

**K.T. Abidkulova<sup>1\*</sup>**, **D.M. Almabek<sup>1</sup>**, **A.A. Ivashchenko<sup>2</sup>**,  
**N.M. Mukhitdinov<sup>1</sup>**, **N.V. Kurbatova<sup>1</sup>**, **B.A. Turalin<sup>3</sup>**,  
**L.N. Karasholakova<sup>4</sup>**

<sup>1</sup>Al-Farabi Kazakh National University, Kazakhstan, Almaty

<sup>2</sup>Institute of Zoology of KN MES RK, Kazakhstan, Almaty

<sup>3</sup>K. Zhubanov Aktobe Regional University, Kazakhstan, Aktobe

<sup>4</sup>Zhetysu University named after I. Zhansugurov, Kazakhstan, Taldykorgan

\*e-mail: karime\_58@mail.ru

## HERBARIUM AS TOOLS IN STUDY OF PLANT DISTRIBUTION AND ECOLOGY (ON THE EXAMPLES KAZAKH SPECIES OF *LEONTICE* AND *GYMNOSPERMIUM*)

The article provides data on the distribution and ecology of Kazakh species *Leontice* L. and *Gymnospermium* Spach. (Berberidaceae Juss.) based on analyses of herbarium specimens from four major scientific institutions in Russia and Kazakhstan. A total of 196 herbarium sheets were processed, 116 from herbarium collections of the V.L. Komarov Botanical Institute of the Russian Academy of Sciences (LE) (St. Petersburg, Russia) and 42 from the Noah's Ark (MW) depository of living systems of the digital herbarium of the Moscow State University named after M.V. Lomonosov (St. Petersburg, Russia). Lomonosov Moscow State University (Moscow, Russia), 25 from the herbarium collection of the Institute of Botany and Phytointroduction (AA) (Almaty, Kazakhstan), and 13 from the scientific depository "Virtual Herbarium ALTB" (ALTB) of the South Siberian Botanical Garden of Altai State University (Barnaul, Russia). Most specimens were collected 100 or more years ago, a minor number in the 50s–80s of the last century, and quite fewer modern, which are mainly represented in the scientific depository of the South Siberian Botanical Garden of Altai State University. All herbarium samples were found in the most ecologically typical habitats of the species. The distribution of *Gymnospermium altaicum* (Pall.) Spach. in the mountains of Tarbagatai and Dzungarian Alatau is uncertain, as the only confirmation of the presence of this species in Tarbagatai is only two herbarium sheets collected in 1840 by Karelin et Kirilloff. As regards the Dzungarian Alatau, no herbarium sheets of this species collected there were found. The results of the research show the possibility of using herbarium specimens to clarify the distribution and ecology of the studied species, as well as the need for additional research, as in the case of the rare species *Gymnospermium altaicum*.

**Key words:** herbarium, Berberidaceae, *Leontice*, *Gymnospermium*, Kazakhstan.

К.Т. Абидкулова<sup>1\*</sup>, Д.М. Алмабек<sup>1</sup>, А.А. Иващенко<sup>2</sup>, Н.М. Мухитдинов<sup>1</sup>,  
Н.В. Курбатова<sup>1</sup>, Б.А. Туралин<sup>3</sup>, Л.Н. Карашолакова<sup>4</sup>

<sup>1</sup>Әл-Фараби атындағы Қазақ Ұлттық Университеті, Қазақстан, Алматы қ.

<sup>2</sup>ҚР БҒМ ҒК «Зоология институты», Қазақстан, Алматы қ.

<sup>3</sup>К. Жұбанов атындағы Ақтөбе өңірлік университеті, Қазақстан, Ақтөбе қ.

<sup>4</sup>І.Жансүгіров атындағы Жетісу университеті, Қазақстан, Талдықорған қ.

\*e-mail: karime\_58@mail.ru

### Гербарий өсімдіктердің таралуы мен экологиясын зерттеу құралы ретінде (Қазақстандық *Leontice* және *Gymnospermium* түрлерінің мысалында)

Мақалада Ресей мен Қазақстанның ірі төрт ғылыми мекемелерінің гербарий коллекциялары үлгілерін талдау негізінде қазақстандық *Leontice* L және *Gymnospermium* Spach. (Berberidaceae Juss.) түрлерінің таралуы мен экологиясы туралы мәліметтер келтірілген. Барлығы 196 гербарий парағы өңделді, оның ішінде 116 гербарий парағы В.Л. Комаров РҒА (LE) атындағы Ботаникалық институттың гербарий қорынан (Санкт-Петербург қ., Ресей), 42 – М.В. Ломоносов атындағы Мәскеу мемлекеттік университетінің цифрлық гербарийінің «Нұх кемесі» (MW) тірі жүйелер депозитарийінен (Мәскеу қ., Ресей), 25 – Ботаника және фитоинтродукция институтының (AA) гербарий қорынан (Алматы қ., Қазақстан) және 13 – Алтай мемлекеттік университетінің Оңтүстік Сібір ботаникалық бағының «Virtual Herbarium ALTB» (ALTB) ғылыми депозитарийінен (Барнаул қ., Ресей). Үлгілердің көбісі 100 жыл және одан да астам уақыт бұрын, аздап өткен ғасырдың

