**N E W S**
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
**SERIES OF BIOLOGICAL AND MEDICAL**
ISSN 2224-5308
Volume 2, Number 338 (2020), 48 – 55 **https://doi.org/10.32014/2020.2519-1629.12**

UDC 57.574 57.06.582 58.581
IRSTI 34.29.35

**Z. A. Inelova[1], M. U. Aitzhan[1], Y. G. Zaparina[1], G. K. Erubayeva[2]**

[1]al-Farabi Kazakh National University, MES RK, Almaty, Kazakhstan;
[2]Turan University, Almaty, Kazakhstan.
E-mail: z.inelova2015@gmail.com

# PLANT BIODIVERSITY OF MONITORING POINTS V.AMANGELDY ALMATY REGION

**Abstract.** The article provides a systematic analysis of the species composition of plants of the flora of v. Amangeldy, Almaty region.

The comprehensive study of regional floras is becoming increasingly important in connection with the implementation of the solution to the problem of studying and preserving biological diversity. Complete information about the composition of the flora of a territory is of great theoretical importance, it allows establishing the structure and Genesis of its components, to identify individual characteristics, to restore the history of formation and trends. This ultimately is the basis of rational use of plant resources and protection of rare and endangered plants, as well as to solve many important economic problems - identifying new sources and resources of medicinal, food, fodder, ornamental and other plants.

One of the main characteristics of any flora is its systematic structure, namely the ratio of families, genera and species, on the one hand, and the quantitative indicators of these taxa that determine its wealth, on the other. These indicators are components of a systematic analysis of flora in general and coenoflora in particular, the data obtained using such analysis are important material for comparative floristry. From this point of view, the systematic structure of the flora acquires the significance of one of the essential indicators that characterize the flora in the regional plan.

The study of the species composition of the flora is of great importance both for understanding the history of flora and landscapes of the region as a whole, and for finding ways to conserve and use biodiversity under conditions of increasing anthropogenic pressure.

Research was carried out by route-reconnaissance method in combination with a detailed study of experimental sites. In the study area – V. Amangeldy was first identified: 112 species from 88 genera and 29 families, with the dominance of the families *Asteraceae* (24 species or 21.4 %, 17 genera), *Rosaceae* (15 species or 13.39%, 11 genera), *Brassicaceae* (11 species, or 9.82 %, 9 genera) from Dicotyledons, and *Poaceae* (11 genera, 12 species, or 10.71 %) from Monocotyledonous plants. The dominant families account for 62 species, which is 55.36 % of the total number of plant species growing in this territory. Leading genera *Artemisia*, *Potentilla* and *Rumex*. On the territory of the study, 33 forage plant species were identified: *Bromus inermis* (Leyss.) Holub., *Rumex confertus* Willd., *Trifolium pratense* L., *Poa bulbosa* L., etc. In connection with the degradation of the vegetation cover number of weed plants was 75 species, among which are: *Rumex crispus* L., *Capsella bursa-pastoris* (L.) Medik., *Cannabis ruderalis* Janisch., *Lathyrus tuberosus* L. and other. Endemic and rare species were not found.

The results of the research will serve as a basis for the rational use of the flora of Amangeldy village in Almaty region, as well as for the conservation of biodiversity. Obtained as a result of a systematic analysis of the flora of Amangeldy, it will help to identify the centers of endemism and relict, as well as to solve the issues of the place and role of this flora in a number of other adjacent floras.

**Key words:** village Amangeldy, systematic analysis, species composition, species, genus, families.

**Introduction.** Vegetation cover is an organized system whose components, ranging from the organismic to the population-species or even phytocenotic, are more or less evolutionarily adapted to the set of abiotic and biotic environmental conditions, functional and structural units. The above seems to us to be true with regard to the vegetation cover as a whole in its relations with the relief-landscape structure

of the natural historical region within which it is formed. In this regard, each natural flora and phytocenoses formed by its species is not just a random set of plant species in a certain area, but a multitude of them, which has its own internal patterns of addition, geographical and genetic relationships [1]. The most important aspect of geobotanical research is the study of the species diversity of the vegetation cover [2].

