IRSTI 34.29.25

A.A. Ivashchenko[1], T.N. Stikhareva[1]*, K.T. Abidkulova[2], V.Yu. Kirillov[1], A.N. Rakhimzhanov[1]

[1]A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry, Shchuchinsk, Kazakhstan
[2]Al-Farabi Kazakh National University, Almaty, Kazakhstan
Corresponding author: kazniiles@mail.ru

Supplement to the flora of tugai forests and adjacent deserts of the Ile-Balkhash region

Abstract. *Based on the results of long-term research by the authors, and taking into account the analysis of literary data, we provide an addition to the desert flora of the Ile-Balkhash region, which includes 86 species from 69 genera and 31 families. Among the most interesting finds are Gagea jensii Levichev & Schnittler, first discovered in Kazakhstan; Allium subscabrum (Regel) RM Fritsch, a recently described narrow-local endemic of the Ili deserts; as well as four species listed in the Red Book of Kazakhstan. The article considers the unstable ecological situation in the surveyed region and the related changes in the species composition of higher plants, we recommend carrying out floristic monitoring of the most vulnerable plant communities, the tugai forests of the Ili River valley, and of the aquatic and semi-aquatic communities of the delta.*
Keywords: *flora, species list, ecosystem, desertification, distribution range type, monitoring.*

DOI: 10.32523/2616-7034-2023-142-1-68-89

Introduction

The study and monitoring of specific floras are especially relevant in ecologically unstable areas, where global climate change increases desertification and alters the hydrological regime in the river basins. In Kazakhstan, one such unstable region is Ile-Balkhash. It occupies a vast territory of the Balkhash depression, bounded by the southern coast of Lake Balkhash, the Chu-Ili mountains, and the Zhetysuskiy Alatau ridge. The modern delta of the Ili River, the area of which is 8200–9750 km^2 according to different estimates, is considered one of the largest remaining deltas in the arid regions of Central Asia. The Ili River is a transboundary river. The upper part of its basin and the main drainage area are located in China, where agricultural water consumption is constantly growing. A further reduction in the river flow may lead to a shallowing and splitting into two parts of Lake Balkhash, and a repetition of the Aral Sea crisis [1].

In accordance with the botanical and geographical zoning, the Ile-Balkhash basin belongs to the North Turan province of the Sahara-Gobi desert region. The phytocoenotic diversity of the territory includes aquatic, marsh, meadow, tugai, and desert vegetation types. However, desert vegetation occupies the largest area [2]. According to the floristic zoning of Kazakhstan [3], most of the Ile-Balkhash region belongs to the Balkhash-Alakol floristic region. The ecological situation in this region has been unstable lately, due to increasing anthropogenic impact (regulation of the Ili River stream bed, creation of the Kapchagai reservoir) and desertification process in general. In this regard, inventory and monitoring of biological diversity in general, and that of the higher plants in particular are very relevant.

The study of the flora and vegetation of the region began in the first half of the 20th century. Among recent studies, we consider the monograph by S.G. Nesterova and Z.A. Inelova [4] to be the most important; it provides a detailed summary of the desert flora of the Ile-Balkhash region and adjacent territories. It lists 933 species and is currently the most complete summary of the region's flora. The authors also made taxonomic, ecological, and geographical analyses of the flora and identified rare species. Nevertheless, based on the in-depth analysis of existing scientific publications, it is possible to make additions to the existing summary of the flora.

In the Ile-Balkhash region, of particular interest are tugai forests, which provide vital ecosystem services in arid areas and act as a barrier to desertification. However, they occupy small areas, suffer from frequent fires, and are also subject to degradation due to the expansion of irrigated agricultural land, soil salinization, and reduced river flow [5-6]. In this regard, the scientific and technical program of the Kazakh Research Institute of Forestry and Agroforestry named after. A.N. Bukeikhana titled "Development of the scientific background for the conservation and increased stability of forest ecosystems in the regions of Kazakhstan" for 2021-2023 includes a section on the study of the current state, stability and restoration of tugai forests in southern Kazakhstan. One of the key elements of the first stages of research is the study of the floristic composition of tugai forests and their dynamics.

The purpose of the present study was to clarify and supplement the existing data on the species composition of tugai forests of the Ili River valley and the adjacent deserts.

Materials and Methods

The study area included the deserts of the Ile-Balkhash region, in particular, the Ili River valley, the Malaysary mountains, and the Ile-Balkhash nature reserve (Figure 1).

Figure 1. The Ile-Balkhash region

We collected material by studying the region's flora, rare plant species, biology and the state of populations of ephemeroid geophytes, in particular, representatives of the genus *Tulipa* L. (1986-2020). The data were also collected during a complex expedition aimed at the development of a natural-scientific justification for the creation of the Ile-Balkhash nature reserve (led by Doctor of Biol. Sci., Prof. E.I. Rachkovskaya and Cand. Sci. B.M. Sultanova., Summer 2010), during the study of rare species (*Berberis iliensis* M. Pop., *Lonicera iliensis* Pojark.) and student fieldwork (2010-2020), as well as during annual route-reconnaissance surveys of turanga woodlands in the Ili River valley and adjacent deserts (2015-2020). In addition, herbarium and photographic materials were used, kindly provided by V.A. Kovshar, O.V. Belyalov, and L.E. Ishkov. The identification of plants was carried out by a florist, Cand. Sci. A.A. Ivashchenko, with the exception of representatives of the genus *Gagea* determined by Cand. Sci. I.G. Levichev (V.L. Komarov Botanical Institute of the Russian Academy of Sciences, St. Petersburg).

When processing materials, scientific publications on the flora of the Ile-Balkhash region were analysed, references to which are provided in species descriptions.

The Latin names of plants are according to the International Plant Names Index (IPNI) [7]; in some cases, synonyms are given according to the "Flora of Kazakhstan" [3, 8-15] and the summary by S.A. Abdulina [16]. Descriptions and analysis of data on the distribution and ecology of species are provided according to the main floristic studies [3, 8-15, 17-27]. The order of families is given according to the system of A. Engler adopted in the "Flora of Kazakhstan" [3, 8-15], the order of species within families, in alphabetical order, and the types of areas, mainly according to V.P. Goloskokov [28]. The distribution of species by vegetation types was carried out according to E.I. Rachkovskaya et al. [29].

Research results are available on the topic of the study

Many publications on the inventory of flora and the description of the vegetation of this region date back to the 1960-the 1980s [30-32]. Further clarifications were obtained mainly due to an in-depth study of individual taxonomic groups (*Gagea* Salisb., *Allium* L., *Tulipa* L.) using modern molecular genetic methods [33-35].

As mentioned above, the most detailed summary of the desert flora of the Ile-Balkhash region was provided by S.G. Nesterova and Z.A. Inelova [4], who listed 933 species. Subsequently, floristic studies in this region continued, including those of certain types of useful plants [36], as well as by the authors of the present article [37-41].

Results and discussion

After processing the collected material and thoroughly analyzing the literature data for this region, we were able to supplement the most recent account of the flora of the region with 86 species, specific information on each of which is given below.

Family Thelypteridaceae Pichi Sermolli

Thelypteris palustris Schott (*Dryopteris thelypteris* (L.) A.Gray, *Thelypteris thelypterioides* (Michx.) Holub) has been recorded in the delta's lake thickets with the participation of *Phragmites australis* (Cav.) Steud. and *Typha angustifolia* L., in particular near Lake Chaconite (13.06.2010). This is a perennial fern with a Holarctic distribution range type; it commonly grows on swampy river banks and lake shores, and in damp swampy forests. It occurs on the territory of almost all of Kazakhstan, except for deserts [3].

Family Sparganiaceae Rudolphi

Sparganium microcarpum Čelak. was recorded only in the Ili River delta, along the shores of Lake Asylbai (15.07.1995, L.E. Ishkov), and in flooded inter-ridge depressions in the Koktala area (19.06.2010). This is a perennial plant with a European-Siberian range type. It grows along the banks of water bodies of almost the entire flat Kazakhstan including the desert zone, from the Caspian Sea to the Balkhash-Alakol basin [3].

Sparganium stoloniferum (Graebn.) Buch. -Ham. ex Juz. is fairly common along the banks of the Ir and Balakoshkan channels, Lake Chakonit (13.06.2010), as well as the lakes Asaubay, Bogushnoye and Shabarkukan (21.06.2010). This is a larger perennial with a Mountain Siberian-Iranian range type, growing along the banks of rivers, lakes, and tributaries throughout Kazakhstan [3].

Family Juncaginaceae Rich.

Triglochin maritima L. was recorded on the shores of Lake Sorbulak (26.05.2013), as well as in the delta of the Ili River in meadow areas with *Phragmites australis* and *Bolboschoenus maritimus* (L.) Palla (19.06.2010). This is a cosmopolitan perennial with a rhizome. It occurs throughout Kazakhstan along lake and river banks, and in wet meadows with slightly saline soils [3].

Family Poaceae Barnhart

Aegilops tauschii Coss. was recorded in the grass layer of turanga sparse forests with *Populus pruinosa* Shrenk on the right bank of the Ili River, slightly below Tamgalytas (18.06.2020) and near the southern edge of the Malaysary pass (16.05.2015), in the altitude range of 428-437 m above sea level [41]. According to the "Flora of Kazakhstan" [3], the distribution range is limited to the adjacent lowlands (Chu-Ili mountains, Zailiyskiy Alatau), although N.N. Tsvelev [27] also included the Southern Balkhash region. This is an annual plant with a Dzhungar-Mediterranean habitat type. It is common in semi-deserts, on clayey crushed stone slopes, from the plains to the middle elevations.

Bromus japonicus Houtt. was recorded as one of the species used in the turanga reforestation (*Populus pruinosa, P. diversifolia* Schrenk) on the sandy slopes of the right bank of the Ili River (437 m, 13.06.2020 and 18.06.2020) [38]. This is an annual plant with a Palearctic range and a wide ecological-phylogenetic range; it often grows as a weed on pebbles and sandy soils throughout Kazakhstan.