50-80 жылдарында жиналған, ал қазіргі заманғы үлгілер өте аз, олар негізінен Алтай мемлекеттік университетінің оңтүстік Сібір ботаникалық бағының ғылыми депозитарийінде бар. Барлық гербарий үлгілері түрлердің экологияға тән тіршілік ету ортасында жиналды. Тарбағатай мен Жоңғар Алатауының тауларында *Gymnospermium altaicum* (Pall.) Spach. таралуы күмән тудырады, себебі Тарбағатайда бұл түрдің бар екендігінің жалғыз дәлелі 1840 жылы Karelin et Kiriloff. жинаған екі гербарий үлгісі болып табылады. Жоңғар Алатауына келетін болсақ, бұл тауларда жиналған осы түрдің бірде-бір гербарий парағы табылмады. Зерттеу нәтижелері зерттелетін түрдің таралуы мен экологиясын нақтылау үшін гербарий үлгілерін пайдалану мүмкіндігін, сонымен қатар сирек кездесетін *Gymnospermium altaicum* түріндегідей қосымша зерттеулер жүргізу қажеттілігін көрсетеді.

**Түйін сөздер:** гербарий, Berberidaceae, *Leontice*, *Gymnospermium*, Қазақстан.

К.Т. Абидкулова<sup>1\*</sup>, Д.М. Алмабек<sup>1</sup>, А.А. Иващенко<sup>2</sup>, Н.М. Мухитдинов<sup>1</sup>,  
Н.В. Курбатова<sup>1</sup>, А.Б. Туралин<sup>3</sup>, Л.Н. Карашолакова<sup>4</sup>

<sup>1</sup>Казахский национальный университет имени аль-Фараби, Казахстан, г. Алматы

<sup>2</sup>Институт зоологии КН МОН РК, Казахстан, г. Алматы

<sup>3</sup>Актюбинский региональный университет имени К. Жубанова, Казахстан, г. Актөбе

<sup>4</sup>Жетысуский университет имени И. Жансугурова, Казахстан, г. Талдықорған

\*e-mail: karime\_58@mail.ru

### Гербарий как инструмент изучения распространения и экологии растений (на примере Казахских видов *Leontice* и *Gymnospermium*)

В статье приводятся данные по распространению и экологии казахских видов *Leontice* L. и *Gymnospermium* Spach. (Berberidaceae Juss.) на основе анализа образцов гербарных коллекций четырех крупных научных учреждений России и Казахстана. Всего обработано 196 гербарных листов, 116 – из гербарных фондов Ботанического института им. В.Л. Комарова РАН (LE) (г. Санкт-Петербург, Россия), 42 – из депозитария живых систем «Ноев Ковчег» (MW) цифрового гербария Московского государственного университета имени М.В. Ломоносова (г. Москва, Россия), 25 – из гербарного фонда Института ботаники и фитоинтродукции (AA) (г. Алматы, Казахстан), и 13 – из научного депозитария «Virtual Herbarium ALTB» (ALTB) Южно-Сибирского ботанического сада Алтайского государственного университета (Барнаул, Россия). Большинство образцов были собраны 100 и более лет назад, немного – в 50-80 гг. прошлого века, и совсем мало современных, которые в основном представлены в научном депозитарии Южно-Сибирского ботанического сада Алтайского государственного университета. Все гербарные образцы собраны в наиболее типичных по экологии местах обитания видов. Сомнение вызывает распространение *Gymnospermium altaicum* (Pall.) Spach. в горах Тарбағатай и Джунгарского Алатау, т.к. единственным подтверждением наличия данного вида в Тарбағатае является всего два гербарных образца собранные в 1840 г. Karelin et Kiriloff. Что касается Джунгарского Алатау, не было найдено ни одного гербарного листа этого вида, собранного там. Результаты исследований показывают возможность использования гербарных образцов для уточнения распространения и экологии исследуемых видов, а также на необходимость дополнительных исследований как в случае с редким видом *Gymnospermium altaicum*.

**Ключевые слова:** гербарий, Berberidaceae, *Leontice*, *Gymnospermium*, Казахстан.

## Introduction

Herbaria are collections of plant specimens collected from different regions of a country and from other countries. The specimen data stored in herbarium collections supports research in a wide range of different disciplines. Most of the data are used in research in species identification, taxonomy, and systematics [1–5]. Herbarium specimens are also very helpful for genetic studies related to phylogeny, comparison of past and current biodiversity, conservation biology, investigating global environmental change, etc. [6–15]. In various areas of botanical research, as we've seen,

herbariums can be successfully used. For that purpose, it would also be possible to use information from the herbarium in order to obtain an early understanding of the distribution and ecological characteristics of a species being studied.

The family Berberidaceae Juss. in Kazakhstan is represented by shrubs and perennial herbaceous plants. According to S.A. Abdulina [16] and M.S. Baitenov [17], the family includes 8 species of the genus *Berberis* L., one monotypic genus *Bongardia* C. A. Mey with a single species *B. chrysogonum* (L.) Spach, distributed in the countries of Western and Central Asia; the genus *Leontice* L., mainly characteristic of the Mediterranean countries,

Western Asia, and Iran-Turan region, with two species *Leontice inserta* Pall. and *L. ewersmanii* Bunge; and the genus *Gymnospermium* Spach, occurring in temperate Eurasia, also with two species: *Gymnospermium alberti* (Regel) Takht. and *G. altaicum* (Pall.) Spach.

