward, tightly pressed to the surface of the fruit. Blossoms III-IV. It grows in grassy-typchak and grassy steppes, and occasionally in forest meadows [1, 12].

Adonis parviflora Fisch. ex DC. — small-flowered, 6–50 cm tall, with straight, branched or simple stem, glabrous or thinly pubescent in the lower part; leaves sessile, glabrous, only the lowest ones on petioles, twice or thrice pinnately dissected into linear lobes; flowers orange or fiery red, with a black spot at the base of petals; sepals 5–8, flat, ovate, glabrous, half the size of the corolla; corolla petals oblong-ovate or lanceolate, in the same or larger number; sapodule dense, oblong, up to 2 cm long and 0.6-0.7 cm long. and 0.6-0.7 cm wide; seeds broadly ovoid, 3.5 mm long and 3 mm wide, narrowed at the apex into a slightly bent spout with a toothed projection under it, glabrous, reticulate-tupomorphic over the whole surface, with a ridged-toothed margin and 2 small teeth. Blossoms V-VI. Grows on storages, saline and wet meadows [1, 13].

Adonis aestivalis L. — 3. summer, coal on fire, 10–50 cm tall; stem straight, branched or simple, glabrous or diffusely hairy; lower leaves petiolate, twice or thrice dissected into linear lobes; flowers few, 1 each at the top of the stem and branches, 1.8–3 cm dia. sepals flat, ovate, glabrous, rarely hairy from below; petals twice as large as sepals, bright fiery-red, rarely yellow, with a black spot at the base; seeds, collected in a dense oblong head, wrinkly-cellular in surface, elongated into a straight spout, below its middle bordered

by a scalloped-toothed margin, with one sharp projection and 2 teeth. Blossoms IV-VI. It grows as an invasive weed in crops, on fallow lands and old cattle camps [1].

Experimental

The work was based on materials stored in the herbarium funds (AA) of the Institute of Botany and Phytointroduction, in herbarium collections of the Kazakh National University named after Al-Farabi of the Department of Biodiversity and Bioresources and Department of agrochemical, soil surveys and integrated survey work DAPO (DAPO and KIR), as well as in the digital herbarium of Moscow State University (MW) of red-listed and rare species of the genus Adonis L. (*A. aestivalis*, *A. apennina* (*A.sibirica*), *A. chrysocyathus, A. parviflora, A. tianschanica*, *A. vernalis*, *A. villosa*, *A. volgensis*) to identify the exact locations of populations in the territory of Kazakhstan.

To further clarify the species composition and modern distribution of the genus Adonis L., an inventory of herbarium material dated 1842–2021 was conducted. Latin names of species are given according to the international platform POWO [14]. The names of floristic regions are based on botanical zoning of the flora of Kazakhstan. The following basic reference materials were used to compile systematic and geographical analyses of the genus Adonis L.: "Flora of Kazakhstan" (1961) [1], "Illustrated identifier of plants of Kazakhstan" (1972) [15], Handbook of plants of Central Asia (1993) [16]. In the process of work in the herbarium data contained in the herbarium were indicated without change on the labels, where the name of collectors, date of collection, geographical and administrative location of the point. In the work, the Latin names of *Adonis* L. species were checked in accordance with the reports of POWO [14].

Results and Discussion

Based on literature and herbarium data, a list of the flora of the genus *Adonis* L. growing in Kazakhstan was compiled, which includes 8 species of perennial herbaceous plants. As a result of the analysis of herbarium materials, 118 actual growing places were identified in herbarium funds of the Institute of Botany and Phytointroduction (AA). It was found 8 species of genus Adonis L. from the flora of Kazakhstan, and further we will present the list of herbarium sheets of plants growing in Kazakhstan:

Identified 50 herbarium sheets of storage, species *A. aestivalis*: Western Melkosopochnik, locus Tersakkan, 27.05.1842, Schrenk A. G.; Pri-Balkhash steppe, Arganatinskiye mountains closer to Lake Balkhash, rocky slopes, 12.04.1902, Sapozhnikov V. V.; Zailiyskiy-Kungei Alatau, Talgar River, foothills, 25.05.1925, Popov M. G.; Pre-Caspian region, Ural province Guryevsky district, Lake Inder, Gypsum sinkhole, 09.06.1927, Ilyin M. M., Grigoriev Yu. S.; Balkhash-Alakul district, Eastern Pribalkhashie, Area between the Karatal river and Uch-Kul lakes, 3 km west of Sarybulak station, wormwood steppe, 08.06.1928, Shipchinskiy N. V.; Zailiyskiy-Kungei Alatau, vicinity of the city. Alma-Ata, slopes of hills on the right bank of the Almatinka River outside the city, 28.05.1928, Lipshits S. Yu.; Zailiyskiy Alatau, Alma-Ata gorge, slopes of stalls outside the city of Almaty, 28.05.1928, Pavlov N. B.; Karatau, Syr-Darya district, Kara-Tau town, Jong Plateau, 17.06.1930, Volkova P. A.; Karatau, Syr-Darya district, east of Bijli Kul lake, 27.05.1930, Volkova P. A.; Karatau, Syr-Darya district, Kara-Tau town, low places of Jong plateau, pasture, 15.06.1930, Volkova P. A.; Karatau, Syr-Darya district, Juvalynsky area, spurs of Kara-Tau ridge, slightly hilly intermountain valley in the upper reaches of Chimbulak, south-west of Ber-Kara gorge about 1 km, 22.06.1931, Kornilova V.S.; Zailiyskiy-Kungei Alatau, Burunday urzhishche, Alma-Ata oblast, Kalininsky district, 25.05.1931, Mukhlya A.V.; Zailiyskiy Alatau, the vicinity of the city. Alma-Ata., Botanical garden, stalls, 25.05.1933, Geld A. I.; Zailiyskiy Alatau, vicinity of Alma-Ata mountain, southern slopes of Zailiyskiy Alatau foothills, light-chestnut soils, 06.06.1933, Kazgiprozem; Kirghiz Alatau, Aulietinsky district, north of Aigulak station — 5-6 km, plain, old deposits 8–10 l., on sierozem, 14.05.1933, Kornilova V.S.; Balkhash-Alakul district, Alma-Ata oblast, Ili station, sands, 09.05.1934, Geld A.I.; Priaralie district, Aral Sea, Barsa-Kelmes island, 1935, Nazarov M. V.; Zailiyskiy Alatau, Zailiyskiy Alatau ridge, Kastek gorge, 25.05.1936, Dmitrieva A. A.; Chu-Iliyskiye mountains, Utyugun river vicinities, shallow soils, 01.06.1936, Kubanskaya Z. V.; Zailiyskiy Alatau, Alma-Ata, on slopes on foothills, 17.05.1936, Shishkin B.K.; Zailiyskiy-Kungai Alatau, vicinity of Alma-Ata, Poganki river gorge, near the path on the slope, 06.06.1936, Shishkin B. K.; Zailiyskiy Alatau, Kastek district, closer to Kastek river gorge, near Dzhilda-Saya, 24.05.1936, Linchevsky O. A.; Dzungarian Ala Tau, Southern slope of Dzungarian Ala Tau, Keityn tract, stony slope, 13.06.1937, Rubtsov N. I.; Zailiyskiy Ala Tau, Syugaty mountains, stony slopes, 14.06.1937, Gorbunova E. P. P.; Dzungarian Ala Tau, Southern part, spurs of Dzungarian Ala Tau, May-Tyube station, about 53 passages, in shallow soils, 14.05.1937, Kubanskaya Z. V.; Karatau Mountains,