Calamagrostis pseudophragmites (Haller f.) Koeler (*C. dubia* Bunge (*C. pseudophragmites* subsp. *dubia* (Bunge) Tzvelev) has been recorded in the tugai thickets of the middle course of the Ili River between Tamgalytas and Malaysary (18.06.2020). According to N.P. Ogar [42], this species is an edifier of communities with *Calamagrostis* spp. and *Elytrigia repens* Desv.; it grows along the banks of the channels of the Ili River delta. This is a perennial with a Palearctic distribution range. It grows in tugai forests, along river banks, sometimes on slightly saline soils, from plains to middle elevations almost throughout Central Asia, including the Balkhash-Alakol basin [3, 27].

Digitaria sanguinalis (L.) Scop. has been recorded only on the sandy banks of the Ili River, 5 km above the settlement Bakanas, in a tugai forest with the participation of *Salix songarica* Andersson, *Elaeagnus angustifolia* L., and *Berberis iliensis*. In Kazakhstan, it has been recorded in the desert regions of Mangyshlak, Muyunkum and Turkestan, and in the lowlands of Western Tien Shan and Zailiyskiy Alatau [3]. Later, N.N. Tsvelev [27] included the South Balkhash region as well. This is an annual plant with a large Palearctic distribution range; it grows on sandy soils, along the banks of rivers and aryks, often as weeds in fields and settlements.

Sclerochloa dura P. Beauv. was recorded in abundance in the flat areas of the turanga forests of the middle course of the Ili River, below the Tamgalytas gorge (18.06.2020). This is an annual plant with an ancient Mediterranean range type; it is mainly confined to weedy areas and is common near roads, in settlements, sometimes in crops, from plains to middle elevations, from the Northern Tien Shan to the Turkestan floristic region [3]. N.N. Tsvelev recorded the species in the Southern Balkhash region [27].

Family Juncaceae Juss.

Juncus articulatus L. was recorded in a tugai forest with the participation of turanga, *Salix songarica,* and *Elaeagnus angustifolia* in the middle part of the Ili River valley, 1-3 km below Tamgalytas (13.06.2020 and 18.06.2020). This is a perennial plant with a Holarctic range type; it grows on sandy shoals, along the banks of rivers and lakes, on plains, and in the mountains throughout Kazakhstan and Central Asia [8, 21].

Juncus compressus Jacq. was recorded together with the previous species in the same place. It is also quite common in the Ili River delta. R.P. Plisak [43] recorded this species in hygrophytic communities on the lake shore in the vicinity of the village Old Koktal and in the floodplain thickets of the Zhideli and Arystan channels. This is a perennial with a Holarctic range type; it grows in river valleys, tugai forests and on the lake shores of almost all flat and mountainous Kazakhstan, including the Pribalkhash plains [21].

Juncus inflexus L. (*J. brachytepalus* V.I.Krecz. & Gontsch.) was recorded in the turanga forests of the middle course of the Ili River (18.06.2020). This is a perennial plant with a Mountainous Middle Asian-Iranian range type growing along the banks of rivers and lakes, and along the streams and aryks of the south-eastern part of Kazakhstan, also in the Balkhash-Alakol depression [8].

Juncus gerardii Loisel. was recorded in thickets of *Elaeagnus angustifolia*, reed, and tamarix in the area of the Pritopar sands (09.06.2010), the channels of Baiminae and Zhideli, and the Kuigan tract (11.06.2010), as well as in the herb-and-reed thickets near the Naryn channel (23.06.2010). This is a common component of communities with *Phragmites australis* and *Calamagrostis epigeios* Steud. in the delta of the Ili River, in particular, in the floodplain of the Arystan channel to the southwest of the village of Karoi [43]. This is a perennial plant with a Palearctic range type growing on the banks of water bodies, in tugai forests, and on wetlands of the whole of Kazakhstan [8].

Family Liliaceae Juss.

Gagea bulbifera Salisb. was observed on clayey and sandy banks of the Ili River near the Kapchagay reservoir (02.04.2006, 15.04.2011, 09.04.2018), as well as in similar habitats downstream of the Ili River, up to Tamgalytas and the Malaysary pass [41]. This is a small bulbous perennial plant with a Pan-Kazakh range type. It grows on crushed stone and fine-ground loess slopes, on plains and in low mountains, in steppe and desert zones, including the Balkhash-Alakol basin, as well as in the low mountains of the Dzhungar Alatau and Northern Tien Shan [8, 18].

In Kazakhstan, the first records of *Gagea jensii* Levichev & Schnittler were made on 10-11.04.2019 in sandy deserts near the road between the village of Bakanas and Karoi (collected by V.A. Kovshar, identified by I.G. Levichev). This is a bulbous perennial plant. It was recently recorded in China, in the vicinity of Urumqi in Xinjiang (hills near a cemetery, 43°43′53″N, 87°35′46″E, 987 m; Yamalik Hill Forest Park, 43°47′26″N, 87°34′21″E, 1,027 m) [44].

Gagea olgae f. *dilatata* Levichev was found in two locations on the southern coast of Lake Balkhash, near the village of Ulken (335 m) and to the north-west of the same settlement (457 m) on 01.04.2015 and 22.04.2015 (collected by V.A. Kovshar, identified by I.G. Levichev). This taxon was described by I.G. Levichev in 1986 using collections of L.S. Krasovskaya from the clay slopes of the foothills of the Chatkal ridge (960 m) and was previously considered endemic to Western Tien Shan [45].

Tulipa kolpakowskiana Regel was recorded on the leveled terraces of the right bank of the Ili River valley, in the Tamgalytas gorge (09-10.04.2018, 13.04.2018), on both sides of the Kapchagai reservoir (21.04.1988, 24.04.1999, 15.04.2011), as well as in the Zhusandala desert, along the Konshengil highway, north-west of the Kurty river canyon (25.04.2018), and in a forest belt near Lake Sorbulak (19.05.2000). This is a bulbous perennial plant with a Dzhungaro-Tian Shan range type. It grows on clayey and less often, on finely crushed and sandy sections of foothill plains, foothills and lowlands, from the Alakol basin to the eastern Karatau. It is common in the southern part of the Pribalkhash plains and along the Ili River valley, up to the Malaysary pass, where it is sometimes found in sparse turanga forests with *Populus pruinosa* [41, 46]. An unfortunate mistake was made in the early work of L.P. Gvozdeva [47], where, in our opinion, the species was described as *Tulipa schrenkii* Regel the range of which does not even reach the Northern Balkhash region, passed to the subsequent reports of S.G. Nesterova and Z.A. Inelova [4], and N.T. Gemedzhieva et al. [36]. The species is listed in the Red Book of Kazakhstan [48].

Family Alliaceae J. Agardh

Allium subscabrum (Regel) R.M. Fritsch (*Allium tulipifolium* var. *subscabrum* Regel, *A. decipiens* Fisch.) was recorded in turanga forests in the middle course of the Ili River valley (16.05.2015, 10.04.2019) [41], as well as in ephemeroid communities in the vicinity of Kapchagai (13.04.2018, 24.04.2019), on sandy soils. This is a perennial, narrow-local endemic of the Ili River valley and adjacent deserts [49].

Allium trachyoscordum Vved. was recorded in abundance in crushed stone areas of deserts between the canyon of the Kurty and Konshengil rivers, as well as in the vicinity of the village Aksuek (25-26.04.2018). This is a perennial with a rhizome; it has a Tian Shan range type, the northern part of which stretches into the desert of Betpakdala. It grows on the outcrops of variegated rocks and on crushed stone slopes of low hills [8, 18].

Family Cyperaceae Juss.

Cyperus fuscus L. was recorded by R.P. Plisak [43] in the floodplain of the Zhideli channel. We found it on the right bank of the Ili River, just below Tamgalytas (11.09.2007). This is an annual plant with a Palearctic range type; it grows in wet meadows and on shoals of water bodies, including the Pribalkhash deserts [21].

Eleocharis acicularis (L.) Roem. & Schult. was described by R.P. Plisak [43] as growing on the shoals of the delta tributary of Arystan to the southwest of the village of Karoi. During the survey of the territory of the future Ile-Balkhash natural reserve, it was found in similar conditions along the floodplains of the Baiminay (11.06.2010) and Zhideli (19.06.2010) channels. This is a small perennial dense sod grass with a Holarctic range type; it grows along shoals, sand banks, and shallow waters of rivers, lakes, and river channels, and is common in the southern regions of Kazakhstan [21].

We recorded *Eleocharis argyrolepis* Kierulff in abundance in submerged depressions between the sandy ranges of channels in the vicinity of the village Koskumbez (21.06.2010). This is a larger perennial with an Eastern Ancient-Mediterranean range type; as it is the case with the previous species, it grows along wet and marshy meadows and along the banks of water bodies throughout Central Asia, including the Balkhash-Alakol basin [8].

Pycreus nilagiricus (Hochst. ex Steud.) Schischk. has been recorded in reed communities in the area of the modern delta of the Ili River, and on the right bank of the Zhideli channel [42]. This is a small annual with a cosmopolitan range type, growing on sandy-silt shoals, along the banks of water bodies, and on wet and swampy meadows of plains and foothills of southern Kazakhstan, including the Balkhash-Alakol basin [8, 21].

Scirpus kasachstanicus Dobrochot. is common in the lower reaches of the Topar River (Lake Berkutinoye), along the shores of the lakes near the Zhideli Channel and in the bays of Balkhash, Arkalyk and Moitan Kultuk. It was also found in the shallow waters of a channel in the middle course of the Ili River, between the Tamgalytas gorge and the Malaysary pass (11.09.2007, O.V. Belyalov). This is a large perennial with a rhizome described by K.V. Dobrokhotova using specimens collected on the territory of the modern delta of the Ili River, in the Semizkul strait. It was previously considered a narrow endemic of Kazakhstan, but was later found in the Amu-Darya Delta and Fergana Valley [21]. It is listed in the Red Book of Kazakhstan [48] as "under threat". It is recommended as a monitoring object.

Scirpus lacustris L. was recorded in abundance by R.P. Plisak [43] along the southern shore of Lake Balkhash [43]; we found it in lakes of the modern delta – Shuberkukan, Bogushnoye, Asaubay, Batpachnoye (21.06.2010) – along the banks of the channels Ir and Balakashkan (13.06.2010). This is a large perennial with a rhizome; it has a Holarctic range type, distributed almost throughout Kazakhstan, including the Balkhash-Alakol basin [8].

Family Araceae Juss.