Botanists have been studying representatives of this family for more than a hundred years [18–31]. Originally, the genus *Leontice* was described by C. Linnaeus [32] and included three species, now belonging to three different genera: *Leontice*, *Caulophyllum* Michx., and *Bongardia* [33]. The genus *Gymnospermium* was described by the French botanist E. Spach in 1839 and originally belonged to the genus *Leontice*; its independence was repeatedly disputed by various botanists. The history of division and distinguishing features of these two genera by the structure of seeds and fruits were described in detail by A.L. Takhtajyan [34],

noting that the currently established independence of the genera was first accepted in the “Flora of Europe” [35].

There is only general information on the distribution of each species in Kazakhstan [36]. The aim of our study was to clarify and supplement information on the location and ecology of *Leontice* and *Gymnospermium* species in Kazakhstan based on data from large herbarium collections in Kazakhstan and Russia.

### Materials and Methods

The objects of our research are the Kazakhstan species *Leontice* and *Gymnospermium* (Fig. 1), which are components of both semi-arid, arid, and forest mountain ecosystems; moreover, one of them, *G. altaicum*, is listed in the Red Book of Kazakhstan [37].



*Gymnospermium alberti*



*Gymnospermium altaicum*



*Leontice ewersmanii*



*Leontice inserta*

**Figure 1** – Species of *Gymnospermium* and *Leontice* in Kazakhstan

To clarify the distribution of these species in Kazakhstan, we have analyzed the herbarium specimens from the collections of the Institute of Botany and Phytointroduction (AA) (Almaty, Kazakhstan), the V.L. Komarov Botanical Institute of the Russian Academy of Sciences (LE) (St. Petersburg, Russia), the scientific depository “Virtual Herbarium ALTB” (ALTB) of the South Siberian Botanical Garden of the Altai State University (Baraul, Russia) (<http://altb.asu.ru/index.php>), and the depository of living systems “Noah’s Ark” (MW) (<https://plant.depo.msu.ru>) of the digital herbarium of the Lomonosov Moscow State University (Moscow, Russia). The Latin names of species have been given according to the summary by S.A. Abdulina [16].

## Results and discussion

In total, we analyzed more than 196 herbarium specimens (Table 1). As a result of the analysis of specimens from herbarium collections, the possible places of their distribution and ecology these four studied species were clarified. Below, we give their synopsis according to the habitats identified during the analysis of these herbarium collections. All descriptions of the locations were given according to the herbarium labels. Unfortunately, not all descriptions were included in the synopsis due to the impossibility of correct identification of some herbarium labels due to their wear and tear, and lack of other additional information, apart from the species name. All entries on the labels were translated from Russian except for those left in the original language – German. We tried to organise herbarium specimens of the studied species according to geographical (mountains, deserts) or administrative (regions) criteria, as it is not always possible to follow only one of them.

**Table 1** – Number of herbarium specimens of Kazakh species of the genus *Leontice* and *Gymnospermium* available in the above mentioned scientific herbaria of Kazakhstan and Russia

Species name	Herbarium Acronym			
	AA	LE	MW	ALTB
<i>Gymnospermium alberti</i> (Regel) Takht.	7	6	13	-
<i>G. altaicum</i> (Pall.) Spach.	8	48	7	13
<i>Leontice ewersmanii</i> Bunge	8	49	10	-
<i>L. inserta</i> Pall.	2	13	12	-
Total:	25	116	42	13

## Family Berberidaceae Juss.

### Genus *Gymnospermium* Spach

#### *Gymnospermium alberti* (Regel) Takht.

Ephemeroïd, herbaceous perennial with a globular tuber. Blooms in March-April. Grows on mountain slopes among shrubs, deciduous trees and junipers in the lower and middle belt of the southern mountains. It occurs in the Kyrgyz Alatau, Karatau and Western Tien Shan [36]. For Kyrgyzstan, the species is listed as subendemic [38].

#### Herbarium of the Institute of Botany and Phytointroduction (AA)

*Karatau mountains*: grassy foothills slopes of Kaz-gurt mountain near Chimkent 12.V.1930, Pavlov N.V.; 1720 m, southern slope, 18.V.1973, Myrzakulov P.M.; Khantali gorge 23 km from Khantali village, left bank of Khantali river, 09.V.1985, Myrzakulov P.M.

*South Kazakhstan region*: stony debris at the place of snow spot at Aksar-saya peak near Nanai village, 23.VI.1948, Pavlov N.V.

*Talas Alatau*: surroundings of Novonikolayevka village, eastern slope of Taldy-Bulak gorge, 01.IV.1937, Masalsky A.P.

*Karzhantau*: Arkabai gorge, under forest canopy on north-western slope, 29.V.1988, V.A. Samoylova.

*Western Tien-Shan*: Sary-Aigyr Mountains, at foothills on clayey soils, 13.V.1989, V.A. Samoylova, A.A. Ivashchenko.

#### Herbarium of the V.L. Komarov Botanical Institute, Russian Academy of Sciences (LE)

*Talas Alatau*: Aksu-Dzhabaglin reserve, beginning of B. Kaindy gorge, 15.VII.1958, Soskov Y.D.