One of the most important problems of our time is the conservation of biological diversity, both of natural populations and by placing species in artificially created reserves. Kazakhstan, as a modern state, has ratified the Convention on Biological Diversity (1994) over the years of independence. However, to carry out the tasks set in the Convention, it is necessary to take an inventory of floristic diversity in order to determine its main components, which can be further balanced and used [3].

Biodiversity is by no means the only, or even the primary, driver of ecosystem functions [4,5,13]. Both biodiversity and ecosystem functions have been known to be driven by common drivers of contemporary environments, such as climate and biotic and abiotic attributes [6-9, 13]. Biodiversity could be also shaped by long-term drivers, such as geological processes, which impart lasting legacies on contemporary environments [10-14].

A standard analysis of the flora is the basis of any floristic study, since it allows you to determine the specifics of the studied flora, its difference from the border flora and flora of remote territories. A systematic analysis aims to identify the taxonomic structure of the studied flora, which is necessary to determine its specificity and place in the phytogeographic hierarchy of large land regions. Each flora has its own quantitative characteristic and, in addition to the total number of species, a certain set of genera and families, which can significantly differ from other floras [15].

The analysis of flora occupies a leading position in comparative floristry and forms the basis of its study. The analysis reveals the taxonomic, coenecological, and chorological parameters of the flora, on the basis of which conclusions are drawn about its wealth, origin, and the role of individual taxa of the rank of a family, genus, and species, including endemic and relict species, of ecological, coenotic, and biomorphological nature components of the flora, the basis is being created for conducting fractional botanical and geographical zoning of the territory and making recommendations for the protection and rational use of certain species [16].

The study of flora is the basis for solving many theoretical and practical issues of taxonomy, Botanical geography, resource studies, as well as to clarify the history of flora and predict its further changes. The inventory of flora is important for the implementation of environmental measures. Intensive human impact on nature leads not only to the loss of many native species, but also to the degradation of vegetation in large areas [17].

The study of the species composition of flora is important both for the knowledge of the history of flora and landscapes of the region as a whole, and for the search for ways to preserve and use biodiversity in the conditions of increasing anthropogenic pressure. In recent years, a number of scientific works have been devoted to the study of biodiversity of terrestrial plants in the Almaty region and numerous field studies have been carried out [18-22].

In recent years, all studies on flora and vegetation have been aimed at preserving biodiversity at different levels of its structural organization (species, population, coenotic, ecosystem, landscape).

**Materials and methods.** The objects of research are flora and vegetation of Amangeldy village (N 43°17.951′E 077°12.509′), Almaty region. The research was conducted by route-reconnaissance method in combination with a detailed study of experimental sites. To solve the tasks in each region, three typical experimental plots of 10 $m^2$ were selected. At each site, three sites with an area of 1 $m^2$ were selected by random sampling. The main research methods were geobotanical and floristic [23]. Floral lists were compiled during walking tours.

When determining plant species, a geobotanical description of the communities of Amangeldy was originally made. According to the geobotanical method: the laying of sites was carried out in tenfold repetition. The species were identified according to the collections of Flora of Kazakhstan, Volume 1-9 [24]. The refinement of the Latin names took place according to the summary of S.K. Cherepanov [25].

**Results and Discussion.** The systematic list of flora of v. Amangeldy village that we have compiled includes 112 plant species belonging to 88 genera and 29 families. Table 1 provides information on the number of species and genera in the families of the studied flora of the Amangeldy territory.