meadow slopes of foothills in the Mingelke Mountains, 08.05.1939, Pavlov N. V.; Betpak-dala, Central Betpak-dala, tract Kok-Ashik among caragannik, 21.05.1940, Rubtsov N. I.; Western Tien-Shan, western spur of Talas Alatau, Aksu-Dzhabagly reserve, overlog adjoining from the north to Aksu canyon, 30.05.1942, Karmysheva N. H.; Priaralie district, Aral Sea, Barsa-Kelmes Island, 06.05.1946, Platonov Y. G.; Chu-Ili Mountains, gorge Kulfiya-Basy tract, near old sheep barn, 13.05.1946, Fisyun V. V.; Djambul obl. V.; Djambul oblast, in a chiwnik on the Chu-Iliyskie Mountains schlefs near Kulakshino station, 23.05.1948, Pavlov N. V.; Chu-Ili Mountains, Chu-Ili watershed, Kopa River basin, near Targap settlement, intermountain valley, 03.06.1949, V. P. Goloskokov; Zailiyskiy-Kungei Alatau, on steppe slope of foothills, 11 km east of Alma-Ata, 22.05.1950, Polyakov P. P.; Djambul oblast, Chu-Iliyskiye mountains, in a thicket of chia near Otar station, 07.05.1951, Pavlov N. V.; Dzungarian Ala Tau, Southwestern spurs of Dzungarian Ala Tau, Chulak Moncha-sai mountains, on slopes among weedy places, near cattle herds, 29.05.1955, V. P. Goloskokov; Dzungarian Ala Tau, Southwestern spurs of Dzungarian Ala Tau, Matay mountains, foothill plain in the upper reaches of Kara-Kaska river near Koyankoz, 17.06.1956, Goloskokov V. P.; Dzungarian Alatau, Southern spurs of Dzhugar Alatau, Altyn-Emel ridge, Tyulkuli Mountains, along the southern stony slopes in the gorge of the Tyulkuli River, 30.06.1956, Goloskokov V. P.; Dzungarian Ala Tau, Southern part, Southwestern spurs of Dzungarian Ala Tau, Karakaska River basin, on deposits near Shanghai MTS, 24.05.1959, Goloskokov V. P.; Dzungarian Ala Tau, Southwestern spurs of Dzungarian Ala Tau, hill 1107 n.a. of the highway near Krasnogorovka, along the slope of the hill, 25.05.1959, Goloskokov V. P.; Dzungarian Ala Tau, Northern spurs of Dzungarian Ala Tau, along plumes near Antonovka, in wheat crops, 08.06.1959, Goloskokov V. P.; Dzungarian Ala Tau, Southern part, Western spurs of Dzungarian Ala Tau, on plumes near Sary-Agach settlement, in weedy places, 06.06.1959, Goloskokov V. P.; Dzungarian Alatau, Southern part, Western spurs of Dzungarian Alatau, near the pass saddle to Mukry village, on steppe slope, 17.06.1960, Roldugin I. I.; Balkhash-Alakul district, east Pribalkhashie, Akrkarly mountains, near Shengeldy village, on dry slopes, 25.06.1960, Roldugin I. I.; Zailiyskiy Alatau, Southwest extremity of Zailiyskiy Alatau, middle course of Karakunuz river (Chu river basin), along northern grassy slopes, 14.06.1963, V.P. Goloskokov; Zailiyskiy Alatau, Eastern spurs of Zailiyskiy Alatau, Syugatinskiye mountains, gorge near cordon, among bushes, 10.06.1963, Goloskokov V. P.; Kirghiz Alatau, foothill loess plain of Kirghiz ridge, ephemeral desert between Lugovaya and Dzhambul, 15.05.1963, Goloskokov V. P.; Karatau, plateau of Syrdarya Karatau, along grassy slopes, 26.05.1963, V. P. Goloskokov; Zailiyskiy-Kungei Alatau, eastern margin of Talgar, altitude 950 m, strongly dissected loess foothills, wormwood communities, 11.05.1994, M. P. Danilov; Zailiyskiy-Kungei Alatau, Almaty region, before Uzynagach on the highway Almaty-Bishkek, h~322 m., 18.05.2018, Sjedina I. A., Otradnykh I. G., Bilibayeva B. K., Zhumadilova A. M.; Kyrgyz Alatau, Zhambyl obl, Zhambyl district, behind the camp “Ruslan”, Nogaisai gorge on the stony eastern slope, altitude 1100 m, 14.05.2021, Kudabaeva G. M., Veselova P. V., Kerdyashkin A. V., Bilibaeva B. K., Osmonali B. B.;