*Karatau Mountains*: rocks near Babai-Kurgan village, 21.IV.1930, Lipschitz S.; in dry channel on meadow slope under Bukuy-Tau peak, 03.VII.1931, Pavlov N.V.; Kara-Uzen gorge, in upper reaches of Boyaldyr river basin, 09.V.1977, Kamelin. R.V., Mikhailova M.A., Mishenkova A.P., Safronova I.N., Solov’ev V.I.

*Southern Kazakhstan*: Syr-Darya region, aul between Antonovka and Kornilovka, 07.III.1912; Prichuisky Moiynkum, eastern slope of Suluter gorge at the height of 200 m, meadow steppe belt, 03.VI.1930, Zapryagaeva F.L.

#### Depository of Living Systems «Noah’s Ark» (MW)

*Karatau Mountains*: grassy foothill slopes of Kaz-gurt mountain near Chimkent, 19.V.1939,

Pavlov N.V.; Turkestan district, north-west of Kurnash village, steep south-eastern stony slope, 24.IV.1935, G.V. Tekutyev; Turkestan district, behind Koch-ashik village, rubbly stony slope, 03.IV.1930, Lipschitz S.; Turkestan district, rocks near Baban-kurgan village, 21.IV.1930, Lipschitz S.; Turkestan district, rock near Baban-kurgan village, 21.IV.1930, Lipschitz S.; in shrubs on stony slope of mountains, in upstream of Kulan-su river, 18.V.1932, Pavlov N.V.; in a dry streambed on a meadow slope of Bukuy-tau peak, 03.VII.1931, Pavlov N.V.; under a snow spot on the top of Kazgurt mountains, 20.V.1939, Kuznetsov N.M.

*South Kazakhstan region:* Bostandyk, Ugamskiy ridge, Boguchal-say est. Boguchal-say, under canopy of walnut forest, 1200 m, 10.V.1954, Pavlov N.V.; stony upland steppe below Aksar-saya peak near Nanai village, 23.VI.1948, Pavlov N.V.; stony debris at the place of a snow spot at Aksar-saya peak near Nanai village, 23.VI.1948, Pavlov N.V.; Bostandyk, along the slope of a ravine above Sidkak village, 03.VI.1953, Pavlov N.V.; Sairam district, artificial forest plantation 3 km south of Karamurat village (28 km south of Belye vody), 22.III.1962, Vlasov M.

#### ***Gymnospermium altaicum* (Pall.) Spach**

Ephemeroïd, herbaceous perennial plant with an almost globular tuber. Flowering in late March-early April. Grows on mountain slopes among shrubs, in apple and fir (Altai) forests. It occurs in Irtysh Land, Zaisan, Altai and Tabagatai Mountains, Dzungarian, Trans-Ili, Kungei and Terskey Alatau, Ketmen ridge, Chu-Ili Mountains [21]. In Russia, it is listed in the Red Book of Altai Krai as a rare and endemic plant with a limited area of distribution [39].

#### **Herbarium of the Institute of Botany and Phytointroduction (AA)**

*Trans-Ili Alatau:* rock benches near the barracks, 01.IV.1930, Pavlov N.V.; north-eastern slope of the steep slope, upper part of the ridge, apple-tree forest, 1550 m, IV.1975, Rodionov B.S.; surroundings of Alma-Ata, upwards from the pioneer camp "Orlenok" on rock benches, 1100 m, 27.IV.1976, Kosenko V.N.; surroundings of Issyk village, 30.IV.1976, Kosenko V.N.; Almaty, rock benches in the area of Kensai 2 cemetery, elevation 960 m, 31.III.2017, Veselova, Mukhtubaeva, Kudabaeva (2 sheets).

*East Kazakhstan region:* Altai, Narym ridge, south-western spurs, in surroundings of Svinchatka village, shrubby piedmont steppe, 05.V.1985, Bidullaeva; Kalbinsky ridge, in surroundings of the upper post, 23.VI.1957, Stepanova E.F.

#### **Herbarium of the V.L. Komarov Botanical Institute, Russian Academy of Sciences (LE)**

*Trans-Ili Alatau:* Semirechensky region, surroundings of Verny city, 15.IV.1891, Killoman; Semirechensky region, surroundings of Verny city, 19.IV.1890, Killoman; surroundings of Verny city, 29.III.1892, Killoman; Semirechensky region, Verny district, 26.III.1905, Sokalskiy N.D.; Semirechensky region, Verny district, 1906, Sokalskiy N.D.; Prope urbem Alma-Ata in decliviis argilosis herbosis supra urbem, 06.V.1934, Popov M.G. (2 sheets); Semirechensky region, foothills surroundings of Verny city, zone of various grasses steppe, altitude 500 m, 1916, Abolin R.; Semirechensky region, foothills to the east of Verny city, 25.III.1911, Skorobogatov; Semirechensky region, basin of Malaya Almatinka river, 01.IV.1904, Ivanov P.; Semirechensky region, northern slopes of Alatau from Verny to Kastek pass, 16.III.1896, Ladygin V.O.; Semirechensky region, gorge to the east from Verny, 12.IV., Poyarkov A.; surroundings of Alma-Ata, about 2,5 km from pioneer camp "Orlyonok", 27.IV.1976, Kosenko V. (2 sheets); surroundings of Talgar village, among ephemeral motley grasses, 03.V.1976, Kosenko V. (3 sheets); surroundings of Issyk village, on the rock benches among ephemeral motley grasses, 30.IV.1976, Kosenko V. (2 sheets); surroundings of Turgeni village, near the brickyard on the rock benches, 08.V.1976, V. Kosenko (2 sheets); bottom of a gorge in loess foothills to the south-east of Verny in a belt of deciduous forest, 16.IV.1916, V.D. Gorodetsky; bottom of a gorge in loess foothills to the south-east of Verny, also on northern slopes in a belt of deciduous forest, 27.III.1916, V.D. Gorodetsky; Almatinka, 28.III.1877, Regel A. (2 sheets); Maloalmatinsky gorge, shrub thickets, 23.IV.1913, Shishkin B., Genina V.; Werny, 17.III.1877, Regel A. (3 sheets); Werny, Almatinka, 20.III.1877, Regel A.; Werny, Kleine Almatinka, 10.IV.1877, Regel A.; near Verny, gorge to the east, 18.III.1914. Poyarkov A.; Semirechensky region, surroundings of Verny, 04.V.1887, Killoman.