Table 1 – Species wealth of the families of Amangeldy

| № | Families | Number of genera | Number of species |
|---|---|---|---|
| 1 | *Asteraceae* Dumort. | 17 | 24 |
| 2 | *Rosaceae* Juss. | 11 | 15 |
| 3 | *Poaceae* Barnhart | 11 | 12 |
| 4 | *Brassicaceae* Burnett | 9 | 11 |
| 5 | *Fabaceae* Lindl. | 5 | 6 |
| 6 | *Chenopodiaceae* Vent. | 4 | 6 |
| 7 | *Lamiaceae* Lindl. | 3 | 3 |
| 8 | *Caryophyllaceae* Juss. | 2 | 2 |
| 9 | *Polygonaceae* Juss. | 2 | 4 |
| 10 | *Malvaceae* Juss. | 2 | 2 |
| 11 | *Balsaminaceae* A. Rich. | 2 | 2 |
| 12 | *Boraginaceae* Juss. | 2 | 2 |
| 13 | *Cyperaceae* Juss. | 2 | 2 |
| 14 | *Ranunculaceae* Juss. | 1 | 1 |
| 15 | *Hypecoaceae* (Dumort) Willk. | 1 | 1 |
| 16 | *Fumariaceae* DC. | 1 | 1 |
| 17 | *Amaranthaceae* Juss. | 1 | 2 |
| 18 | *Salicaceae* Mirb. | 1 | 1 |
| 19 | *Cucurbitaceae* Juss. | 1 | 1 |
| 20 | *Ulmaceae* Mirb. | 1 | 1 |
| 21 | *Cannabaceae* Endl. | 1 | 1 |
| 22 | *Urticaceae* Juss. | 1 | 1 |
| 23 | *Euphorbiaceae* Juss. | 1 | 2 |
| 24 | *Apiaceae* Lindl. | 1 | 1 |
| 25 | *Rubiaceae* Juss. | 1 | 1 |
| 26 | *Solanaceae* Juss. | 1 | 2 |
| 27 | *Convolvulaceae* Juss. | 1 | 2 |
| 28 | *Scrophulariaceae* Juss. | 1 | 2 |
| 29 | *Plantaginaceae* Juss. | 1 | 2 |

In the study area of Amangeldy, 112 species were identified from 88 genera and 29 families, with the dominance of the families *Asteraceae* (24 species or 21.4 %, 17 genera), *Rosaceae* (15 species or 13.39%, 11 genera), *Brassicaceae* (11 species or 9.82 %, 9 genera) from dicotyledons, and *Poaceae* (11 genera, 12 species, or 10.71 %) from monocotyledonous plants. The dominant families account for 62 species, which is 55.36 % of the total number of plant species growing in this territory (figure 1). Leading genera *Artemisia*, *Potentilla* and *Rumex*. No endemic species have been identified. The ratio of the main taxonomic groups shows that all species belong to the Department Angiospermae (angiospermae) – 112 species.

Table 2 – Distribution of plants of Amangeldy in systematic groups

| Systematic group | Number of families | Number of genera | Number of species | % of the total number of species |
|---|---|---|---|---|
| Angiosperms: | | | | |
| 1) dicotyledonous | 27 | 75 | 98 | 87,5 % |
| 2) monocotyledonous | 2 | 13 | 14 | 12,5 % |

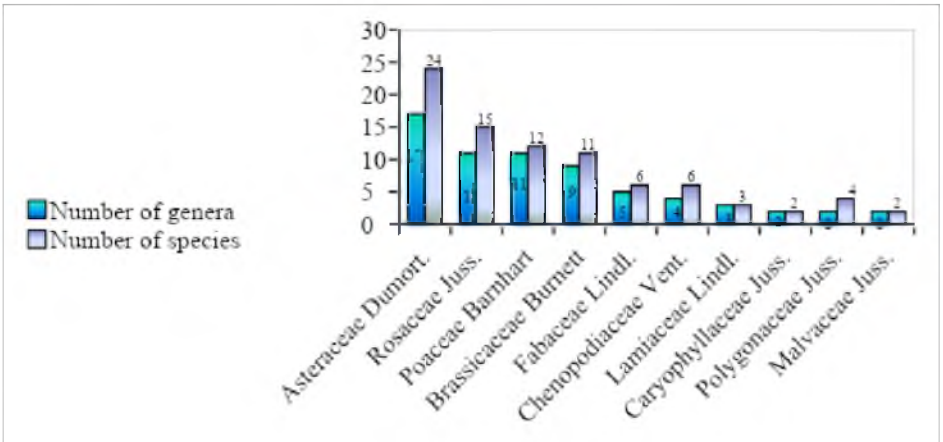


Figure 1 – 10 leading Amangeldy point families

The flora of v. Amangeldy has 28 families, out of 4 (13.79 % of the total) with the largest number of species, which are the head part of the spectrum of flora families. In the remaining 25 families, the number of species is represented by a smaller number.