During the survey of the territory of the future Ile-Balkhash natural reserve, *Acorus calamus* L. was found in the grass-and-herb community with *Elaeagnus angustifolia* in the Zhideli channel (349 m; 11.06.2010). This is a strong perennial with a rhizome. It has a Holarctic range type; in Kazakhstan, it is distributed only in the eastern part of the country, from the Irtysh to the Balkhash-Alakol basin. The westernmost distribution location was the Koktal River; it has never been recorded in the valley of the Ili River [8, 50].

Family Polygonaceae Juss.

Polygonum aviculare L. is common in places with burnt reeds and tugai forest. In similar conditions, it has been recorded at the dry bottom of Lake Balkhash (12.06.2010), and in the turanga forests (*Populus pruinosa*) in the middle course of the Ili River, in heavily trampled places (19.04.2016, 18.06.2020) [38, 41]. R.P. Plisak [43] noted its appearance in 1971 in the area of the modern delta of the Ili

River, along the banks of the Zhideli channel. This is an annual with a Holarctic range type, growing as weed throughout Kazakhstan and Central Asia [9, 18]. In the study area, the population numbers are unstable; the plant appears and disappears from year to year.

Polygonum hydropiper L. was recorded by R.P. Plisak [43] on the banks of the Zhideli channel [43]. We recorded the species in a tugai forest with *Elaeagnus angustifolia* on the banks of the Bayminay channel (11.06.2010) and in marsh communities on the banks of the Ili River, just below the Tamgalytas gorge (18.06.2020). This is a coastal-aquatic annual with a Holarctic range type; it grows along the banks of rivers, streams, and aryks, from the plains to the middle elevations of all Kazakhstan [9, 18].

Polygonum persicaria L. was recorded by R.P. Plisak [43] in the floodplain of the Zhideli channel (modern delta of the Ili River). This is a cosmopolitan annual; it grows in conditions similar to those of the previous species, i.e. on the banks of water bodies and in humid places, sometimes as weed [9, 18].

Family Chenopodiaceae Vent.

Chenopodium rubrum L. was found in flooded depressions of the Ili River delta, near the Koktal gorge (19.06.2010), as well as along the shores of Lake Sorbulak (26.05.2013) and the Ili River, just below the Tamgalytas gorge (18.06.2020). This is an annual with a Holarctic range type, growing on brackish soils along river valleys and water bodies, sometimes as weeds, almost throughout Kazakhstan. In particular, it has been recorded in the Balkhash-Alakol depression [9, 19]. R.P. Plisak [43] recorded this species in the reed beds of Ahmedsu bay.

Halimione verrucifera (M.Bieb.) Aellen was recorded only in the basin of Lake Alakol, in the south-western part of the Balkhash region between the villages of Aksuek and Burabaytal (26.04.2018). This is a semi-shrub with a South Palearctic range type, growing on brackish meadows and salt marshes of desert and steppe plains of Kazakhstan [9, 19].

Kalidium schrenkianum Bunge ex Ung.-Sternb. was recorded in halophytic communities with the predominance of *Suaeda physophora* Pall. and *Halostachys belangeriana* (Moq.) Botsch., on the coastal plains of Lake Balkhash (21.06.2010). This is a dwarf shrub with a Turano - Mountainous Central Asian range type, previously considered endemic to Kazakhstan [9], but was later found in Kyrgyzstan and Tajikistan [19]. It grows along the salt lakes shores in the eastern part of Kazakhstan, from Turgay and the Balkhash-Alakol depression [9].

Family Nymphaceae D.C.

Nymphaea candida J.Presl & C.Presl was recorded in two delta lakes, Chakonite and Asaubai (13.06.2010 and 21.06.2010). This is a relic of aquatic flora growing in lakes, river deltas, and bays almost throughout Kazakhstan, except for mountains [10, 19].

Family Ranunculaceae Juss.

Anemone gortschakowii Kar. & Kir. was found only on crushed stone sections of the right bank of the Kapchagay reservoir (13.04.2008, 02.05.2011). This is a perennial with a Dzhungaro-Pamiro-Alai range type, inhabiting crushed stone slopes of the low mountains of Tien Shan and Dzhungar Alatau [10, 19].

Batrachium divaricatum Wimm. was recorded by R.P. Plisak [43] on shoals and in the delta channels of Zhideli and Arystan. This is an aquatic perennial with a Holarctic range type, dwelling in freshwater lakes, rivers, and channels on the plains and in the Tien Shan mountains [19].

Family Brassicacieae Burnett

Camelina microcarpa Andrz. ex DC. has been repeatedly recorded in sparse turanga forests on the right bank of the Ili River, from the gorge Tamgalytas to the Malaysary pass (16.05.2015; 11.06.2019; 18.06.2020), as well as in herbal desert communities with a predominance of *Ceratocarpus arenarius* L.

between the settlements of Konshengil and Aksuek (26.04.2018). Everywhere, it has been found in small numbers. This is an annual with a Palearctic range type, growing on loess and sandy hills, near roads and in the fields of plains and foothills of almost all Kazakhstan [10].

Erophila verna (L.) DC. was noted only in the Ili River valley, just below the Tamgalytas gorge, by the road, in a plant community with the participation of *Tulipa kolpakowskiana* (09.04.2018). This is a small early blooming annual with a Euro-Siberian - Ancient Mediterranean range type, growing on the fine ground and crushed stone hill slopes, and in sandy places near roads, from plains to the middle elevations. In Kazakhstan, it occurs from the Caspian and Aral deserts to the foothills of the Western and Northern Tien Shan [20].

Brassica elongate Ehrh. (*Erucastrum armoracioides* Litv.) was recorded in small numbers by the road in the vicinity of Lake Sorbulak and north-west of the Kurta Canyon (19.05.2000), as well as near the water edge on the right bank of the Kapchagai reservoir (28.06.2013, V.G. Epictetov). This is a perennial, less often a biennial with a Palearctic range type, growing near roads, in fields, sometimes in wormwood meadows almost throughout Kazakhstan, including the Balkhash-Alakol basin [10, 20].

Family Resedacieae DC.

Reseda lutea L. was growing as a small group of a dozen flowering individuals in the southern part of Prikaskelen Moyinkums (26.05.2013). This is a perennial with a Holarctic range type, previously known only from Western Kazakhstan and several locations in the Western Tien Shan [10, 20]. In the late twentieth and early twenty-first centuries, it was spreading within the boundaries of Kazakhstan, Uzbekistan and Kyrgyzstan [45, 51-52].

Family Crassulaceae DC.

Rosularia turkestanica A.Berger was found only in the rocky areas of the left bank of the Kapchagai reservoir in the area of the hydroelectric plant (15.04.2005). This is a perennial with the Dzhungaro-Pamiro-Alai distribution type, growing on crushed stone and rocky slopes at middle elevations in the southeast and south of Kazakhstan. It was previously considered endemic to this region [10], but subsequently found in the neighboring countries of Central Asia [20].

Family Grossulariaceae DC.

Ribes saxatile Pall. has been found so far only in one location, on a rocky slope of the right bank of the Ili River, in the Tamgalytas gorge (05.04.2006, 09.04.2018, 26.04.2019). This is a shrub with an Altai-Central-Kazakhstan-Tian Shan distribution type; according to one report [20], it also grows in the Pribalkhash deserts.

Family Rosaceae Juss.

Potentilla virgata Lehm. (*P. dealbata* Bunge) was found in tugai forests with *Hippophae rhamnoides* L. on the right bank of the Ili River, near Bakanas (11.06.1991), as well as in turanga groves above the Tamgalytas gorge (18.06.2020). This is a perennial with a Mountainous Siberian-Mountainous Middle Asian range type, growing along the banks of water bodies, and on wet, sometimes brackish meadows of almost all Kazakhstan [21].

Family Fabaceae Lindl.

Medicago lupulina L. was found in the delta of the Ili River on the right bank of the Zhideli channel, northwest of the settlement Novyj Koktal [42], as well as in the Koskumbez area (20.06.2010) and in the middle of the Ili River valley [38]. This is an annual or biennial with a Palearctic range type, found in meadows, river valleys, and sometimes on deposits throughout Kazakhstan and Central Asia [11, 22].

Medicago trautvetterii Sumnev. was found on the right bank of the Kaskelen River, a few kilometres to the north of the Kapchagai highway (26.05.2013). Information about this finding was published earlier [52]. This is a perennial grass endemic to Kazakhstan, growing in wet basins, solonchak and dry meadows of the Central Kazakhstan shallow hill and desert zone, including the Moiynkums, Zaysan, and Balkhash-Alakol basins [11]. According to later reports [22], the species also grows in Dzhungar Alatau and Tarbagatay, and according to Yu.A. Kotukhov [53], in Western Altai and the Kalbinskiy ridge.

Oxytropis puberula Boriss. is common in the modern Ili delta; it has been found in meadows with *Calamagrostis epigeios*, *Elytrigia repens* and *Phragmites australis* northwest of the settlement of Novyj Koktal [42], on shoals in the vicinity of the village Karoi and along the banks of the Arystan channel [43]. We found the species in reed beds of flooded inter-ridge depressions near Koskumbez and the Kokzhide channel (18.06.2010). This is a perennial with a Turanian-Mountainous-Middle Asian range type growing along riverbanks and in floodplain meadows of the desert zone [23].

Family Apiaceae Lindl.

Cuminum setifolium Koso-Pol. (*Psammogeton setifolius* Boiss.) was found in sandy areas in the outskirts of a turanga grove with *Populus pruinosa* on the right bank of the Ili River (428 m), near the Malaysary pass (16.05.2015). This is an annual with a Turanian-Mountainous-Middle Asian range type growing in sandy deserts and semi-deserts, from the Aral Sea to the Balkhash-Alakol depression [12, 23].

Hymenolyma bupleuroides (Schrenk ex Fisch. & C.A.Mey.) Korovin was found in abundance in the wormwood-emeretum communities in the Zhusandala desert, between the villages of Konshengil and Aksuek (25.04.2018). This is a monocarpic plant with a Mountainous Central Asian-Central Kazakh range type growing on sandy and crushed stone plains and lowlands; it has been recorded in the Ile-Balkhash region by floristic reports [12, 23].