*Tarbagatai:* in ruperstribus montium Tarbagatai, praesertim ad torrentem Tscheharak-Assu frequens, 1840, Karelin et Kiriloff.

*Eastern Kazakhstan:* Ust-Kamenogorsk, Prigonnaya mountain, northern shrubby slope, 29.V.1931, Shishkin B., Steinberg E., Sumnevich G.; Kalbinsky ridge, Ulan district, Asybulak village, south-western ravine of the mountain, among grass, 24.V.1939, Grubov V.; Kaljirskaya valley, on the left side of Kaljira river, Alekseevskiy village, 13.IV.1908, Keller B.A.

**Depository of Living Systems «Noah's Ark» (MW)**

*Trans-Ili Alatau:* foothills, surroundings of Verny city, zone of various grasses steppe, altitude 500 m, 20.III.1916, Abolin R.; Alma-Ata, rock benches near military town, 12.IV.1939, Pavlov N.V.; rock benches in surroundings of Alma-Ata, northern slope with shrubs, 04.V.1936, Goloskokov V.P.

*Altai:* village Shemonaikha, on Mokhnataya hill, 26.IV.1901, Krylov P.;

*Eastern Kazakhstan:* 40 km to the south of Ust-Kamenogorsk city, surroundings of village Skalistoe, valley of steppe stream, 20.IV.1987, Smirin V.M.;

*Tarbagatai:* in ruperstribus montium Tarbagatai, praesertim ad torrentem Tscheharak-Assu frequens, 1840, Karelin et Kiriloff.

**Scientific depository "Virtual Herbarium ALTB"**

*East Kazakhstan region:* Kalbinsky ridge, surroundings of Samsonovka village, foothill of southern slope, in shrubs, 08.V.1970 (2 leaves); Kalbinsky ridge, 12 km to the north-west of village Panteleymonovka, 07.V.2009, Sherin I.A., Galkin A.V. (3 sheets); 5 km to the south of Ust-Kamenogorsk city, left bank of Ablaketka river, stony slope of southern exposure, 10.IV.1997, Shmakov A.I. (2 sheets); 4 km from Shemonaikha village, bridge over Uba river, eastern slope, 15.IV.1990; Kurchum district, western spurs of Narymsky ridge near Kaznakovskaya crossing on Bukhtarma reservoir, scrubby, turf slopes, N 48°44', E 83°28', 05.V.2001, S.A. Dyachenko; Kurchum district, spurs of Kurchum ridge, Kukumbai mountains, 42 km from Kurchum village, rubbly slopes of gorge, N 48°27', E 84°10', 06.V.2001, Diachenko S.A.; Kurchum district, southern spurs of Azutau ridge, Bulgar-Tabatty mountains, slopes of northern exposure with juniper, N 48°16', E 85°22', 08.V.2001, Diachenko S.A.; Kolba, Chechek Pass, 24.IV.1988, Tsyganov A.P.; Ulansky District, Kalba Range, eastern macro-slope of mount Medvedka, elevation 1200 m, N 49°34'50", E 82°37'12", 30.V.2006, Smirnov S.V., Kutsev M.G., Kurilo A.I., Skalozubov R.G.

**Genus *Leontice* L.*****Leontice ewersmanii* Bunge**

A strong perennial plant with an ovoid tuber. Blooms in March-April. It grows on clay and sandy soils in the desert plains and foothills, sometimes as a weed in crops, wastelands and roadsides. Distribution: in the Kzyl-Orda region, Muyun-kum,

Lake Balkhash Region, Kyzyl-kum, Turkestan, Dzungarian, Trans-Ili Alatau and Kungei Alatau, Ketmen-Terskey Alatau (Syugaty valley), Chu-Ili Mountains, Kyrgyz Alatau, Western Tien Shan [21].

**Herbarium of the Institute of Botany and Phytointroduction (AA)**

*Dzungarian Alatau:* south-western spurs, Chulak, Moncha-sai mountains, along steppe fine-grained places in the middle part of the gorge, 28.V.1928, Goloskokov V.P.

*Kyzyl-Kum:* Syr-Darya district, northern slope of Balyk-tau mountain, 23.IV.1930, Golovanov; Central Nuratau, 800 m elevation, 27.IV.1975, Baitenov M.S.; Shubarbaital gorge, south-eastern stony slope, 05.VI.1980. Kudabaeva G.M. (2 sheets).