The top 10 families comprise 85 species (75.89 % of the total), more than half of all species in the region. The first three families include 51 species (45.5 % of the total).

The richest in the number of species is the family, significantly "breaking away" in the number of species from all others: *Asteraceae* Dumort-24 species (21.4 %).

At the point of Amangeldy, plants were harvested in a dandelion-motley community. The projective coverage of the community is 70-80 %. A change of grass stand was also observed. Fodder species (cereals, wormwood) in some places were replaced by weeds, plants of low value in terms of forage qualities (gingerbread - *Xanthium strumaruim*) and poisonous (brunets – *Sophora alopecuroides*).

a – *Artemisia annua* L

b – *Trifolium pratense* L

c – *Bromus inermis* (Leyss.) Holub

d – *Rumex conifertus* Willd

Figure 2 – Variety of plants at the monitoring point of Amangeldy village

The following dominant and fodder species were collected for analysis in the dandelion-herb community: *Artemisia annua* L. (figure 2 a) – annual wormwood from the family *Asteraceae* Dumort, *Trifolium pratense* L. (figure 2 b) - meadow clover from the family *Fabaceae* Lindl. In the second community taken – *Bromus inermis* (Leyss.) Holub. (figure 2 c) – boneless bonfire from the family *Poaceae* Barnhart, *Rumex confertus* Willd. (figure 2 d) - horse sorrel from the family *Polygonaecae* Juss.

On the territory of Amangeldy, 33 forage plant species grow. The following plants are representatives of fodder species: *Bromus inermis* (Leyss.) Holub., *Rumex confertus* Willd., *Trifolium pratense* L., *Poa bulbosa* L., *Artemisia scoparia* Waldst. & Kit., *Stipa capillata* L., *Lathyrus tuberosus* L., *Chenopodium album* L., *Carex physodes* Bieb., *Achillea millefolium* L., etc.

The degradation of the natural vegetation cover was also observed, and now fodder plants were replaced by weedy species of little value. On the territory of Amangeldy, 75 weed species of plants were identified. These include the following plant species: *Rumex crispus* L., *Capsella bursa-pastoris* (L.) Medik., *Cannabis ruderalis* Janisch., *Lathyrus tuberosus* L., *Artemisia vulgaris* L., *Xanthium strumarium* L., *Stipa capillata* L., *Inula britannica* L., *Hypecoum parviflorum* Kar. &Kir.and etc.

**Conclusion.** Based on the research and analysis of the results, the data obtained, the following conclusions are made:

– based on the analysis of literature data, as well as our own research on the study and collection of plants at the monitoring point v. Amangeldy compiled a list of plants, including 112 species belonging to 88 genera and 29 families.

– the first ten leading families contain 85 species and make up 75.2 % of the total species composition of the flora of the study area. The leading families in this taxonomic composition are *Asteraceae* (24 species, or 21.2 % of the total number of species, 17 genera), *Rosaceae* (15 species or 13.2%, 11 genera), *Poaceae* (12 species, which is 10.6 % of the total, 11 species).

– leading of the genus *Artemisia*, *Potentilla* and *Rumex*.

No endemic species have been identified.

**Funding.** This work was carried out within the framework of the program and targeted funding: "Comprehensive assessment of unutilized and banned pesticides impact on genetic status and health of population of Almaty region" (IRN BR05236379), Contract No. 206 dated March 19, 2018.