15 herbarium sheets of storage, species *A. apennina (A. sibirica*) were revealed: Altai, Western Altai, Ivanovsky ridge, East Kazakhstan region, Ridder district, northern slope of Mount Kretovaya, 26.06.1937, Kuznetsov N. M.; Altai, Western Altai, north west of Ridder, on rocks of unnamed peak close to Mount Golukha, at a height of 1650 m. elevation, 31.07.1947, Polyakov P. P.; Saur-Tarbagatai, Tarbagatai ridge, foothills of the northern slope, in a hollow at an altitude of h~1600 m, 15.07.1948, Stepanova E. F.; Saur-Tarbagatai, Tarbagatai ridge, foothills of the northern slope, in a hollow at an altitude of 1600 m, 15.07.1948, Stepanova E. F.. F.; Saur-Tarbagatai, ridge, Tarbagatai, northern slope north of Khabar-Asu pass, 5 km, tipchak steppe, 15.08.1948, Stepanova E. F. F.; Altai, South Altai, Altai Tarbagatai, Bukhtarma basin, Urylka river near Uryl village, tract “Bakanaz”, altitude 1300 m, forest belt of north-western slope, 01.06.1955, Razlivalov G. M.; Saur-Tarbagatai, East Kazakhstan region, Tarbagatai district, Monrak ridge, northwest spurs, Tuyuk gorge, 26.05.1981, Rakityanskaya T. M.; Altai, South Altai, East Kazakhstan region, Tarbagatai ridge, Monrak ridge, northwest spurs, Tuyuk gorge, 26.05.1981. M.; Altai, Southern Altai, East Kazakhstan Region, Sarymsakty Ridge, southwest spurs, Tuyuk Gorge, 26.05.1981, Rakitianskaya T. Sarymsakty, south-eastern slope, Tekeli river valley, h~1600 m., 02.08.1985, Bialieva R. A.; Altai, Southern Altai, VKO, South Altai ridge, western part, northern slope, lower forest border, h~1800 m., 20.08.1986, Ivashchenko A. A. A.; Altai, Southern Altai, Chindagatui River on the way to the headwaters, near the 1st hut, h~1820 m., thin coniferous forest, with meadow-steppe grass and rock outcrop, 28.07.1986, Ivaschenko A. A.; Altai, Southern Altai, VKO, Southern Altai ridge, northern slope of the lower border of the forest, left bank of Kara-Kab, depression h~1840 m, 03.07.1987, Ivaschenko A. A. A.; Altai, Southern Altai, VKO, Southern Altai Ridge, 3 km east of the Pronikha River, forest, h~1300 — 1400 m, 27.07.1987,

Ivashchenko A. A. A., Isaev E. B.; Altai, Southern Altai, East Kazakhstan Region, Southern Altai Range, upper reaches of the Kara-Kaba River, left bank, in coniferous forest, 30.06.1987, Isaev E. B.; Altai, Southern Altai, East Kazakhstan Region, Southern Altai Range, upper reaches of the Kara-Kaba River, meadow glades in forest, 30.06.1987, Isaev E. B.; Altai, Central Altai, Berel, valley of the right bank of the Bukhtarma River, h~1500 m., reedgrass meadow at the top of the meadow of Kainar Mountain, 04.06.1999, Kudabaeva G. M.; Altai, Central Altai, left bank of the Bukhtarma River, h~1100 m., roadside scree on the road to Rakhmanovskie Klyuchi, 30.05.1999, Kudabaeva G. M.;

7 herbarium sheets of storage, species *A. chrysocyathus* were found: Zailiyskiy Alatau, East Talgar River, northern slopes under rocks, margins h~2600 m., 14.06.1936, Bykov B. A.; Zailiyskiy Alatau, Karga-Uldy river basin (Aksai-Kaskelen interfluve), moistened soils of subalpine belt, 05.07.1936, Goloskokov V. P.; Zailiyskiy Alatau, Malaya Almatinka, straight slot, upper reaches, 30.06.1936, Popov M. G.; Zailiyskiy Alatau, Issyk River, upper reaches of eastern sai (at the pass to Turgenskaya Tesken-su), grassy slopes, 2700 m. a.s.l., the river is located in the upper reaches of the river, 14.07.1937, Popov M. G.; Ketmen-Terskey Alatau, Tien Shan, Ketmen ridge, Karatau, upper reaches of the Sumbe river, 19.07.1962, Arystangaliev S.A.; Ketmen,- Terskey Alatau, Tien-Shan, Ketmen ridge, tract of Three Slits, alpine belt near snowfields, 19.07.1963, Arystangaliev S. A.; Ulutau, Kovylypolyno-typchak community, on light-chestnut soils of interfold plain, Dzhezkazgan region, Ulutau agriculture, 28.04.1979, Kazgiprozem;