*Trans-Ili Alatau:* Kastek mountains, Kurdai pass, western slope, fine-grained lowlands, 18.V.1976, Nelina N.V.; Kastek mountains, Kurdai pass, in lowlands, 21.IV.1976, Eremina N.H.; Kastek mountains, Kurdai pass, 21.IV.1976, Karmysheva N.K.

**Herbarium of the V.L. Komarov Botanical Institute, Russian Academy of Sciences (LE)**

*Dzungarian Alatau:* south-western spurs, Chulak, Moncha-sai mountains, along steppe fine-grained places in the middle part of the gorge, 28.V.1955, Goloskokov V.P. (3 sheets)

*Trans-Ili Alatau:* Semirechensky region, Pishpek uyezd, Kurdai pass, plateau at the top of the pass, 19.IV.1913, Shishkin V., Genina V. (3 sheets); Kurdai pass, 20-21.III.1879, Fetissow A. (4 sheets); Kurdai pass, right in the mountains, 13.V.1976, Kosenko V.N.; Kurdai, 15.IV.1880, Fetissow; Semirechensky region, Pishpek uyezd, in foothills of Chu-Ili range, village Georgievskoe, Sovetkina M.; Kendyk Tas mountains, 07.V.1886, Krassnow (2 sheets); Semirechensky region, Pishpek uyezd, between Konstatinovskaya-Syugatinskaya stations, 28.V.1909, Mikhelson A.; Semirechensky region, Pishpek uyezd, Kamyshansk village, 23.VI.1916, Tsingerling Yu;

*Southern Kazakhstan:* in the surroundings of Kabud-say station of Arys-Tashkent railway, wormwood steppe, 26.III.1962, Gubash I.; Syr-Darya region, hilly foothills of Western Tien-Shan in the area of borders of Tashkent and Chimkent uyezds, surroundings of Suksuk-kuduk well on steppe escarpments, 28.IV.1926, Yarmolenko A. (2 sheets); Syr-Darya region, Arys station, steppe, 29.III.1911, Dimo N.A., Sprygin I.I., Shulga I.A.; Turkestan, Tashkent uyezd, Suksuk-kuduk,

02.V.1926; hilly foothills of the Western Tien-Shan near Tashkent (Syr-Darya region) between the village of Kazanskiy (Chigerino) and the railway station, 04.V.1926, Yarmolenko A.; slopes of flat loess hills near Kabul-say junction of Arys-Tashkent railway 25 km south of Arys station, thickets, 07.V.1961, Vlasov M.I. (2 sheets); in the surroundings of Kabul-sai junction, Arys-Tashkent railway, wormwood steppe, 26.III.1962, Vlasov M.; between Kabul-say station and 42nd junction of Arys-Tashkent railway, 22.V.1956, Soskov Yu.; Syr-Darya region, Tashkent uyezd, crops between Keles station and Darbazy, 17.IV.1916, Kultiasov M.; between 42-43 junctions of Tashkent railway, on the road from Arys station to Tashkent, 19.V.1958, Soskov Y.D. (2 sheets); Chingildy station, 21.V.1877, Fetissow (2 sheets);

*Kyrgyz Alatau*: northern slope, south-eastern slope of Sulutur river gorge, 1900 m high, 31.V.1930, Igolkin G.I.

*Kyzyl-Kum*: foothills between Sherekty and Kara-tau, in steppe, 13.V.1932, Rusanov F.; wormwood steppe 4 km west-southwest of Kurak-Bai village, 22.V.1932, Afanasyev K.

*Semirechensky region*: Pishpek uyezd, right bank of the Chu river, open grassy steppe on slightly elevated place near Ulan-Tumsuk mountain, 20.V.1916, Somatkina M., Chausova S.

#### **Depository of Living Systems «Noah's Ark» (MW)**

*Western Tien-Shan*: on clay hills of Kaplanbek, 06.IV.1923, Korovin V.

*Karatau*: Ak-tau mountain, steppe slope. Near Leontievka village, 16.V.1934, Chilikina L.

*Trans-Ili Alatau*: Kurday pass, dry steppe, 26.V.1939, Pavlov N.V.; dry steppe at Kurday pass, 16.V.1939, Pavlov N.V.

*Southern Kazakhstan*: South Kazakhstan region, near Arys station, between 42nd passing-track and Kobulsay, 07.V.1961, Gubanov I.A.; between Chimkent, Tashkent and Syr-Darya, 23.IV.1975, Pimenov M.G.; the steppe in 20 km to the south-east from Arys, 19.V.1958, Gubanov I.A.; Syr-Darya region: Kaplanbek tract, bogara, 28.III.1922, Vvedensky A.I.; Dzhambul region, surroundings of village Chernorechenskoe, Chu river valley, 06.VI.1969, Pimenov M.G.

*Central Kazakhstan*: Karsakpai district, on mountain slopes near Karsakpai plant, 01.V.1930, Smirnov E.

#### ***Leontice inserta* Pall.**

Ephemeroïd. Perennial herbaceous plant with an ovoid or globular tuber. Flowering in April. It grows on rubble slopes of low mountains, on sandy, clay

and saline soils in deserts, and in saxaul thickets. It occurs in the Caspian Sea region, Mugodzhary, Emba, Turgai, Western Kazakh Uplands, Zaisan, northern Ustyurt, Aral Sea region, Kzyl-Orda region, Betpakdala, Muyunkum, Balkhash lake region, Dzungarian Alatau, Ketmen, Terskey Alatau [21]. In China, this species is regionally included in the List of Key Protected Wild Plants of Xinjiang Province [40].