**З. А. Инелова[1], М. У. Айтжан[1], Е. Г. Запарина[1], Г. К. Ерубаева[2]**

[1]әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан;
[2]Тұран Университеті, Алматы, Қазақстан

## АЛМАТЫ ОБЛЫСЫНДАҒЫ МОНИТОРИНГТІ НҮКТЕ, АМАНГЕЛДІ АУЫЛЫНЫҢ ӨСІМДІКТЕРІНІҢ АЛУАНТҮРЛІЛІГІ

**Аннотация.** Мақалада Алматы облысы, Амангелді ауылы флорасының өсімдіктерінің түрлік құрамына жүйелі талдау жүргізілді.

Аймақтық флораны жан-жақты зерттеу биологиялық әртүрлілікті зерттеу және сақтау проблемасын шешуді жүзеге асыруға байланысты аса маңызды болып келеді. Белгілі бір аумақ флорасының құрамы туралы толық мәліметтер маңызды теориялық мәнге ие, себебі оның компоненттерінің құрылымы мен генезисін орнатуға, жеке ерекшеліктерін анықтауға, қалыптасу тарихын және өзгеру үрдісін қалпына келтіруге мүмкіндік береді. Бұл өсімдік ресурстарын ұтымды пайдаланудың және өсімдіктердің сирек кездесетін және жойылып бара жатқан түрлерін қорғауды ұйымдастырудың негізі болып саналады, сондай-ақ көптеген маңызды шаруашылық проблемаларды шешу үшін дәрілік, тағамдық, жемдік, сәндік және басқа да өсімдіктердің жаңа көздері мен ресурстарын анықтау үшін маңызды.

Кез келген флораның негізгі сипаттамаларының бірі – оның жүйелі құрылымы, атап айтқанда, бір жағынан, тұқымдастардың, тектер мен түрлердің арақатынасы және екінші жағынан, осы таксондардың байлығын анықтайтын сандық көрсеткіштері. Бұл көрсеткіштер, тұтас алғанда, флораны жүйелі талдаудың құрамдас бөлігі болып табылады және мұндай талдаудың көмегімен алынған деректер салыстырмалы

флористика үшін маңызды материал болып есептеледі. Осы тұргыдан алганда, флораның жүйелі құрылымы аймақтық жоспарда флораны сипаттайтын маңызды көрсеткіштердің біріне ие болады.

Флораның түрлік құрамын зерттеу жалпы аймақтың флорасы мен ландшафттарының тарихын тану үшін де, өсіп келе жатқан антропогендік қысым жагдайында биоалуантүрлілікті сақтау және пайдалану жолдарын іздеу үшін де маңызды мәнге ие.

Зерттеулер эксперименттік учаскелерді егжей-тегжейлі зерттеумен ұштастыра отырып, маршруттық-рекогносцировкалық әдіспен жүргізілді. Зерттелетін Амангелді аумагында алгаш рет: *Asteraceae* (24 түр немесе 21,4 %, 17 түр), *Rosaceae* (15 түр немесе 13,39 %, 11 түр), *Brassicaceae* (11 түр немесе 9,82 %, 9 түр) қос жарнақты өсімдіктерден және *Poaceae* (11 түр, 12 түр немесе 10,71 %) дара жарнақты өсімдіктерден 112 түр анықталды. Басым тұқымдастардың үлесіне 62 түр келеді, бұл осы аумақта өсетін өсімдіктердің жалпы санының 55,36 %-ын құрайды. Жетекші туыстар: *Artemisia*, *Potentilla* және *Rumex*. Зерттеу аумагында өсімдіктердің 33 жемдік түрі анықталды: *Bromus inermis* (Leyss.) Holub., *Rumex confertus* Willd. Өсімдік жамылгысының тозуына байланысты арамшөптің саны 75 түрді құрады, олардың ішінде: *Rumex crispus* l., *Capsella bursa-pastoris* (L.) Medik., *Cannabis ruderalis* Janisch., *Lathyrus tuberosus* L. және т.б. бар. Эндем және сирек кездесетін түрлер табылган жоқ.