Turgenia latifolia Hoffm. has been repeatedly recorded as a weed growing on the roadsides: on the left bank of the Kapchagai reservoir in a plant community with *Tulipa kolpakowskiana* (21.04.1988), near Lake Sorbulak (26.05.2013), and in the vicinity of the village of Konshengil (20.05.2000). It is an annual, mainly weedy plant with a Dzhungaro-Mediterranean range type; it often grows in fields and on deposits, on crushed stone and loess soils, and sometimes on fixed sands, from plains to the middle elevations. It has been recorded in the Balkhash-Alakol floristic region [12], although, in a later report [23], only the Zaysan basin and Moyynkums were indicated as the desert distribution range.

Family Primulaceae Vent.

Androsace maxima L. (*Androsace turczaninowii* Freyn) has been described as a common species in crushed stone and sandy areas of the Ili River valley on both banks of the Kapchagai reservoir (15.04.2005, 09.04.2018), in turanga forests between the Tamgalytas gorge and the Malaysary pass (11.06.2019), and on the plateau above the right side of the valley of this area (05.04.2018). This is an early-flowering annual with a Eurasian range type, dwelling on loess hills, pebbles, and crushed stone slopes, from the plains to the upper belt of mountains; it has not been found in the Balkhash-Alakol basin [13]. In later reports, the Pribalkhash deserts were included in the distribution range of this species [24].

Lysimachia vulgaris L. has been found only once along the shores of Lake Asylbay, near the settlement of Karoi (16.08.2005, L.E. Ishkov). This is a perennial with a South Palearctic range type growing along the banks of rivers and lakes, and on floodplain meadows throughout Kazakhstan, except for mountains [13, 24].

Family Menyanthaceae Dumort.

Nymphoides peltata (S.G. Gmel.) Kuntze: in 2010, during the survey of the territory of the future Ile-

Balkhash natural reserve, quite large populations were found in six freshwater lakes of the modern delta of the Ili River – Batpachnoye, Bogushnoye, Shubarkutan, Chakonit-1, Chakonit-2, and Asaubay (13.06.2010, 21.06.2010). This is an aquatic perennial with a rhizome. It has a Palearctic range type and grows in lakes, ponds, and river channels, mainly on the plains, almost throughout Kazakhstan; it has been recorded by the majority of reports in the Balkhash-Alakol basin [13, 24]. Interestingly, V.A. Kostin [54] did not find it in the delta of the Ili River from 1968-1979. The species is listed in the Red Book of Kazakhstan [48]. It is recommended as a monitoring object.

Family Convolvulaceae Juss.

Convolvulus pseudocantabrica Schrenk has been found on sandy sections of the right bank of the Kapchagai reservoir (10.07.1986, 16.05.1995) and in deserts near the settlement of Konshegil (20.05.2000). This is a perennial with a Mountainous Central Asian range type growing on clay slopes and sandstone outcrops from the plains to the upper mountain belts throughout Central Asia [24].

Family Cuscutaceae Dumort.

Cuscuta lehmanniana Bunge was recorded in tugai thickets on the right bank of the Ili River, just above the Tamgalytas gorge (13.06.2020); it was also mentioned in the summary of economically important plants of the Balhash region [36]. This is an annual with a Turanian range type parasitizing on tree and shrub species, and on large grasses in tugai forests, and often in orchards of the whole of South Kazakhstan [13, 24].

Family Boraginaceae Juss.

Heterocaryum rigidum A.DC. has been found in thinned turanga thickets (*Populus pruinosa*) near the Malaysary pass (16.05.2015, 13.04.2016) and in the wormwood-ephemeroid deserts with *Krascheninnikovia ceratoides* (L.) Gueldenst. between the Kurti River canyon and the Konshengil gorge (25.04.2018). This is an annual with a Turanian-Iranian range type, growing on sandy and crushed stone slopes, from the plains to the middle elevations in a large area of Kazakhstan and throughout Central Asia [13, 24].

Lithospermum arvense L. *(Rhytispermum arvense* L.) Rchb.f.) was found in the wormwood-ephemeroid deserts between the canyon of the Kurta River and the Konshengil gorge (25.04.2018). This is an annual with a Palearctic range type growing in river valleys and on sandy, loess and crushed stone soils, from the plains to the middle elevations throughout Central Asia [13, 24].

Lithospermum tenuiflorum L. (Link.) (Rhytispermum *tenuiflorum (*Moris) Rchb.f.) was found on the crushed-stone slopes of the right bank of the Kapchagai reservoir (15.04.2005). This is an annual growth in river valleys, on rocky and crushed stone slopes of foothills, and sometimes as a weed on arable land and deposits. It occurs mainly in the foothills and low mountains of the Dzhungar Alatau and Tien Shan. It has not been found in the Balkhash-Alakol basin [13, 24].

Lycopsis orientalis L. has been found on the right bank of the Ili River in ephemeroid communities with the participation of *Tulipa kolpakowskiana* near the Tamgalytas gorge (13.04.2018), as well as in turanga forests downstream of the river (13.04.2016, 11.06.2019). This is an annual with a Dzhungaro-Mediterranean range type, found on fine-earth and crushed stone slopes, along roads, and often as a weed on arable land and deposits of the southern part of the desert and mountainous Kazakhstan [13].

Myosotis caespitosa Schultz was found by R.P. Plisak [43] on the shore of the Kapchagai reservoir, 2-3 km from the water line, in wormwood grasslands with the participation of *Alhagi pseudalhagi* Desv. This is a perennial with a Palearctic range type confined to wetlands and swampy places along the banks of water bodies, tugai forests, and springs. It is found almost throughout Kazakhstan, including the Balkhash-Alakol depression and the Pribalkhash deserts [13, 24].

Myosotis micrantha Pall. ex Lehm. was found in abundance on the crushed stone slope of the right bank of the Ili River in the Tamgalytas gorge (13.04.2018). This is an annual with a Palearctic range type growing on crashed stone slopes among shrubs, and on pebbles and sandy-silt sediments in the river valleys of Northern, Central and Southern Kazakhstan [24].

Rochelia cardiosepala Bunge was found on the rocky and crushed stone slopes of the left bank of the lower part of the Kapchagai reservoir (15.04.2005). This is an annual with a Mountainous Central Asian-Iranian range type growing on dry river beds, on slopes, and often as weed in the fields and on deposits of southern Kazakhstan, from the plains to the middle elevations; it has been recorded in the Pribalkhash deserts and the Ili River valley [24].

Rochelia retorta (Pall.) Lipsky has been found in sparse forests with *Populus pruinosa* on the right bank of the Ili River, under the Malaysary pass [41]. This is annual with the Mountainous Central Asian range type, a common inhabitant of loess and sandy loam deserts, and crushed stone slopes of foothills. It is more widespread than the previous species and can be found from the Caspian Sea to the entire chain of mountain ranges from Tarbagatay to Western Tien Shan [13].

Family Lamiaceae Lindl.

Lamium amplexicaule L. was found on fine gravel slopes on both shores of the Kapchagai reservoir (21.04.2007, 23.04.2011). This is an early-flowering annual with a Holarctic range type growing on rocky and crushed stone slopes, often as weed near roads, and on deposits from the plains and foothills to the middle elevations. It occurs sporadically almost throughout Kazakhstan [25].

Lycopus exaltatus L.f. occurs along the Ili River banks and in tugai forests of the middle part of the valley below the Tamgalytas gorge (13.06.2020 and 18.06.2020). This is a perennial with a Palearctic range type growing in tugai thickets, along the banks of rivers and lakes from the plains to the middle elevations of almost all of Kazakhstan [13, 25].

Mentha asiatica Boriss. was found in the coastal turanga thickets (*Populus pruinosa, P. diversifolia*) just below the Tamgalytas gorge (18.06.2020). In previous years, N.P. Ogar [42] found this species in ravine meadows along the banks of the channels of the modern delta of the Ili River. This is a perennial with an Altai-Iranian range type growing along the banks of streams and aryks, in the river valleys from the plains to the middle elevations. It is found throughout Central Asia, including the mountains of southern Kazakhstan, but has not been recorded in the Balkhash-Alakol basin and the Ili River valley [13, 25].

Nepeta cataria L. was repeatedly found at only one point, on the crushed-stone slope of the right bank of the Ili River, in the thickets of the Tamgalytas gorge (09.06.2018, 26.04.2019). This is a perennial with a Palearctic range type growing in shrublands, on stony slopes, often as weed, and occurring sporadically throughout Kazakhstan [25].

Paraeremostachys dshungarica (Popov) Adylov, Kamelin & Makhm. (*Eremostachys dshungarica* (Popov) Golosk.) was found in two locations in the southwestern part of the region: in the Akdala gorge (06.05.2005) and in the Konshengil gorge (20.05.2000). This is a perennial with a Dzhungaro-Eastern Tian Shan range type, growing along the foothills and on plains with sandy and crushed stone soils; it has been recorded in the Balkhash-Alakol basin and the Pribalkhash deserts [13, 25].

Phlomoides gymnocalyx (Schrenk) Adylov, Kamelin & Makhm. (*Eremostachys gymnocalyx* Schrenk) has been recorded in plant communities with artemisia (*Artemisia terrae-albae* Krasch., *Artemisia turanica* Krasch.) and ephemeroids (*Poa bulbosa* L., *Tulipa* buhseana Boiss.) in the Taucuma desert (25.06.2018) and in the vicinity of the village of Aydarly (27.05.1998), as well as in plant communities with the participation of *Carex physodes* M.Bieb. in one case and *Salsola orientalis* S.G.Gmel., *Salsola arbusculiformis* Drobow, *Nanophyton erinaceum* Bunge in the other case. This is a perennial with a Dzhungaro-North Tian Shan range type endemic to Kazakhstan. It grows on the sandy soils of the plains and foothills of the Balkhash-Alakol depression, the Chu-Ili mountains, and the western part of the Dzhungar Alatau [13, 25].

Salvia aethiopis L. has been repeatedly recorded near the roads in the vicinity of the Kapchagai reservoir (11.07.1986, 24.06.1987, 30.05.2016, 13.06.2020), on the Arkharly pass (13.06.1993), on roadsides between the village of Saryozek and the Altyn-Emel Pass (02.06.2002), on the Altyn-Emel Pass (06.06.2016), and in the Kaskelen (01.05.2015, 10.06.2016). The species has been spreading in recent decades. In some cases, numerous populations of the species were found on the desert plains, occupying an area of more than 1 km^2, for example, near the highway leading to Bakanas, in the vicinity of Kerbulak (13.06.2020); whereas in the inland part of the valley of the Ili River, only single individuals were found (18.06.2020). In June 2021, extensive thickets of the species were registered by us in the village of Saryozek, where we didn't find it a few years ago. This is a perennial with a Dzhungaro-Mediterranean range type. In the "Flora of Kazakhstan" [13], it was mentioned as growing in Karatau and the Chu-Ili mountains, and later, in the Kyrgyz Alatau [25], although a little earlier V.P. Goloskokov [28] had already described it as part of the flora of the Dzhungar Alatau.