#### **Herbarium of the Institute of Botany and Phytointroduction (AA)**

*Betpak-dala*: eastern end of the desert, loamy, moist soil, 21.IV.1976, Orazova A.O.

*Balkhash lake region*: 9-12 km from Bakanas village eastwards to Birlik village, among wormwood-rhubarb-saxaul vegetation, altitude 403 m, N 44°48'37.7" and E 076°35'53.1", 29.IV.2015, Ramazanova M.

#### **Herbarium of the V.L. Komarov Botanical Institute, Russian Academy of Sciences (LE)**

*Aral sea region*: area of Aralsk, mounds of small gopher, spring 1958, Vartavsky; Aral Sea, Auzy Kum-aral, 09.V.1902, Berg L.

*South Kazakhstan*: Syr-Darya region, sands among saxaul forest between Bil-kora tract and old Chu river bed, 30.V.1916, Sowtypkina M.; Syr-Darya region, Kazalinsk, Ak-suat, 01.V.1903, Berg L.; Boktagaryk wormwood sand steppe, 14.V.1905, Abramov V.A.; Syr-Darya region, Perovskiy uyezd, sands of Taigakum station, 16.IV.1906, Nikolskiy V.V.; island of Asche-Kul lake, 09.V.1905, Abramov V.A.; near Baylakum station, 100 versts from Perovsk, 1908, Malyshev S.I.

*Balkhash lake region*: Eastern Betpak-dala, western shore of Balkhash lake, near Myn-Aral village on solonets, 07.VI.1949, Goloskokov V.P. (2 sheets).

#### **Depository of Living Systems «Noah's Ark» (MW)**

*Atyrau region*: clay desert on the shore of Lake Inder, N 48°30'50", E 51°52'30", 05.V.2011, Onipchenko V.G.

*Karatau*: north-eastern foothills of the eastern part of the ridge, Kur-Shabakty tract, wormwood semidesert, 17.V.1936, Chilikina L.; Transkaratau desert, wormwood-boyalish plain between river Uzen and Ak-sumbe, 12.V.1939, Pavlov N.V.; Pre-Karatau desert, in saxaul thickets near Chiyli station, 16.V.1939, Pavlov N.V.

*Aktobe region*: south of Zharkamys village, Chirkola ridge, chalk outlier Kaban-kulak, on a plume, 25.V.1967, Tscherkassova G.I.

*Balkhash lake region:* Uch-Tyube, Eskeldy, 28.VI.1929, Berezin V.A.; in desert steppe near Myn-aral, 20.V.1951, Pavlov N.V.; in saxaul forest between 5 and 6 pickets of Karaganda tract, 17.V.1951, Pavlov N.V.

*Northern Aral Sea region:* sandy steppe, 11.V.1931, Serova E.; clay steppe, 28.V.1931, Serova E.; clay steppe at the foothills of mountains, 10.V.1931, Serova E.

*Mangyshlak region:* Ustyurt plateau, 70 km south-east of Beineu village, 06.V.1983, Rusanovich I.I.

The maximum information on the distribution of *Leontice* and *Gymnospermium* species in Kazakhstan was obtained thanks to the herbarium of V.L. Komarov Botanical Institute of the Russian Academy of Sciences (116 sheets), followed by the digitized collection of Lomonosov Moscow State University (42 sheets). The least of data was obtained from the collections of the Institute of Botany and Phytointroduction and the scientific depository “Virtual Herbarium ALTB” (25 and 16 sheets, respectively). According to species, the data were distributed in the following order: the largest number of specimens of *Gymnospermium altaicum* (76 sheets), followed by *Leontice ewersmanii* (67 sheets), *Leontice inserta* (27 sheets), and *Gymnospermium alberti* (26 sheets). In terms of the time of collection, specimens collected 100 and more years ago predominate. Not too many specimens are dated 50-80 years from the last century, and only a few modern herbarium specimens, most of the latter are presented in the Scientific depository “Virtual Herbarium ALTB”.

*Gymnospermium altaicum.* Most of his finds are from the foothills of the Trans-Ili Alatau, especially in the surroundings of the former town of Verny (currently Almaty), and from the Altai mountain ranges in eastern Kazakhstan. Only 2 herbarium sheets were collected in the Tarbagatai Mountains and dated 1840. More recent finds of the species date from the late 1990s and early 2000s.

*Leontice ewersmanii.* Most of the herbarium specimens were gathered in South Kazakhstan in loess hilly foothills, in wormwood steppes. A significant herbarium was also collected in the area of the Kurdai Pass. Only a few herbarium sheets

refer to the Dzungarian Alatau (Chulak Mountains), Kyzyl-Kumam, Central Kazakhstan and Kyrgyz Alatau.

*Leontice inserta.* The herbarium was collected in desert areas of the Balkhash Lake region, the Aral Sea region, in South Kazakhstan, in the west of Kazakhstan (Mangyshlak, Atyrau and Aktobe regions). The most recent finds in 2015 were noted in the Balkhash Lake region.