Жүргізілген зерттеулердің нәтижелері Алматы облысы, Амангелді ауылының флорасын тиімді пайдалануга, сондай-ақ биоэртүрлілікті сақтауга негіз болады. Амангелді кентінің флорасына жүйелі талдау жүргізу нәтижесінде алынган эндемизм және реликтілік орталықтарын анықтауга, сондай-ақ осы флораның басқа жақын флоралар қатарындагы орны мен рөлі мәселелерін шешуге мүмкіндік береді.

**Түйін сөздер:** Амангелді ауылы, систематикалық анализ, түрлік құрылым, түр, туыс, тұқымдас.

**З. А. Инелова[1], М. У. Айтжан[1], Е. Г. Запарина[1], Г. К. Ерубаева[2]**

[1]Казахский Национальный университет им. аль-Фараби, Алматы, Казахстан;
[2]Университет Туран, Алматы, Казахстан

## БИОРАЗНООБРАЗИЕ РАСТЕНИЙ МОНИТОРИНГОВОЙ ТОЧКИ С. АМАНГЕЛДЫ АЛМАТИНСКОЙ ОБЛАСТИ

**Аннотация.** В статье приведен систематический анализ видового состава растений флоры с. Амангельды Алматинской области.

Всестороннее изучение региональных флор приобретает всё большее значение в связи с реализацией решения проблемы изучения и сохранения биологического разнообразия. Полные сведения о составе флоры той или иной территории имеют важное теоретическое значение, позволяют установить структуру и генезис ее компонентов, выявить индивидуальные особенности, восстановить историю формирования и тенденции изменения. Это, в конечном итоге, является основой рационального использования растительных ресурсов и организации охраны редких и исчезающих видов растений, а также для решения многих хозяйственно важных проблем – выявления новых источников и ресурсов лекарственных, пищевых, кормовых, декоративных и других растений.

Одной из основных характеристик любой флоры является её систематическая структура, а именно соотношение семейств, родов и видов, с одной стороны, и количественные показатели этих таксонов, определяющие её богатство – с другой. Эти показатели являются составляющими систематического анализа флор в целом и ценофлор в частности, полученные при помощи такого анализа данные являются важным материалом для сравнительной флористики. С этой точки зрения систематическая структура флоры приобретает значение одного из существенных показателей, характеризующих флору в региональном плане.

Изучение видового состава флоры имеет большое значение как для познания истории флоры и ландшафтов региона в целом, так и для поиска путей сохранения и использования биоразнообразия в условиях нарастающего антропогенного давления.

Исследования проводили маршрутно-рекогносцировочными методом в сочетании с детальным исследованием экспериментальных участков. По результатам исследований флоры в Алматинской области, села Амангельды, с использованием маршрутного метода и метода закладывания пробных площадок в

100 м2, определено количество видов. На исследуемой территории Амангельды впервые выявлено: 112 видов из 88 родов и 29 семейств, с доминированием семейств *Asteraceae* (24 вида или 21,4 %, 17 родов), *Rosaceae* (15 видов или 13,39 %, 11 родов), *Brassicaceae* (11 видов или 9,82%, 9 родов) из Двудольных, и *Poacea* (11 родов, 12 видов или 10,71 %) из Однодольных растений. На долю доминирующих семейств приходится 62 вида, что составляет 55,36 % от общего количества видов растений, произрастающих на данной территории. Ведущие рода *Artemisia, Potentilla* и *Rumex.* На территории исследования выявлено 33 кормовых видов растений*: Bromus inermis* (Leyss.) Holub., *Rumex confertus* Willd., *Trifolium pratense* L., *Poa bulbosa* L. и др. В связи с деградацией растительного покрова количество сорных растения составило 75 видов, среди которых: *Rumex crispus* L., *Capsella bursa-pastoris* (L.) Medik., *Cannabis ruderalis* Janisch., *Lathyrus tuberosus* L. и др. Эндемичных и редких видов не обнаружено.