13 herbarium sheets of storage, *A. parviflora* species were identified: Eastern Melkosopochnik, Songaria, in desertis fl. Ajagus djac., 31.05.1840, Schrenk A. G.; Western Melkosopochnik, Atassu, 05.1843, Dzungarian Alatau, Songaria, in vallibus montium Maitass, 1.06.1843, Schrenk A. G.; Schrenk A. G.; Mugodzhary mountains, Aktobe province, Bayurubai mountain, upper part of a gully falling from the mountain to the slope, small terrace on the slope falling to the gully, 21.05.1927, Rusanov F. N.; Chu-Ili mountains, vicinity of the Utyugun river, shallow hollow, 01.06.1936, Kubanskaya Z. V.; Zailiyskiy Alatau, Syugaty mountain, western stony slopes, 14.06.1937, Gorbunova E. P.; Betpak-dala, Central Betpak-dala, Kok-Ashik tract, among caragannik, 21.05.1940, Rubtsov N. I.; Dzungarian Alatau, Southern part, Southwest spurs of Dzungarian Alatau, Chulak, Moncha-sai mountains, on weedy places, near cattle camps, 31.05.1955, Goloskokov V. P.; Western Tien-Shan, Karjantau, Churgunus gorge at the place of former cattle camp, 31.05.1983, Samoilova V. A.; Kyrgyz Alatau, Western part of Kyrgyz Alatau, foothills at the entrance to the Aspara gorge, grasses, 17.05.1984, N. V. Nelina; Kyrgyz Alatau, southern macroslope, Kara-Archa valley, talweg, 28.05.1984, N. V. Nelina; Karatau, Karatau ridge, Birisek gorge, stony slope of southern exposure, 08.05.1989, Samoylova V. A.; Karatau, Turkestan ridge, Isfana and Lyaylek interfluves, Shaldybaldy tract, north-western slope, orange flowers, 23.04.2007, Tanybaeva M. R., Lazkov G. A.;

There were 9 herbarium sheets of *A. tianschanica* species: Dzungarian Alatau, Northern part, Lepsin district, 24.05.1940, Polyakov P. P.; Kungei Alatau, northern slopes of mountains above Kurmekty river, 15.05.1942, Lazarenko A. S.; Kungei Alatau, Kurmekty, southern slopes in exposition, among bushes, h~1800 m., 04.05.1942, Lazarenko A. S. S.; Kungei Alatau, Kurmekty, southern slopes in the exposition, among bushes, h~1800 m., 04.05.1942, Lazarenko A. S. S.; Ketmen-Terskey Alatau, area of the middle course of the river Kegen, western extremity of the mountains Shol-Adyr, among cereal-grass steppe, 15.08.1946, Rubtsov N. I., Stepanova E. F. F.; Dzungarian Alatau, western spurs of Dzungarian Alatau, Katurkain Mountains, upper reaches of Karagaily River, along northern steppe slopes, 27.05.1959, V. P. Goloskokov; Zailiyskiy-Kungai Alatau, Eastern extremity of Kungai Alatau ridge, Karkara river valley, hills along Iri-su river in 3 km from the highway to Kegen, 01.06.1966, Borjaev K. G. G.; Kungai Alatau, Eastern extremity of Kungai Alatau ridge, Karkara river valley, along Iri-su river 3-4 km from ford through Karkara river, 01.06.1966, Boryaev K.; Zailiyskiy-Kungai Alatau, Eastern spurs of Kungai Alatau ridge, hills and foothills along Irsu river, 03.06.1975, Lushpa O. U.; Kyrgyz Alatau, Eastern spurs of Kungai Alatau ridge, hills and foothills along Irsu river, 03.06.1975, Lushpa O. U. U.; Kyrgyz Alatau, Kyrgyz Alatau ridge, Toguzbulak tract (between Alamedin and Issyk-Ata rivers), grassy slopes up from the highway, 12.05.1976, Karmysheva N. H.;

Identified 2 herbarium storage sheets, species *A. vernalis*: Semipalatinsk hog, Semipalatinsk district, in a forest, 1931, Dmitrieva A. A.; Centr. Kazakhstan. Celinograd region, Lake Kurgaljin, Karazhar tract on the way to Kurgaljino settlement, 01.06.1976, A. Turganbekova;

There are 3 herbarium storage sheets of *A. villosa* species: Karkaraly, Songaria, in montibus Arkalyk et Arkat, 1841, Schrenk A. G.; Karkaraly, Songaria, in montibus Karkaraly, 06.1843, Schrenk A. G.; Altai, East Kazakhstan oblast, Zyryanovsky region, vicinity of Berezovka village, northern gentle, shrubby slope, 17.05.2004, Grebenyuk A., Ankova A.;