Salvia deserta Schangin has been repeatedly noted near the road in the vicinity of the Kapchagai reservoir and the area of Kerbulak along the highway to Bakanas (24.06.1987, 13.06.2020), as well as in dry meadow-steppe sections in the Ili River valley. In addition, the species was found in the floodplain of the middle part of the Ili River valley in dry steppe areas, in the sparse forests of *Elaeagnus angustifolia* (02.06.2019). This is a perennial with a Pan-Kazakh range type growing in dry meadows and in steppes, on mountain slopes, and in river valleys, often as a weed near roads, housing, and sometimes in crops. It is distributed almost throughout Kazakhstan [13, 25].

Family Solanaceae Juss.

Hyoscyamus niger L. occurs sporadically, most often as single individuals throughout the Ili River valley to the modern delta [38]. It was also recorded by N.G. Gemedzhieva et al. [36]. This is a weedy annual with a Palearctic range type, growing near roads, housing, on deposits, and on arable land throughout Kazakhstan. Its distribution and abundance, as it is also the case with some other annual weeds, are not stable.

Family Scrophulariaceae Juss.

Verbascum songoricum Schrenk has been repeatedly recorded near roads in the Kapchagai reservoir and along the Bakanas highway, up to the Malaysary pass (24.06.1987; 30.04.2009; 13.06.2020), as well as in the area of Lake Sorbulak (26.05.2013). This is a biennial with a Mountainous Central Asian-Iranian range type growing in river valleys, at the roadsides, and on deposits and slopes from the plains to the upper belt of mountains. The species is widely distributed almost throughout Kazakhstan but has not been recorded in the Balkhash-Alakol basin [14, 25].

Family Orobanchaceae Vent.

Cistanche ambigua Beck was found in saxaul thickets near the southeastern bay of Lake Balkhash (26.04.2018). This is a perennial with a Mongolian-Turkish-Iranian range type growing on sands, along the channels of dried rivers of the Southern part of the desert zone of Kazakhstan, including the Balkhash region [14, 26].

Orobanche cernua Loefl. was found in the wormwood deserts near the village Konshengil (08.05.2005). This is a perennial with a Mountainous-Mediterranean range type growing on sands, in tugai forests, and on crushed-stone slopes from the plains to the middle ranges of southern Kazakhstan, including the Pribalkhash deserts [14, 26].

Family Valerianaceae Batsch.

Valeriana chionophila Popov & Kult. was found on rocky slopes of the left bank of the Kapchagay reservoir in the hydroelectric plant (15.04.2005, 09.04.2018). This is a tuberous perennial with a Tian Shan-Pamiro-Alai range type growing in crushed stone areas of flat deserts and mountain slopes; it has

been found also in the Ili River valley [26]. The species is listed in the Red Book of Kazakhstan [48]. It is proposed as a monitoring object.

Valerianella plagiostephana Fisch. & C.A.Mey. was found in the wormwood deserts to the southeast of the settlement Konshengil (25.04.2018) and in the vicinity of the village Aksuek (26.04.2018). This is an annual with a Mountainous Central Asian-Iranian range type growing on clay and crushed stone soils of plains and mountains of southern Kazakhstan [14, 26].

Valerianella szovitsiana Fisch. & C.A.Mey. was found on rocky slopes of the left bank of the Kapchagai reservoir (30.04.2009). This is an annual with a Dzhungaro-Mediterranean range type growing in conditions like that of the previous species, including in the Balkhash region [26].

Family Asteraceae Dumort.

Bidens tripartita L. was found in the delta part of the Ili River valley in the vicinity of the village Koktal (19.06.2010), as well as in reed beds and inland communities of the Zhideli and Arystan channels [42-43]. It occurs sporadically, and its presence, as is the case with some other annuals, is not stable – in some years it appears and then disappears. For this reason, this species is not on the floristic list of one of the major economically important plant surveys accomplished in the region studied [36]. This is a cosmopolitan annual growing along the banks of rivers, lakes and springs, on marshes, and sometimes as a weed on irrigated lands throughout Kazakhstan and Central Asia [14, 26].

Brachyactis ciliata Ledeb. R.P. Plisak [43] described the plant as a part of reed (*Phragmites australis)* and mixed-grass communities along the banks of the Ili River and in flooded depressions in the modern delta. This is an annual with a Mountainous Siberian-Mountainous-Middle Asian habitat type, growing on wet, slightly saline soils of near-water habitats of the entire Kazakhstan [14].

Cephalorrhynchus soongoricus (Regel) Kovalevsk. was found on a rocky and crushed stone slope of the right bank of the Ili River in the Tamgalytas gorge (26.04.2019). This is a perennial with a Dzhungaro-Pamiro-Alai range type growing among shrubs on the mountain slopes of southern and southeastern Kazakhstan; it was also found in the Balkhash-Alakol basin [15, 26].

Erigeron nigrimontanus Popov (*Psychrogeton nigromontanus* (Boiss. & Buhse) Grierson) was found by R.P. Plisak and N.P. Ogar [42-43] in wet meadows of the modern delta of the Ili River. This is a biennial with a Turanian-Iranian range type growing in meadows, near springs, and often as a weed in the fields throughout the south of Kazakhstan, except for high mountains [14, 26].

Lachnophyllum gossypinum Bunge occurs scattered in the middle of the Ili River valley. It was found by us as part of sedge-grass deserts with the participation of *Salvia aethiopis* near the Kapchagai-Kerbulak highway (13.06.2020). This is an annual with a Mountainous Middle Asian Iranian range growing on clayey and crushed stone soils of desert plains and foothills of southern Kazakhstan; it has not been recorded in the Balkhash-Alakol basin and the Pribalkhash deserts [14, 26].

Lactuca serriola L. (*Lactuca scariola* L.) was found in turanga forests of the middle course of the Ili River (18.06.2020). The species is quite common in wormwood meadows of the modern delta of the Ili River [42], as well as in the reed beds with *Alhagi kirghisorum* and *Kraschenninnikovia ceratoides*, and in burnt tugai forests with *Elaeagnus angustifolia* in the Zhideli Channel and the Kokzhide gorge (17.06.2010). This is an annual, less often a biannual with a Holarctic range type growing on coastal pebbles, dry slopes, among shrubs, often as weed on deposits, fields and near roads. It is found throughout Kazakhstan and Central Asia [15, 26].

Lactuca undulata Ledeb. was found in desert communities on the right bank of the Kapchagai reservoir near the exit to the Kapchagai-Bakanas highway (17.06.1986). This is a smaller annual with a Dzhungaro-Iranian range type found on sandy and clay soils, inland pebbles, and sometimes on crashed stone slopes of plains and mountains throughout Kazakhstan and Central Asia [15, 26].

Pseudohandelia umbellifera (Boiss.) Tzvelev was found growing sporadically on the plains in the vicinity of Lake Sorbulak (19.05.2000, 26.05.2013, O.V. Belyalov), in desert communities on the edge of

turanga forests on the right bank of the Ili River under the Malaysary pass (16.05.2015), and near the highway north of the Kerbulak gorge (15.05.1995). This is a biennial, rarely a perennial with a Dzhungaro-Iranian range type growing on sands, loess, and crushed stone slopes of hills of flat deserts of southern Kazakhstan and along the foothills of mountains, from Dzhungar Alatau to Western Tien Shan [15].

Pulicaria vulgaris Gaertn. (*Pulicaria prostrata* Asch.) was found along the bank of a channel in the middle course of the Ili River, below the Tamgalytas gorge (11.09.1987). This is an annual with a Palearctic range type growing in wet meadows, near water bodies, and sometimes as weed near roads and in crops. It is found almost throughout Kazakhstan and Central Asia, except in the mountains. The species has been found also in the Pribalkhash deserts [14, 26].

Steptorhamphus crassicaulis (Trautv.) Kirp. was found on the crushed stone slopes of the left bank of the Kapchagai reservoir near the hydroelectric plant (30.04.2009). In similar habitats, it was recorded along the right bank of the reservoir, 10-15 km upstream [40]. This is a perennial with the Dzhungaro-Pamiro-Alai range type growing on dry crushed stone slopes, sometimes in the rock cracks, in the lower and middle mountain belts of the south and southeast of Kazakhstan [15, 26].

Conclusion

Over the years of research in the Ile-Balkhash region, and taking into account the analysis of available scientific publications, the authors additionally identified 86 plant species from 69 genera and 31 families not listed in the last generalized summary by S.G. Nesterova and Z.A. Inelova [4]. Of those, cryptogams were represented by one species; monocotyledons, by 24 species from 16 genera and 8 families; and dicotyledons, by 60 species from 52 genera and 22 families. By the vegetation type, the species were distributed as follows: tugai, including turanga forests, 20 species; grassy marshes and aquatic ecosystems, 9 species; meadows, 17 species; plain deserts, 18 species; foothill deserts of the petrophytic type, 21 species. Four species were rare and listed in the Red Book of Kazakhstan, and one species (*Gagea jensii* Levichev & Schnittler) described in China was first discovered in Kazakhstan.

Due to the unstable ecological situation in the region which affects, among other things, the species composition of plant communities, we propose to include the following vegetation types in the floristic monitoring system:

turanga forests;

tugai forests with *Hippophae rhamnoides, Berberis iliensis*, *Lonicera iliensis* in the Bakanas area;

grass marshes and aquatic areas with *Nymphoides peltata* and *Nymphaea candida*, in particular in the area of the modern delta.

We recommend conducting monitoring studies in these types of vegetation at least once every 10 years.

New species discoveries indicate that there is great potential for previously undiscovered plants in the region, which is of great scientific and practical interest.

Funding. This study was funded by the Ministry of Ecology, Geology, and Natural Resources of the Republic of Kazakhstan (BR10263776).