Результаты проведенных исследований послужат основой для рационального использования флоры с. Амангельды Алматинской области, а также сохранения биоразнообразия. Полученные в результате проведения систематического анализа флоры с. Амангельды, позволят выявить центры эндемизма и реликтовости, а также решать вопросы места и роли данной флоры в ряду других прилежащих флор.

**Ключевые слова:** с. Амангельды, систематический анализ, видовой состав, вид, род, семейства.

**Information about authors:**

Inelova Z.A., candidate of biological sciences, associate Professor; Deputy Dean for educational, methodical and educational work faculty Biology and Biotechnology, al-Farabi Kazakh National University, Almaty, Kazakhstan; z.inelova2015@gmail.com; https://orcid.org/0000-0001-8778-5848

Aitzhan M.U., PhD student faculty Biology and Biotechnology, al-Farabi Kazakh National University, Almaty, Kazakhstan; mentay1000@gmail.com; https://orcid.org/0000-0002-5945-7406

Zaparina Ye.G., master student faculty Biology and Biotechnology, al-Farabi Kazakh National University, Almaty, Kazakhstan; zaparina.elena06@gmail.com; https://orcid.org/0000-0001-6191-3573

Yerubayeva G.K., Candidate of Biological Sciences; Head of Department (Tourism and service), Turan University; https://orcid.org/0000-0001-9038-8616

## REFERENCES

[1] Tsahueva F.P. (2011) Systematic analysis of the flora of xerophilic communities in the foothills of Dagestan [Sistematicheskij analiz flory kserofil'nyh soobshhestv predgornogo Dagestana] Bulletin of the Socio-pedagogical Institute. N 4 (12) (in Russ.).

[2] Tursumbekova G. Sh., Petrachuk A.A. (2017) Species diversity of the grass-shrub layer of the Uspensky reserve in the Tyumen region [Vidovoe raznoobrazie travjano-kustarnichkovogo jarusa zakaznika «Uspenskij» Tjumenskij oblasti] Bulletin of the Altai state agrarian University. N 12 (158) (in Russ.).

[3] Myrzaly G.Zh., Ishmuratova M.U., Ivlev V.I., Matveev A.N. (2014) Analysis of the flora of the Ulytau mountains (Central Kazakhstan) [Analiz flory gor Ulytau (Central'nyj Kazahstan)]. N 4 (76). P. 45-52 (in Russ.).

[4] Giling D.P., Beaumelle L., Phillips H.R.P, Cesarz S., Eisenhauer N., Ferlian O., et al. (2018) A niche for ecosystem multifunctionality in global change research, Glob Chang Biol. P. 763-774 (in Eng.).

[5] Manning P., van der Plas F, Soliveres S., Allan E., Maestre F.T., Mace G., et al. (2018) Redefining ecosystem multifunctionality, Nat Ecol Evol. P. 427-436 (in Eng.).

[6] Maestre F.T., Quero J.L., Gotelli N.J., Escudero A., Ochoa V., Delgado-Baquerizo M., et al. (2012) Plant species richness and ecosystem multifunctionality in global drylands, Science. P. 214-218 (in Eng.).

[7] Tedersoo L., Bahram M., Põlme S., Kõljalg U., Yorou N.S., Wijesundera R., et al. (2014) Global diversity and geography of soil fungi. Science. 346: 1256688. (in Eng.).

[8] Grytnesn J-A, McCain C.M. (2007) Elevational trends in biodiversity, Encyclopedia of Biodiversity. P. 1-8 (in Eng.).

[9] Partel M., Bennett J.A., Zobel M. (2016) Macroecology of biodiversity: disentangling local and regional effects, New Phytol. P. 404–410 (in Eng.).

[10] Jimenez-Alfaro B., Girardello M., Chytry M., Svenning J.C., Willner W., Gegout J.C., et al. (2018) History and environment shape species pools and community diversity in European beech forests, Nat Ecol Evol. P. 483-90 (in Eng.).

[11] Martiny J.B., Bohannan B.J., Brown J.H., Colwell R.K., Fuhrman J.A., Green J.L., et al. (2006) Microbial biogeography: putting microorganisms on the map, Nat Rev Microbiol. 4: 102–12 (in Eng.).