19 herbarium sheets of storage, species *A. volgensis* were identified: Spurs of the Common Syrt, Uralskaya province, Uralsk, vicinity of Bannov's garden in the steppe, 04.1918, Larin I. V.; Tobolo-Ishimsky, Akmolinsky vicinity, Sovenkovsky experimental site, steppe, 20.05.1920, Sheludyakova V. A.; Tobolo-Ishimsky, Akmolinsky vicinity, Sovenkovsky experimental site, on slopes and depressions, 26.04.1920, Sheludyakova V. A.; Spurs of the Common Syrt, Ural Province, Uralsk vicinity, Stepanov garden blooms, in steppe, bloomed, 03.05.1924, Larin I. B.; Aktobe province, Wil-Emba interfluve, ascent to Turkestan watershed between the rivers Wil and Temir, sandy grassy steppe, 28.05.1926, Rozhevits R. Yu, Avramchik M. N.; Aktobe province, Wil-Emba interfluve, 20 ver. south of Temir not reaching the watershed, sandy grassy steppe, 31.05.1926, Knorring O. E.; Spurs of General Syrt, Ural district, Teplovsky district, vicinity of farm Dzharykin, sandy sagebrush steppe, 05.06.1929, Dmitrieva A. A.; Spurs of the Common Syrt, Ural district, Teplovsky district, vicinity of Dzharykina farm, grassy steppe, 17.06.1929, Dmitrieva A. A.; Pre-Caspian, Ural district, Dzhambeity district, grassy steppe, 09.05.1930, Dmitrieva A. A.; Tobolo-Ishimsky, Kustanay district, Kel-Aralskaya volost, area of Zhukova farm, sandy chernozem, abundant, 04.1930, Dmitriev G.; Karaganda region, closer to Chechen-mountain settlement, sagebrush-typchak steppe, 24.04.1939, Linchevskiy O. A..; Northern Kazakhstan, Akmola region, Atbasar district, 3 km north-west of the central farmstead of Kiev state farm, 15.05.1954, Kurochkina L. Y.; Western Melkosopochnik, Akmola region, Atbasar district, right bank of the river Kayrakty, on slopes to the bank, 22.05.1954, Lushpa O. U.; Akmola region, Atbasar district, Malogum, black earth of type plains steppe north of the river Kayrakty, 14.05.1954, Kisykov U. U.; Akmola region, Atbasar rayon, Malogum, chernozem type plains steppe north of the river Kayrakty, 14.05.1954, Kisykov U. K.; Western Melkosopochnik, Akmola region, Atbasar district, Ostrovsky State Farm. Kovilnaya steppe, 10.05.1954, Lushpa O. U.; Tobol-Ishimskiy, Northern Kazakhstan, Kustanay city vicinity, soil station of the Institute of Soil Science, Tselina, 09.06.1968, Sokolov S. A.; Aktobe region, Aktobe district, floodplain of Butak river, 05.1991, Aipeisova S.; Akmola region, vicinity of Korgalzhyn village, h~343 m., 06.2019, Kubentayev S.; Akmola region, vicinity of Kara egin village, altitude h~381 m., 29.04.2019, Kubentayev S.

In the funds of the Al-Farabi Kazakh National University herbarium specimens were from 18 actual place of growth. There were found 5 species of genus *Adonis* L. from the flora of Kazakhstan:

7 herbarium storage sheets, species *A. aestivalis* were identified: Alma-Ata vicinity, Botanical Garden, counters, 17.05.1933, Geld A.; Zailiyskiy Alatau, Talgar vicinity, southern tip, northern slope, 06.06.1936, Belousova; KSSR, Aral Sea, Barsa Kelmes Island, north-east of the factory, 27.05.1940, Demchenko L.; Alma-Ata vicinity, Kauchukpromkhoz, No. 13, Krym-sagyz crops, 29.04.1942, Kornilova; Almaty region, Uigur district, Aksu village, 25.05.1954, Mansurova, Kibirova; Alma-Ata region, Kegen district, collective farm named after Gorky, Kuluk-tau, Dalayty-say gorge, 06.07.1954, Terekhov; Ketmen-tau ridge, Bolshoy Kirgizsky gorge, steppe slopes, south-western slope, 20.07.1972, Ospanova, Yereshika (Fig. 1).

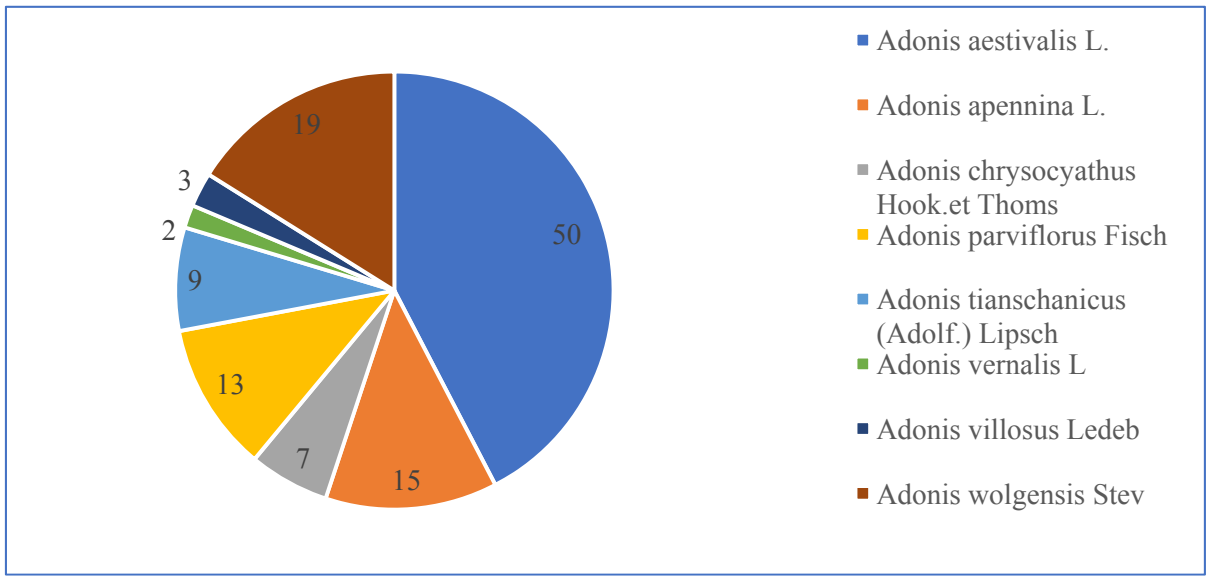

Figure 1. Herbarium collections of *Adonis* L. species, Institute of Botany and Phytointroduction (AA)

3 herbarium sheets of storage, species *A. chrysocyathus* were found: Eastern Talgar, h~2600 m, 14.06.1936, Bykov B.; Zailiyskiy Alatau, Kargauyldy, moistened slopes of subalp, 05.07.1938, Bykov B.; Zailiyskiy Alatau, Issyk Gorge, northern slope h~2800, near rocks, 17.06.1938, Bykov B.;