Acknowledgements. The authors are grateful to I.G. Levichev for determining the species of the genus *Gagea*, to O.V. Belyalov, V.A. Kovshar, B.M. Sultanova, V.G. Epictetov, for taking part in expeditions, as well as to M.E. Abidkulov and V.Y. Ishkov, for fascilitating field visits.

Список литературы

1. Липка О.Н., Мазманянц Г.М., Исупова М.В., Алейников А.А., Замолодчиков Д.Г., Каганов В.В. Подходы к разработке крупномасштабных проектов по адаптации к изменениям климата на основе экосистем в дельте р. Или (Казахстан) // Проблемы экологического мониторинга и моделирования экосистем. – 2020. – Т. 32. – № 3-4. – С. 88-119.

2. Королева Е.Г., Дикарева Т.В., Дикарев В.А. Оценка природно-обусловленных опасностей в природном резервате «Иле-Балхаш» (Казахстан) // Аридные экосистемы. – 2019. – Т. 25. – № 4(81). – С. 61-70.

3. Флора Казахстана. Т. 1. – Алма-Ата: АН КазССР, 1956. – 354 с.

4. Нестерова С.Г., Инелова З.А. Флора пустынь Иле-Балхашского региона. – Алматы: Қазақ университеті, 2012. – 190 с.

5. Thevs N. Forest Landscape Restoration in the Caucasus and Central Asia. Background study for the Ministerial Roundtable on Forest Landscape Restoration in the Caucasus and Central Asia. – Astana, 2018. 1-65 p.

6. Zeng Y., Zhao C., Kundzewicz Z.W., Lv G. Distribution pattern of Tugai forests species diversity and their relationship to environmental factors in an arid area of China // PLoS ONE. – 2020. – V. 15. – N. 5. – e0232907.

7. IPNI. 2021. International Plant Names Index. Published on the Internet http://www.ipni.org, The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Botanic Gardens. [Retrieved 01 October 2021].

8. Флора Казахстана. Т. 2. – Алма-Ата: АН КазССР, 1958. – 305 с.

9. Флора Казахстана. Т. 3. – Алма-Ата: АН КазССР, 1960. – 477 с.

10. Флора Казахстана. Т. 4. – Алма-Ата: АН КазССР, 1961. – 548 с.

11. Флора Казахстана. Т. 5. – Алма-Ата: АН КазССР, 1961. – 516 с.

12. Флора Казахстана. Т. 6. – Алма-Ата: АН КазССР, 1963. – 466 с.

13. Флора Казахстана. Т. 7. – Алма-Ата: АН КазССР, 1964. – 515 с.

14. Флора Казахстана. Т. 8. – Алма-Ата: АН КазССР, 1965. – 466 с.

15. Флора Казахстана. Т. 9. – Алма-Ата: АН КазССР, 1966. – 651 с.

16. Абдулина С.А. Сосудистые растения Казахстана. – Алматы: Стека, 1998. – 188 с.

17. Определитель растений Средней Азии. Критический конспект флоры. Т. 1. – Ташкент: Фан, 1968. – 229 с.

18. Определитель растений Средней Азии. Критический конспект флоры. Т. 2. – Ташкент: Фан, 1971. – 364 с.

19. Определитель растений Средней Азии. Критический конспект флоры. Т. 3. – Ташкент: Фан, 1972. – 268 с.

20. Определитель растений Средней Азии. Критический конспект флоры. Т. 4. – Ташкент: Фан, 1974. – 275 с.

21. Определитель растений Средней Азии. Критический конспект флоры. Т. 5. – Ташкент: Фан, 1976. – 276 с.

22. Определитель растений Средней Азии. Критический конспект флоры. Т. 6. – Ташкент: Фан, 1981. – 397 с.

23. Определитель растений Средней Азии. Критический конспект флоры. Т. 7. – Ташкент: Фан, 1983. – 416 с.

24. Определитель растений Средней Азии. Критический конспект флоры. Т. 8. - Ташкент: Фан, 1986. – 192 с.

25. Определитель растений Средней Азии. Критический конспект флоры. Т. 9. – Ташкент: Фан, 1987. – 402 с.

26. Определитель растений Средней Азии. Критический конспект флоры. Т. 10. – Ташкент: Фан, 1993. – 692 с.

27. Цвелев Н.Н. Злаки СССР. – Москва: Наука, 1976. – 788 с.

28. Голоскоков В.П. Флора Джунгарского Алатау. – Алма-Ата: Наука, 1984. – 222 с.

29. Rachkovskaya E.I., Volkova E.A., Khramtsov V.N. (eds.) Botanical Geography of Kazakhstan and Middle Asia (Desert Region). – St. Petersburg: Komarov Botanical Institute, 2003. – 424 p.

30. Курочкина Л.Я. Растительность песчаных пустынь Казахстана // Растительный покров Казахстана. Т. 1. – Алма-Ата: АН КазССР, 1966. – 191-582 с.

31. Кубанская З.В. Солянковые пустыни Казахстана. – Алма-Ата: Наука, 1980. – 206 с.

32. Плисак Р.П. Смена растительности современной реки Или в связи с изменением гидрологического режима // Структура и продуктивность растительности пустынной зоны Казахстана. – Алма-Ата: АН КазССР, 1978. – 109-122 с.

33. Levichev I.G. The synopsis of the genus Gagea (Liliaceae) from the Western Tien-Shan // Botanicheskii Zhurnal. – 1990. – V. 75. – N. 2. – P. 225-234.

34. Peterson A., Harpke D., Levichev I.G., Beisenova S., Schnittler M., Peterson J. Morphological and molecular investigations of Gagea (Liliaceae) in southeastern Kazakhstan with special reference to putative altitudinal hybrid zones // Plant Systematics and Evolution. – 2016. – V. 302. – N. 8. – P. 985-1007.

35. Christenhusz M.J.M., Govaerts R., David J.C., Hall T., Borland K., Roberts P.S., Tuomisto A., Buerki S., Chase M.W., Fay M.F. Tiptoe through the tulips - cultural history, molecular phylogenetics and classification of *Tulipa* (Liliaceae) // Botanical Journal of the Linnean Society. – 2013. – V. 172. – N. 3. – P. 280-328.

36. Гемеджиева Н.Г., Грудзинская Л.М., Каржаубекова Ж.Ж., Курбатова Н.В. Ресурсная характеристика хозяйственно-ценных растений Прибалхашья (цистанхе, ревень гармала, солодка): монография. Труды института ботаники и фитоинтродукции. Т. 23 (9). – Алматы: Институт ботаники и фитоинтродукции, 2017. – 224 с.

37. Иващенко А.А., Султанова Б.М. Анализ флоры проектируемого Иле-Балхашского природного резервата // Материалы Международной научно-практической конференции «Актуальные проблемы геоботаники», посвященной памяти выдающегося ученого, основоположника казахстанской ботанической школы, академика НАН РК, д.б.н. Б. А. Быкова в связи с 100-летием со дня рождения. – Алматы, Институт ботаники и фитоинтродукции, 2011. – 349 с.

38. Бегенов А.Б., Аметов А.А., Есжанов Б.Е., Абидкулова К.Т., Сатыбалдиева Г.К., Тыныбеков Б.М., Баймурзаев Н.Б., Чилдибаева А.Ж. Методическое руководство по проведению учебной практике по ботанике – Алматы: Қазақ университеті, 2015. – 78 с.

39. Султанова Б.М., Рачковская Е.И., Иващенко А.А., Березовиков Н.Н., Евстифеев Ю.Г., Грюнберг В.В., Малахов Д.В., Кертешев Т.С., Белгубаева А.Е. Биологическое разнообразие проектируемого Иле-Балхашского природного резервата // Вестник КазНУ. Серия экологическая. – 2012. – Т. 1. – № 33. – С. 230-233.

40. Иващенко А.А., Эпиктетов В.Г. Дополнения к флоре национального парка «Алтын Эмель» // Материалы международной научной конференции «Интродукция растений: современное состояние, проблемы и перспективы». – Харьков: Коллегиум, Харьковский национальный университет им. В.Н. Каразина, 2019. – 474 с.

41. Stikhareva T., Ivashchenko A., Kirillov V., Rakhimzhanov A. Floristic diversity of threatened woodlands of Kazakhstan formed by *Populus pruinosa* Schrenk // Turkish Journal of Agriculture and Forestry. – 2021. – V. 45. – N. 2 - P. 165-178.

42. Огарь Н.П. Сезонная и разногодичная изменчивость луговых сообществ, их продуктивность / Динамика луговой растительности долины реки Или // Динамика пойменной растительности рек Чу и Или. – Алма-Ата: Наука, 1985. – 85-133 с.

43. Плисак Р.П. Изменение растительности дельты реки или при зарегулировании стока. – Алма-Ата: Наука, 1981. – 216 с.

44. Peterson A., Levichev I.G., Peterson J., Harpke D., Schnittler M. New insights into the phylogeny and taxonomy of Chinese species of Gagea (Liliaceae) - speciation through hybridization // Organisms Diversity & Evolution. – 2011. – V. 11. – N. 5. – P. 387-407.

45. Красовская Л.С., Левичев И.Г. Флора Чаткальского заповедника. – Ташкент: ФАН, 1986. – 176 с.

46. Иващенко А.А., Белялов О.В. Казахстан – родина тюльпанов. – Алматы: Атамура, 2019. – 368 с.

47. Гвоздева Л.П. Растительность и кормовые ресурсы пустыни Сары-Ишик-Отрау. – Алма-Ата: АН КазССР, 1960. – 203 с.

48. Красная книга Казахстана. Т.2, Ч. 2. Растения (Изд.-е 2-е, исправленное и дополненное). – Астана: LTD "Art-Print XXI", 2014. – 452 с.

49. Friesen N., Smirnov S.V., Leweke M., Seregin A.P., Fritsch R.M. Taxonomy and Phylogeny of *Allium* section *Decipientia* (Amaryllidaceae): Morphological characters do not reflect the evolutionary history verified by molecular markers // Botanical Journal of the Linnean Society. – 2021. – V. 197. – N. 2. – P. 190-228.

50. Ролдугин И.И. Аир (*Acorus calamus* L.) в Балхаш-Алакульской впадине // Труды Института ботаники АН КазССР. – 1964. – Т. 18. – С. 31-40.