*Gymnospermium alberti.* The main finds were found in the mountain ranges of the Western Tien Shan in South Kazakhstan, mainly the Karatau Mountains.

### Conclusion

We critically analyzed more than 196 herbarium specimens from large herbarium collections of four scientific organizations in Russia and Kazakhstan. All of the botanical specimens were collected within the most typical natural environments of the species, which supports the data presented in the literature regarding the geographical distribution and ecology of the Kazakhstan species *Leontice* and *Gymnospermium*. The distribution of *Gymnospermium altaicum* in the mountains of Tarbagatai and Dzungarian Alatau is questionable, because the only evidence of its presence in Tarbagatai is the only two herbarium specimens collected in 1840 by Karelin et Kiriloff. The distribution of *Gymnospermium altaicum* in the mountains of Tarbagatai and Dzungarian Alatau is questionable, as the only evidence of the presence of this species in Tarbagatai is the only two herbarium specimens collected in 1840 by Karelin et Kiriloff. Also, in these four collections, we were unable to find any herbarium sheets with this species from Dzungarian Alatau. In our opinion, it is needed additional research to clarify the occurrence of rare species *Gymnospermium altaicum* in the mountains of Tarbagatai as well as Dzungarian Alatau. It is also necessary to monitor this species in the foothills of the Trans-Ili Alatau (surroundings of Almaty), where, according to herbarium data, it was often found in the late XIX–early XX centuries. The last herbarium specimens were collected in 2017 only in the surroundings of Kensai cemetery.



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#### **Авторлар туралы мәлімет:**

*Абидкулова Каримә Тулегеновна – (автор корреспондент) әл-Фараби атындағы Қазақ ұлттық университеті биология және биотехнология факультетінің биоалуантүрлілік және биоресурстар кафедрасының PhD докторанты (Алматы, Қазақстан, email: karime\_58@mail.ru)*

*Алмабек Даяна Муратқызы – әл-Фараби атындағы Қазақ ұлттық университеті биология және биотехнология факультетінің биоалуантүрлілік және биоресурстар кафедрасының аға оқытушысы (Алматы, Қазақстан, email: mizzadm@gmail.com)*

*Иващенко Анна Андреевна – биология ғылымдарының кандидаты, Қазақстан Республикасы Ғылым және жоғары білім министрлігі Зоология институтының жетекші ғылыми қызметкері (Алматы, Қазақстан, email: ivashchenkoanna64@gmail.com)*

*Мухитдинов Наштай Мухитдинович – биология ғылымдарының докторы, әл-Фараби атындағы Қазақ ұлттық университеті биология және биотехнология факультетінің биоалуантүрлілік және биоресурстар кафедрасының профессоры (Алматы, Қазақстан, email: nashtay41@gmail.com)*

*Курбатова Наталья Владимировна – биология ғылымдарының кандидаты әл-Фараби атындағы Қазақ ұлттық университеті биология және биотехнология факультетінің биоалуантүрлілік және биоресурстар кафедрасының аға оқытушысы (Алматы, Қазақстан, email: kurbatova\_nv77@mail.ru)*

*Туралин Бауыржан Алпысбайұлы – Қ. Жұбанов атындағы Ақтөбе өңірлік университеті биология кафедрасының аға оқытушысы (Алматы, Қазақстан, email: bauke\_1982@mail.ru)*

*Карашолокова Лаззат Наушабаевна – Ph.D, I.Жансүгіров атындағы Жетісу университеті техникалық ғылымдар жоғары мектебінің қауымдастырылған профессоры (доцент), (Алматы, Қазақстан, email: karasholakova.lazzat@mail.ru)*

#### **Information about authors:**

*Abidkulova Karime – (corresponding author), PhD Student of the Department of Biodiversity and Bioresources, Faculty of Biology and Biotechnology, al-Farabi Kazakh National University (Almaty, Kazakhstan, email: karime\_58@mail.ru)*

*Almabek Dayana – Lecturer of the Department of Biodiversity and Bioresources, Faculty of Biology and Biotechnology, al-Farabi Kazakh National University (Almaty, Kazakhstan, email: mizzadm@gmail.com)*

*Ivashchenko Anna – Candidate of Biological Sciences, Leading Researcher of the Institute of Zoology of the Ministry of Science and Education of the Republic of Kazakhstan (Almaty, Kazakhstan, email: ivashchenkoanna64@gmail.com)*

*Mukhitdinov Nashtay – Doctor of Biological Sciences, Professor of the Department of Biodiversity and Bioresources, Faculty of Biology and Biotechnology, al-Farabi Kazakh National University (Almaty, Kazakhstan, email: nashtay41@gmail.com)*

*Kurbatova Natalia – Candidate of Biological Sciences, Senior Lecturer of the Department of Biodiversity and Bioresources, Faculty of Biology and Biotechnology, al-Farabi Kazakh National University (Almaty, Kazakhstan, email: kurbatova\_nv77@mail.ru)*

*Bauyrzhan Turalin – Senior Lecturer of Department of Biology Aktobe Regional University named after K. Zhubanov (Aktobe, Kazakhstan, email: bauke\_1982@mail.ru)*

*Karasholakova Lazzat – Ph.D, Associate Professor of Higher School of Technical Sciences of Zhetysu University named after I. Zhansugurov (Taldykorgan, Kazakhstan, email: karasholakova.lazzat@mail.ru)*

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