[12] Vass M, S. L. (2017) The legacy of the past: effects of historical processes on microbial metacommunities, Aquat Micro Ecol. 79: 13–9 (in Eng.).

[13] Hu A., Wang J.c, Sun H.D, Niu B., Si G., Wang J., Yeh C.-F., Zhu X., Lu X., Zhou J., Yang Y., Ren M., Hu Y., Dong H., Zhang G. (2020) Mountain biodiversity and ecosystem functions: interplay between geology and contemporary environments // ISME Journal 2020 Springer Nature (in Eng.).

[14] Myers N., Mittermeier R.A., Mittermeier C.G., da Fonseca G.A.B., Kent J. (2000) Biodiversity hotspots for conservation priorities, Nature. 403: 853–8 (in Eng.).

[15] Magomadova R.S., Tajsumov M.A., Abdurzakova A.S., Astamirova M.A. M., Hasueva B.A., Omarhadzhieva F.S., Israilova S.A. (2014) Analysis of the xerophyte flora of The Russian Caucasus [Analiz flory kserofitov Rossijskogo Kavkaza], Bulletin of KrasGAU. N 6 (in Russ.).

[16] Ivanov A.L. (2018) Systematic analysis of the flora of The Russian Caucasus [Sistematicheskij analiz flory Rossijskogo Kavkaza] Bulletin of the Samara scientific center of the Russian Academy of Sciences, t. 20, N 5 (4) (in Russ.).

[17] Laktionov, Aleksej Pavlovich avtoref.disser.na soiskanie uch. stepeni doktora biol. nauk: Flora Astrahanskoj oblasti, ee analiz i sovremennoe sostojanie. Astrakhan, 2010 (in Russ.).

[18] Bajtulin I.O. (1978) Structure and operation of the root system of plants [Stroenie i rabota kornevoj sistemy rastenij]. Alma-ata, Nauka. 312 p. (in Russ.).

[19] Bajtulin I.O. (1984) Ecological conditionality and cenobiotic significance of the underground tier of phytocenosis / Bajtulin I.O. // Ecomorphosis of the plant root system in natural communities and culture. Alma-ata, Nauka. P. 132-152 (in Russ.).

[20] Nesterova S.G. (1984) Plant ecology of the middle mountains of the TRANS-ili Alatau: (water regime). Almaty: Science, 132 p. (in Russ.).

[21] Nesterova S.G. Экология высокогорных растений Заилийского Алатау. Алматы: Қазақ университеті, 1998. 107 p. (in Russ.).

[22] Nurzhanova A.A., Kalugin S.N., Ajtasheva Z.G., Zhumasheva Zh., Kashkeev K., Oraz S., Kusainova Zh., Turasheva S. (2014) Features of adaptive processes in plants of the Cucurbitaceae family growing under conditions of pesticide contamination [Osobennosti adaptivnyh processov u rastenij semejstva Cucurbitaceae, proizrastajushhih v uslovijah pesticidnogo zagrjaznenija] Bulletin Of KazNU ser. Biol. N 1/1 (60). P. 301-304 (in Russ.).

[23] Lavrenko E.M. and Korchagin A.A. (1959–1972) Field geobotany V. L. Komarov Botanical Institute of the USSR Academy of Sciences. M.-L. of the USSR Academy of Sciences. Vol. 1-4 (in Russ.).

[24] Vasil'evna A.N., Gamajunova A.P., Goloskokov V.P., Zajceva L.G., Karmysheva N.H., Orazova A., Roldugin I.I., Semiotrecheva N.L., Terehova V.I., Filatova N.S., Fisjun V.V., Cagolova V.G. (1956-1966) Flora Of Kazakhstan, Publishing house Of the Academy of Sciences of the Kazakh SSR, Almaty (in Russ.).

[25] Cherapanov S.K. Vascular plants of the USSR (1981) Leningrad "Science", Leningrad branch (in Russ.).