4 herbarium sheets of storage, species *A. parviflora* were found: KazSSR, Aral Sea, Barsa-Kelmes Island north-east of the factoria, 27.05.1940, Demchenko L.; KazSSR, Aral Sea, Barsa-Kelmes Island, gray earth loam, 27.05.1940, Demchenko L., Pavlov U.V.; KazSSR, Dzhambul obl., in chievnik on Chu-Ili mountains shleiv near Kulakshina station, 23.05.1948, Pavlov N.V.; KazSSR, Right bank of Ili river 5–10 km south of Tash-Murun, sandy valley, 11.05.1962, Iksanov N.V., Iksanov N.V.; KazSSR, Ili river, 5–10 km south of Tash-Murun, sandy valley, 11.05.1962, Iksanov N.V.; KazSSR, Ili river, 5–10 km south of Tash-Murun;

3 herbarium sheets of storage, species *A. tianschanica* were revealed: Kungei Alatau, Kegensky Alatau, steppe, 11.06.1935, Kornilova V.S., Bykov B.; Kegensky district, 11.06.1935, Kornilova V.S., Bykov B.; Alma-Ata region, Narynkol district, Akbiet village, Southern slope of Akbiet tract, 19.07.1954, Terekhov V.I.;

Identified 1 herbarium sheet of storage, species *A. villosa*: KazSSR, East-Kazakhstan oblast, neighborhood of Shemonaikha, in hollows of slopes among shrubs, 04.05.1946, Solomchenka (Fig. 2).

The herbarial leaves of the species *A. apennina* (*A. sibirica*), *A. wolgensis* and *A. vernalis* are absent.

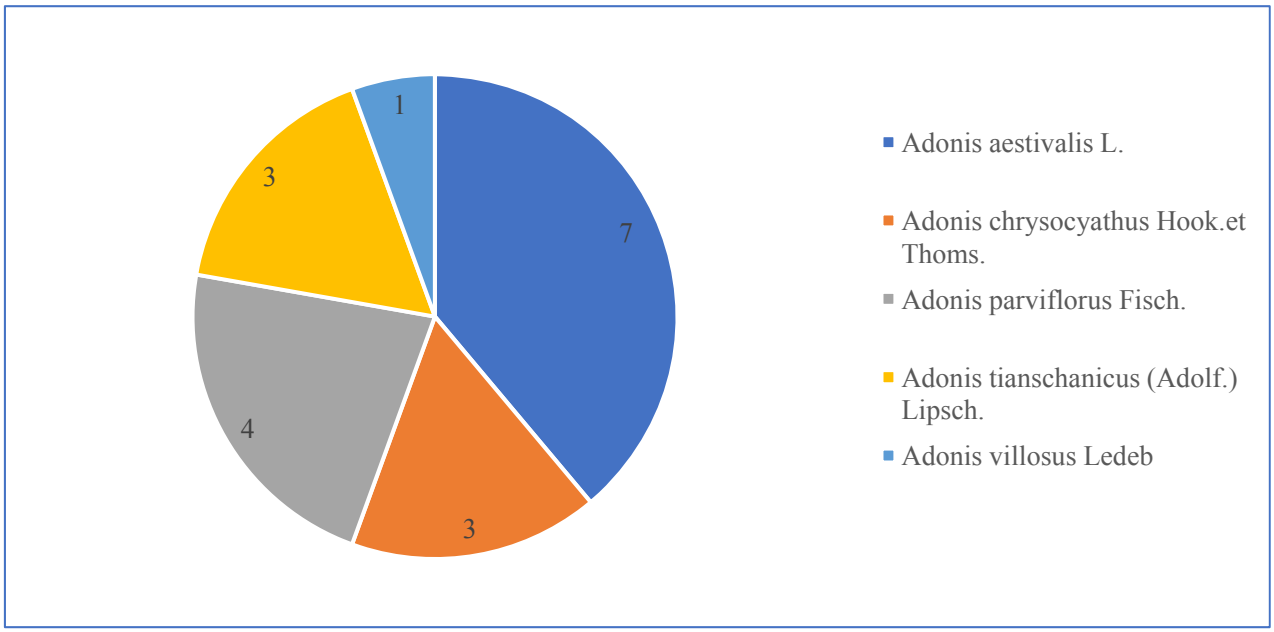

Figure 2. Herbarium collections of *Adonis* L. species, Al-Farabi Kazakh National University

The following herbarium sheets are represented in the DAPO and KIR herbarium collections of 4 species of the genus *Adonis* L. in the study area (Fig. 3): 2 herbarium storage sheets of *A. parviflora* species were found: Alma-Ata region, Turgenskoye gorge, slope, 05.05.1981, Kazenas; Djambul region, Talas district, Intermountain valley, on meadow gray loamy soils, 06.06.1986, Dementeva I. V., Romanova T. G.;

2 herbarium sheets of storage, species *A. aestivalis* were revealed: Chimkent oblast, Aksu-Dzhabagly reserve, middle mountain h~1900 m, lower part on dark brown soils, 10.06.1970, Usenoko, Kazenas; Djambul oblast, Merken district, rural orkug Pobeda, complicated sands, 27.04.19, Strelnikov;

2 herbarium storage sheets of *A. wolgensis* species were found: Dzhezkazgan region, Ulutau district lands, 28.04.1979, Kazenas O. D.; Semipalatinsk region, Ayaguzovsky district, Akchatau farm, 16.05.1981, Yakovlev;

1 herbarium storage leaf of the species A. vernalis was found: Semipalatinsk region, Ayaguz district, interspot depression, on meadow-chestnut soils, 24.04.1983, Victorov E. E., Kazenas O. D.;

Herbarium materials of species of the genus *Adonis* L. collected from the territory of Kazakhstan, in herbarium funds of MSU, Faculty of Biology, Department of Geobotany, Laboratory Herbarium revealed the following herbarium storage sheets:

Only 3 herbarium sheets of the species *A.apennina (A.sibirica*) are represented in the herbarium collection of MSU (Fig. 4): Southern Altai, Sarymsakty Mountains, vicinity of Katon-Karagai, forest meadow, 10.05.1962, Seregin A. P.; Western (Kazakhstan) Altai, Katon-Karagai district, East Kazakhstan region, 13.08.1972, Pimenov M.; Western (Kazakhstan Altai), East Kazakhstan region, Auezov street, Katon-Karagai district, 15.08.1972, Voronov A. G.;

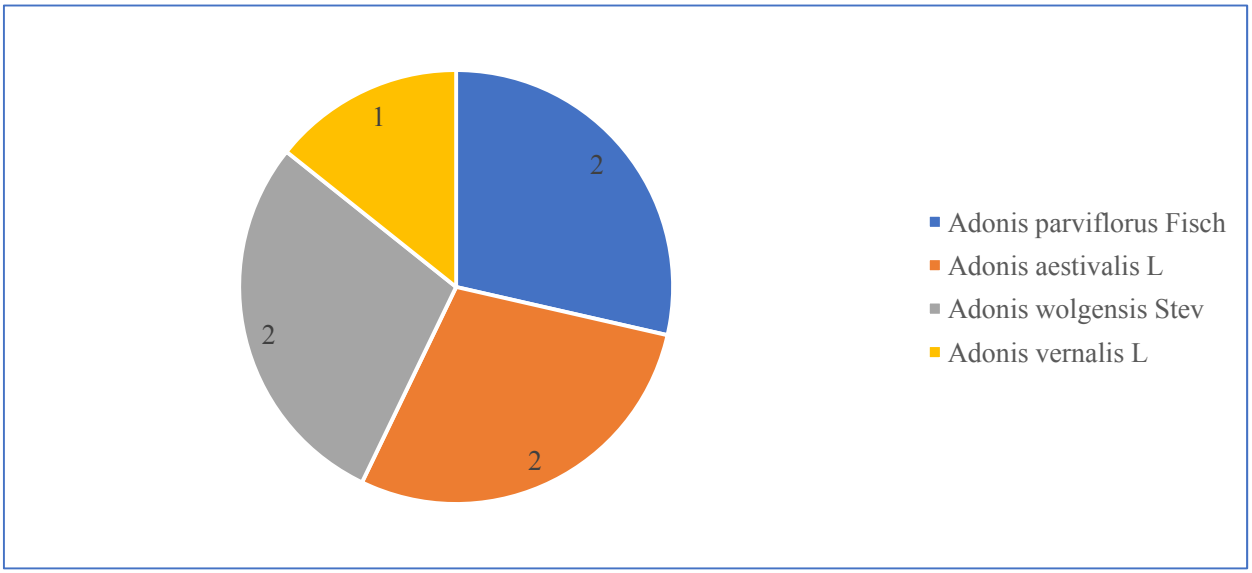

Figure 3. Herbarium collections of species of *Adonis* L., DAPO and KIR

Herbarium fund of MSU is presented only 2 herbarium sheets of *A. villosa* species: East Kazakhstan region, vicinity of Skalistoe village, 40 km south of Ust-Kamenogorsk city, Valley of steppe brook, on a slope, 27.04.1987, Smirin V.M.; East Kazakhstan, vicinity of Leninogorsk, steppe slopes of mountains, 05.1969, A.P. Poshkurlat.