51. Лазьков Г.А., Султанова Б.А. Кадастр флоры Кыргызстана. Сосудистые растения. – Бишкек: Национальная академия наук Кыргызской Республики, 2014. – 126 с.

52. Иващенко А.А., Белялов О.В. Новые флористические находки на юге и юго-востоке Казахстана // Ботанические исследования Сибири и Казахстана. – 2015. – № 21. – С. 94-100.

53. Байтулин И.О., Котухов Ю.А. Флора сосудистых растений Казахстанского Алтая. – Алматы: Konica Minolta, 2011. – 158 с.

54. Костин В.А. Редкие и исчезающие виды высших водных растений водоемов реки Или и озера Балхаш // Ботанические материалы Гербария Института ботаники Академии наук Казахской ССР. – 1983. – Вып. 13. – С. 111-115.

А.А. Иващенко[1], Т.Н. Стихарева[1], К.Т. Абидкулова[2], В.Ю. Кириллов[1], А.Н. Рахимжанов[1]

[1]Ә.Н. Бөкейхан атындағы Қазақ орман шаруашылығы және агроорманмелиорация ғылыми-зерттеу институты, Щучинск, Қазақстан

[2]Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан

Іле-Балқаш өңірінің тоғайлы ормандары мен іргелес шөлдері флорасына қосымша

Аңдатпа. Авторлардың көпжылдық зерттеулерінің нәтижелері бойынша әдеби деректерді талдауды ескере отырып, Іле-Балқаш шөлді өңірінің флорасына толықтырулар келтіріледі, олардың құрамына 69 туыстың, 31 тұқымдастың 86 түрі кіреді. Ең қызықты олжалардан Қазақстан аумағында алғаш рет табылған *Gagea jensii* Levichev & Schnittler; жақында сипатталған Іле өңірі шөлдерінің шағын жергілікті эндемигі *Allium subscabrum* (Regel) R. M. Fritsch; сондай-ақ Қазақстанның Қызыл кітабына енгізілген төрт түрі аталып өтілген. Зерттелген аймақтағы тұрақсыз экологиялық жағдайды және жоғары өсімдіктердің түрлік құрамының осыған байланысты өзгеруін ескере отырып, ең осал өсімдіктер қауымдастықтарында – Іле өзені алқабының тоғайлы ормандарында, қазіргі дельтаның су және су маңы қауымдастықтарында флористикалық мониторинг жүргізу ұсынылады.

Түйін сөздер: флора, түрлер тізімі, экожүйе, шөлейттену, ареал типі, мониторинг.

А.А. Иващенко[1], Т.Н. Стихарева[1], К.Т. Абидкулова[2], В.Ю. Кириллов[1], А.Н. Рахимжанов[1]
[1]Казахский научно-исследовательский институт лесного хозяйства и агролесомелиорации имени А.Н. Букейхана, Щучинск, Казахстан
[2]Казахский национальный университет имени аль-Фараби, Алматы, Казахстан

Дополнение к флоре тугайных лесов и прилегающих пустынь Иле-Балхашского региона

Аннотация. По результатам многолетних исследований авторов с учетом анализа литературных данных приводятся дополнения к флоре пустынного Иле-Балхашского региона, которые включают 86 видов из 69 родов и 31 семейства. Из самых интересных находок отмечаются *Gagea jensii* Levichev & Schnittler, впервые обнаруженный на территории Казахстана; *Allium subscabrum* (Regel) R.M. Fritsch, недавно описанный узколокальный эндемик Приилийских пустынь, а также четыре вида, занесенные в Красную книгу Казахстана. Учитывая нестабильную экологическую ситуацию в обследованном регионе и связанные с этим изменения видового состава высших растений, рекомендуется проводить флористический мониторинг в наиболее уязвимых растительных сообществах – тугайных лесах долины р. Или, водных и околоводных сообществ современной дельты.

Ключевые слова: флора, список видов, экосистема, опустынивание, тип ареала, мониторинг.

References

1. Lipka O.N., Mazmaniants G.M., Isupova M.V., Aleynikov A.A., Zamolodchikov D.G., Kaganov V.V. Podhody k razrabotke krupnomasshtabnyh proektov po adaptacii k izmeneniyam klimata na osnove ekosistem v del'te r. Ili (Kazahstan) [Approaches to a large-scale ecosystem-based adaptation project development in the Ili River delta (Kazakhstan)], Problemy ekologicheskogo monitoringa i modelirovaniya ekosistem [Problems of ecological monitoring and ecosystem modeling], 32(3-4), 88-119 (2020). [in Russian]

2. Koroleva E.G., Dikareva T.V., Dikarev V.A. Ocenka prirodno-obuslovlennyh opasnostej v prirodnom rezervate «Ile-Balhash» (Kazahstan) [Assessment of natural hazards in the Ile-Balkhash nature reserve (Kazakhstan)], Aridnye ekosistemy [Arid Ecosystems], 9(4), 264-272 (2019). [in Russian]

3. Flora Kazahstana. T. 1 [Flora of Kazakhstan. V. 1] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1956, 354 p.). [in Russian]

4. Nesterova S.G., Inelova Z.A. Flora pustyn' Ile-Balhashskogo regiona [Flora of the deserts of the Ile-Balkhash region] (Almaty, Kazakh University, 2012, 190 p.). [in Russian]

5. Thevs N. Forest Landscape Restoration in the Caucasus and Central Asia. Background study for the Ministerial Roundtable on Forest Landscape Restoration in the Caucasus and Central Asia (Astana, 2018, 1-65 p.).

6. Zeng Y., Zhao C., Kundzewicz Z.W., Lv G. Distribution pattern of Tugai forests species diversity and their relationship to environmental factors in an arid area of China, PLoS ONE, 15(5), e0232907 (2020).

7. IPNI. 2021. International Plant Names Index. Published on the Internet http://www.ipni.org, The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Botanic Gardens. [Retrieved 01 October 2021].

8. Flora Kazahstana. T. 2 [Flora of Kazakhstan. V. 2] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1958, 305 p.). [in Russian]

9. Flora Kazahstana. T. 3 [Flora of Kazakhstan. V. 3] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1960, 477 p.). [in Russian]

10. Flora Kazahstana. T. 4 [Flora of Kazakhstan. V. 4] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1961, 548 p.). [in Russian]

11. Flora Kazahstana. T. 5 [Flora of Kazakhstan. V. 5] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1961, 516 p.). [in Russian]

12. Flora Kazahstana. T. 6 [Flora of Kazakhstan. V. 6] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1963, 466 p.). [in Russian

13. Flora Kazahstana. T. 7 [Flora of Kazakhstan. V. 7] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1964, 515 p.). [in Russian]

14. Flora Kazahstana. T. 8 [Flora of Kazakhstan. V. 8] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1965, 466 p.). [in Russian]

15. Flora Kazahstana. T. 9 [Flora of Kazakhstan. V. 9] (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1966, 651 p.). [in Russian]

16. Abdulina S.A. Sosudistye rasteniya Kazahstana [Vascular plants of Kazakhstan]. (Steka, Almaty, 1998, 188 p.). [in Russian]

17. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory. T. 1 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 1] (Fan, Tashkent, 1968, 229 p). [in Russian]

18. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory. T. 2 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 2] (Fan, Tashkent, 1971, 364 p). [in Russian]

19. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 3 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 3] (Fan, Tashkent, 1972, 268 p). [in Russian]20. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 4 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 4] (Fan, Tashkent, 1974, 275 p). [in Russian]

21. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 5 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 5] (Fan, Tashkent, 1976, 276 p). [in Russian]

22. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 6 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 6] (Fan, Tashkent, 1981, 397 p). [in Russian

23. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 7 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 7] (Fan, Tashkent, 1983, 416 p). [in Russian]

24. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 8 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 8] (Fan, Tashkent, 1986, 192 p). [in Russian]

25. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 9 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 9] (Fan, Tashkent, 1987, 402 p). [in Russian]

26. Opredelitel rastenij Srednei Azii. Kriticeskij konspekt flory, T. 10 [Determinant of plants of Central Asia. Critical synopsis of flora. V. 10] (Fan, Tashkent, 1993, 692 p.). [in Russian]

27. Tsvelev N.N. Zlaki SSSR [Poaceae of the USSR]. (Science, Moscow, 1976, 788 p.). [in Russian]

28. Goloskokov V.P. Flora Dzhungarskogo Alatau [Flora of the Dzungar Alatau]. (Science, Alma-Ata, 1984, 222 p.). [in Russian]

29. Rachkovskaya E.I., Volkova E.A., Khramtsov V.N. (eds.) Botanical Geography of Kazakhstan and Middle Asia (Desert Region). (Komarov Botanical Institute, St. Petersburg, 2003, 424 p.).

30. Kurochkina L.Ya. Rastitel'nost' peschanyh pustyn' Kazahstana [The vegetation of the sandy deserts of Kazakhstan], Rastitel'nyj pokrov Kazahstana [The vegetational cover of Kazakhstan]. (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1966, P. 191-582). [in Russian].

31. Kubanskaya Z.V. Solyankovye pustyni Kazahstana [*Salsola* deserts of Kazakhstan]. (Science, Alma-Ata, 1980, 206 p.). [in Russian]

32. Plisak R.P. Smena rastitel'nosti sovremennoj reki Ili v svyazi s izmeneniem gidrologicheskogo rezhima [Change of vegetation of the modern Ili River due to a change of the hydrological regime], Struktura i produktivnost' rastitel'nosti pustynnoj zony Kazahstana [Structure and productivity of vegetation of the desert zone of Kazakhstan]. (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1978, P. 109-122). [in Russian]

33. Levichev I.G. The synopsis of the genus Gagea (Liliaceae) from the Western Tien-Shan, Botanicheskii Zhurnal, 75(2), 225-234 (1990).

34. Peterson A., Harpke D., Levichev I.G., Beisenova S., Schnittler M., Peterson J. Morphological and molecular investigations of Gagea (Liliaceae) in southeastern Kazakhstan with special reference to putative altitudinal hybrid zones, Plant Systematics and Evolution, 302(8), 985-1007 (2016).

35. Christenhusz M.J.M., Govaerts R., David J.C., Hall T., Borland K., Roberts P.S., Tuomisto A., Buerki S., Chase M.W., Fay M.F. Tiptoe through the tulips - cultural history, molecular phylogenetics and classification of *Tulipa* (Liliaceae), Botanical Journal of the Linnean Society, 172(3), 280-328 (2013).