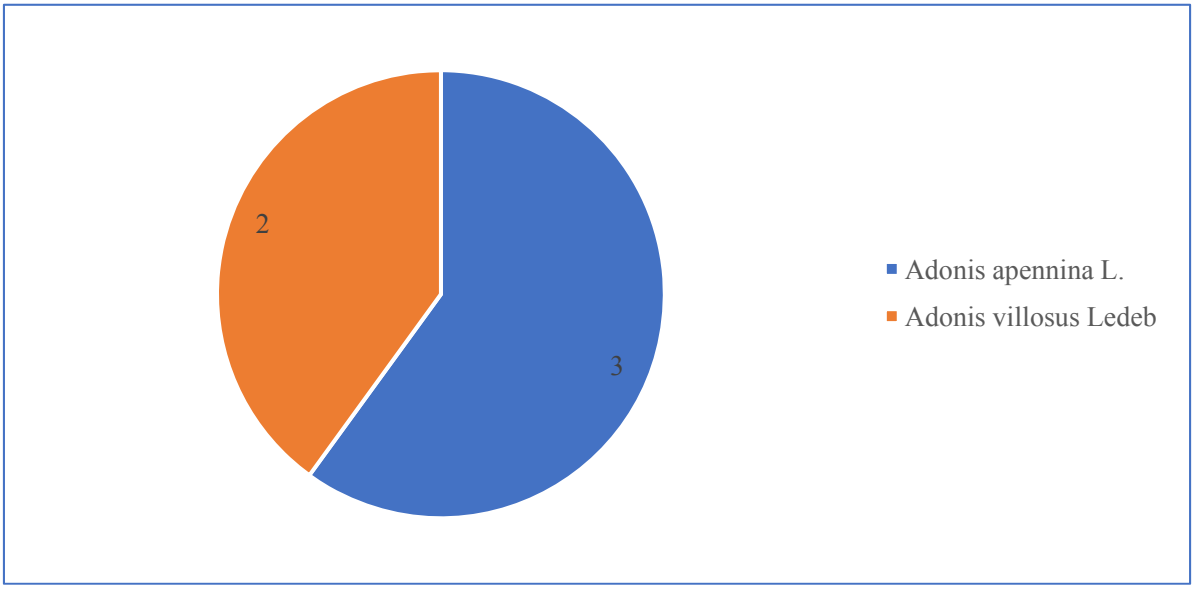

Figure 4. Herbarium collections of *Adonis* L. species, Herbarium Fund of MSU

Conclusions

The largest number of specimens of *A. aestivalis* (50) is represented in the herbarium collection of the Institute of Botany, while other collections reviewed contain a minimum number of specimens of this species. The analysis of the species' places of occurrence indicates its greatest representation in the Kungai Alatau. However, individual specimens were recorded in the territory of Almaty and Jambul regions along the Chu River, as well as in general in the territory of the Zailiyskiy Alatau. The species is confined to the heights of mountains, to rocky and wet habitats, as well as to sandy soils. Of the analyzed specimens of Adonis apennina L., 15 are represented in the collection of the Institute of Botany and Phytointroduction (AA) and *A. chrysocyathus* 7 specimens, *A. parviflora* 13 specimens, *A. tianschanica* 9 specimens, *A. vernalis* 2 specimens, *A. villosa* 3 specimens and *A. volgensis* 19 specimens, growing in Dzungarian Alatau, along the Talgara and Malaya Almatinka rivers and in Central Kazakhstan. The species grows on moist soils along coniferous trees, along river banks, on mountains, on stony slopes. The studied genus in the collection of DEPO is represented in small herbarium sheets, in collections of MSU and KazNU practical not collected and not studied, thus these species of the genus is endangered.

All specimens viewed date mainly from 1932–1972, modern collections are extremely scarce. Thus, research is needed to identify the current state of biodiversity of species and their natural growing points of these species.

Acknowledgments

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Adonis L. туысы түрлерінің таралу аймағын зерттеу

Мақалада *Adonis* L. туыс түрлерінің Қазақстанда таралуы туралы мәліметтер келтірілген. *Adonis* туыс түрлерінің заманауи таралу орындарын әрі қарай нақтылау және түгендеу мақсатында ботаникалық ұйымдардың негізгі гербарий қоры зерттелді. Жүргізілген талдаулар түрлердің ең көп кездесетіні Алматы облысына тиесілі екенін көрсетті. Қазақстанда таралуын нақтылау және *Adonis* L. туысы түрлерінің өсу нүктелерін құру үшін әл-Фараби атындағы ҚазҰУ, Ботаника және фитоинтродукция институты, Алматы қаласының АТЗ және КІЖД, Мәскеу мемлекеттік университетінің цифрлық гербарийы бойынша жалпы 148 гербарий парағы (1843-2021 жж.) қаралып, өңделді. Негізінен олар 1843 жылдан басталса, ең көп саны 1940-1972 жылдарға тиесілі, ал негізгі коллекторлар С.А. Арыстанғалиев, Б.Быков, Н.В. Павлов, А.А. Иващенко. Қазақстан флорасында *Adonis* L. туысының 8 түрінің 148 нақты өсу нүктесі анықталды, олар: *Adonis aestivalis* L., *Adonis apennina* L. (*Adonis sibirica* Patr.ex Ledeb.), *Adonis chrysocyathus* Hook.f. & Thomson*., Adonis parviflora* Fisch*., Adonis tianschanica (*Adolf*.)* Lipsch., *Adonis vernalis* L., *Adonis villosa* Ledeb., *Adonis volgensis* Steven ex DC. *Adonis* L. туысы түрлерінің көбісі Жоңғар Алатауында, Батыс Алтайда, Тарбағатай және Іле-Күнгей-Алатауында анықталды, олар сирек кездеседі және саны азаюда. Географиялық тұрғыдан ең көп тарағандары *A. aestivalis, A. parviflora* және *A. tianschanica*. Жүргізілген зерттеу *Adonis* L. туысының Қазақстан флорасындағы түрлері мен таралуы туралы ақпаратты жүйелеуге, нақтылауға және толықтыруға мүмкіндік берді.

Кілт сөздер: таралу, гербарий, флористикалық аймақтар, есепке алу, Қазақстан.

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Изучение ареала распространения видов рода *Adonis* L.

В статье представлены данные о распространении видов рода *Adonis* L. в Казахстане. С целью дальнейшего уточнения мест распространения и инвентаризации современного произрастания видов рода *Adonis* был изучен основной Гербарный фонд ботанических организаций. Проведенные анализы показывают, что наибольшая встречаемость видов отмечена в Алматинской области. Для уточнения распространения и составления точек встречаемости видов рода *Adonis* в Казахстане было просмотрено и обработано 148 гербарных листов (1843–2021) из Казахского национального университета имени Аль-Фараби, Института ботаники, ДАПО и КИР и цифрового гербария Московского государственного университета. Представлены сборы с 1843 г., наибольшее количество сборов приходится на 1940–1972 гг., и основными коллекторами являются С.А. Арыстангалиев, Б. Быков, Н.В. Павлов, А.А. Иващенко. Было выявлено 148 фактических мест произрастания для 8 видов *Adonis* из флоры Казахстана: *Adonis aestivalis* L., *Adonis apennina* L. (*Adonis sibirica* Patr.ex Ledeb.), *Adonis chrysocyathus* Hook.f. & Thomson*., Adonis parviflora* Fisch*., Adonis tianschanica (*Adolf*.)* Lipsch., *Adonis vernalis* L., *Adonis villosa* Ledeb., *Adonis volgensis* Steven ex DC. Видовое разнообразие *Adonis* L. установлено в Джунгарском Алатау, Западном Алтае, Тарбагатайском и Иле-Кунгей-Алатау, которые классифицируются как редкие и их численность сокращается. Географически наиболее распространенными являются *A. aestivalis*, *A. parviflora* и *A. tianschanica*. Проведенное исследование позволило систематизировать, уточнить и дополнить информацию о видовом разнообразии и распространении рода *Adonis* L. во флоре Казахстана.

Ключевые слова: распространение, гербарий, флористические регионы, инвентаризация, Казахстан.

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