36. Gemedzhieva N.G., Grudzinskaya L.M., Karzhaubekova Zh.Zh., Kurbatova N.V. Resursnaya harakteristika hozyajstvenno-cennyh rastenij Pribalhash'ya (cistanhe, reven' garmala, solodka): monografiya. Trudy instituta botaniki i fitointrodukcii. T. 23 (9). [Resource characteristics of economically valuable plants of the Balkhash region (cistanche, rhubarb garmala, licorice): monograph. Works of the Institute of Botany and Phytointroduction. Vol. 23 (9)]. (Institute of Botany and Phytointroduction, Alma-Ata, 2017, 224 p.). [in Russian]

37. Ivashchenko A.A., Sultanova B.M. Analiz flory proektiruemogo Ile-Balhashskogo prirodnogo rezervata. Materialy Mezhdunarodnoj nauchno-prakticheskoj konferencii «Aktual'nye problemy geobotaniki», posvyashchennoj pamyati vydayushchegosya uchenogo, osnovopolozhnika kazahstanskoj botanicheskoj shkoly, akademika NAN RK, d.b.n. B. A. Bykova v svyazi s 100-letiem so dnya rozhdeniya [Analysis of the flora of the projected Ile-Balkhash natural reserve. Materials of the International Scientific and Practical Conference "Actual problems of geobotany" dedicated to the memory of the outstanding scientist, founder of the Kazakh Botanical School, academician of the National Academy of Sciences of the Republic of Kazakhstan, Doctor of Biological Sciences B. A. Bykov in connection with the 100th anniversary of his birth]. Almaty, May 11-13, 2011. Almaty, Institute of Botany and Phytointroduction. 2011, 349 p. [in Russian]

38. Begenov A.B., Ametov A.A., Eszhanov B.E., Abidkulova K.T., Satybaldieva G.K., Tynybekov B.M., Baymurzaev N.B., Childibaeva A.Z. Metodicheskoe rukovodstvo po provedeniyu uchebnoj praktike po botanike [Methodological guide for conducting educational practice in botany]. (Қазақ universiteti, Almaty, 2015, 78 p.). [in Russian]

39. Sultanova B.M., Rachkovskaya E.I., Ivashchenko A.A., Berezovikov N.N., Evstifeev Y.G., Gryunberg V.V., Malakhov D.V., Kerteshev T.S., Belgubaeva A.E. Biologicheskoe raznoobrazie proektiruemogo Ile-Balhashskogo prirodnogo rezervata [Biological diversity of the projected Ile-Balkhash natural reserve], Vestnik KazNU. Seriya ekologicheskaya [Eurasian Journal of Ecology], 1(33), 230-233 (2012). [in Russian]

40. Ivashchenko A.A., Epitketov V.G. Dopolneniya k flore nacional'nogo parka «Altyn Emel'». Materialy mezhdunarodnoj nauchnoj konferencii «Introdukciya rastenij: sovremennoe sostoyanie, problemy i perspektivy» [Additions to the flora of the National Park "Altyn Emel". Materials of the international scientific conference and schools "Plant introduction: current state, problems and prospects"]. Kharkiv, May 14-17, 2019. Kharkiv: Collegium, V.N. Karazin Kharkiv National University. 2019. 474 p. [in Russian]

41. Stikhareva T., Ivashchenko A., Kirillov V., Rakhimzhanov A. Floristic diversity of threatened woodlands of Kazakhstan formed by *Populus pruinosa* Schrenk, Turkish Journal of Agriculture and Forestry, 45(2), 165-178 (2021).

42. Ogar' N.P. Sezonnaya i raznogodichnaya izmenchivost' lugovyh soobshchestv, ih produktivnost' / Dinamika lugovoj rastitel'nosti doliny reki Ili [Seasonal and multi-annual variability of meadow communities, their productivity / Dynamics of meadow vegetation of the Ili River valley], Dinamika pojmennoj rastitel'nosti rek CHu i Ili [Dynamics of floodplain vegetation of the Chu and Ili Rivers] (Science, Alma-Ata, 1985, P. 85-133). [in Russian]

43. Plisak R.P. Izmenenie rastitel'nosti del'ty reki Ili pri zaregulirovanii stoka [Changes in vegetation of the Ili River delta during flow regulation]. (Science, Alma-Ata, 1981, 216 p.). [in Russian]

44. Peterson A., Levichev I.G., Peterson J., Harpke D., Schnittler M. New insights into the phylogeny and taxonomy of Chinese species of Gagea (Liliaceae) - speciation through hybridization, Organisms Diversity & Evolution, 11(5), 387-407 (2011).

45. Krasovskaya L.S., Levichev I.G. Flora CHatkal'skogo zapovednika [Flora of the Chatkal Nature Reserve] (Fan, Tashkent, 1986, 176 p.). [in Russian]

46. Ivashchenko A.A., Belyalov O.V. Kazahstan – rodina tyul'panov [Kazakhstan is the birthplace of tulips] (Atamura, Almaty, 2019, 368 p.). [in Russian]

47. Gvozdeva L.P. Rastitel'nost' i kormovye resursy pustyni Sary-Ishik-Otrau [Vegetation and forage resources of the Sary-Ishik-Otrau desert]. (Academy of Sciences of the Kazakh SSR, Alma-Ata, 1960, 203 p.). [in Russian]

48. Krasnaya kniga Kazakhstana. [Red Book of Kazakhstan] 2. Ch. 2. Plant (Izd.-e 2-e. ispravlennoye i dopolnennoye), [Vol. 2, Part 2. Plants] (Ed. 2nd, revised), (LTD "Art-Print XXI", Astana, 2014, 452 p.).

49. Friesen N., Smirnov S.V., Leweke M., Seregin A.P., Fritsch R.M. Taxonomy and Phylogeny of *Allium* section *Decipientia* (Amaryllidaceae): Morphological characters do not reflect the evolutionary history verified by molecular markers, Botanical Journal of the Linnean Society, 197(2), 190-228 (2021).

50. Roldugin I.I. Air (*Acorus calamus* L.) v Balhash-Alakul'skoj vpadine [*Acorus calamus* L. in the Balkhash-Alakul Valley], Trudy Instituta botaniki AN KazSSR [Works of the Institute of Botany of the Academy of Sciences of the Kazakh SSR], 18, 31-40 (1964). [in Russian]

51. Laz'kov G.A., Sultanova B.A. Kadastr flory Kyrgyzstana. Sosudistye rasteniya [Cadastre of flora of Kyrgyzstan. Vascular plants] (National Academy of Sciences of the Kyrgyz Republic, Bishkek, 2014, 126 p.). [in Russian]

52. Ivashchenko A.A., Belyalov O.V. Novye floristicheskie nahodki na yuge i yugo-vostoke Kazahstana [New floristic findings in the south and southeast of Kazakhstan], Botanicheskie issledovaniya Sibiri i Kazahstana [Botanical studies of Siberia and Kazakhstan], 21, 94-100 (2015). [in Russian]

53. Baitulin I.O., Kotukhov Yu.A. Flora sosudistyh rastenij Kazahstanskogo Altaya [Flora of vascular plants of the Kazakhstani Altai] (Konica Minolta, Almaty, 2011, 158 p.). [in Russian]

54. Kostin V.A. Redkie i ischezayushchie vidy vysshih vodnyh rastenij vodoemov reki Ili i ozera Balhash [Rare and endangered species of higher aquatic plants of reservoirs of the Ili River and Lake Balkhash], Botanicheskie materialy Gerbariya Instituta botaniki Akademii nauk Kazahskoj SSR, Alma-Ata [Botanical materials from the Herbarium of the botanical Institute of the Academy of sciences of the Kazakh SSR, Alma-Ata], 13, 111-115 (1983). [in Russian]

Information about authors:

Ivashchenko A.A. – Candidate of Biological Sciences, Research consultant of A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry, 58 Kirov str., Shchuchinsk, Kazakhstan.

Stikhareva T.N. – Candidate of Biological Sciences, Associate Professor, Chief Scientific Secretary of A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry, 58 Kirov str., Shchuchinsk, Kazakhstan.

Abidkulova K.T. – Senior lecturer of the Departament of biodiversity and bioresources of Al-Farabi Kazakh National University, 71 al-Farabi ave., Almaty, Kazakhstan.

Kirillov V.Yu. – Candidate of Chemical Sciences, Associate Professor, Deputy Chairman of the Management Board for Research of A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry, 58 Kirov str., Shchuchinsk, Kazakhstan

Rakhimzhanov A.N. – Ph.D., Chairman of the Management Board of A.N. Bukeikhan Kazakh Research Institute of Forestry and Agroforestry, 58 Kirov str., Shchuchinsk, Kazakhstan.

Иващенко А.А. – биология ғылымдарының кандидаты, Ә.Н. Бөкейхан атындағы Қазақ орман шаруашылығы және агроорманмелиорация ғылыми-зерттеу институтының ғылыми сарапшы, Киров көш., 58, Щучинск, Қазақстан.

Стихарева Т.Н. – биология ғылымдарының кандидаты, қауымдастырылған профессор, Ә.Н. Бөкейхан атындағы Қазақ орман шаруашылығы және агроорманмелиорация ғылыми-зерттеу институтының бас ғылыми хатшысы, Киров көш., 58, Щучинск, Қазақстан.

Абидкулова К.Т. – биоалуантүрлілік және биоресурстар кафедрасының аға оқытушысы әл-Фараби атындағы Қазақ ұлттық университеті, әл-Фараби даңғ. 71, Алматы, Қазақстан.

Кириллов В.Ю. – химия ғылымдарының кандидаты, қауымдастырылған профессор, Ә.Н. Бөкейхан атындағы Қазақ орман шаруашылығы және агроорманмелиорация ғылыми-зерттеу институтының басқарма төрағасының ғылым жөніндегі орынбасары, Киров көш., 58, Щучинск, Қазақстан.

Рақымжанов А.Н. – PhD докторы, Ә.Н. Бөкейхан атындағы Қазақ орман шаруашылығы және агроорманмелиорация ғылыми-зерттеу институтының басқарма төрағасы, Киров көш., 58, Щучинск, Қазақстан.