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FLORA OF THE AIYRTAU DISTRICT OF THE NORTH KAZAKHSTAN REGION: SPECIES COMPOSITION, LIFE FORMS AND ECOLOGICAL GROUPS OF PLANTS

The plants occurring in the flora of the Aiyrtau district of the North Kazakhstan region were selected as the object of research. During the study, it was found that the flora of the Aiyrtau district of the North Kazakhstan region consists of 80 plant species belonging to 22 genera and 60 families. Families, such as *Asteraceae* Bercht., *Amaranthaceae* Juss., *Fabaceae* Lindl., *Plantaginaceae* Juss., and *Poaceae* Barnhart., prevailed according to the number of species. Ecological analysis of plants has shown that mesophytes, mesoxerophytes, and hygromesophytes predominate. The classification of plant species by life forms revealed semi-shrubs – 2 species, perennial herbaceous plants – 53 species, annual herbaceous plants – 20 species, and biennial herbaceous plants – 5 species. According to C. Raunkiaer's classification, the following groups of plants were identified: hemicryptophytes (50 species; 62.5%), therophytes (11 species; 13.75%), cryptophytes (16 species; 20%), chamaephytes (1 species; 1.25%) and nanophanerophytes (2 species; 2.5%). The results of the research work allow for supplementing the data on the flora of the North Kazakhstan region, specifically the Aiyrtau district.

Key words: flora, biodiversity, systematic analysis, species composition, life forms, ecological groups of plants.

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Солтүстік Қазақстан облысы Айыртау ауданының флорасы: өсімдіктердің түрлік құрамы, тіршілік формалары және экологиялық топтары

Зерттеу нысаны ретінде Солтүстік Қазақстан облысы Айыртау ауданының флорасында кездесетін өсімдіктер таңдалды. Зерттеу барысында Солтүстік Қазақстан облысы Айыртау ауданының флорасынан 22 тұқымдас, 60 туысқа жататын өсімдіктердің 80 түрі анықталды. Түрлер саны бойынша *Asteraceae* Bercht., *Amaranthaceae* Juss., *Fabaceae* Lindl., *Plantaginaceae* Juss. және *Poaceae* Barnhart. сияқты тұқымдастар басым болды. Өсімдіктердің экологиялық талдауы мезофиттер, мезоксерофиттер және гигромезофиттердің басым екенін көрсетті. Өсімдіктердің тіршілік формалары бойынша жіктелуі бұталардың – 2 түрді, көпжылдық шөптесін өсімдіктердің – 53 түрді, бір жылдық шөптесін өсімдіктердің – 20 түрді және екіжылдық шөптесін өсімдіктерді – 5 түрді қамтитыны анықталды. К. Раункиер классификациясына сәйкес өсімдіктердің келесі топтарға бөлінді: гемикриптофиттер (50 түр; 62,5%), терофиттер (11 түр; 13,75%), криптофиттер (16 түр; 20%), хамефиттер (1 түр; 1,25%) және нанофанерофиттер (2 түр; 2,5%). Зерттеу жұмысының нәтижелері Солтүстік Қазақстан облысының, атап айтқанда Айыртау ауданының флорасы туралы деректерді толықтыруға мүмкіндік береді.

Түйін сөздер: флора, биоалуантүрлілік, жүйелі талдау, түрлік құрамы, тіршілік формалары, өсімдіктердің экологиялық топтары.

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Флора Айыртауского района Северо-Казахстанской области: видовой состав, жизненные формы и экологические группы растений

В качестве объекта исследования были выбраны растения, встречающиеся во флоре Айыртауского района Северо-Казахстанской области. В ходе исследования было установлено, что флора Айыртауского района Северо-Казахстанской области состоит из 80 видов растений, относящихся к 22 родам и 60 семействам. По количеству видов преобладали такие семейства, как *Asteraceae* Bercht., *Amaranthaceae* Juss., *Fabaceae* Lindl., *Plantaginaceae* Juss. и *Poaceae* Barnhart. Экологический анализ растений показал, что преобладают мезофиты, мезоксерофиты и гигромезофиты. Классификация видов растений по жизненным формам выявила полукустарники – 2 вида, многолетние травянистые растения – 53 вида, однолетние травянистые растения – 20 видов и двулетние травянистые растения – 5 видов. Согласно классификации К. Раункиера, были выделены следующие группы растений: гемикриптофиты (50 видов; 62,5%), терофиты (11 видов; 13,75%), криптофиты (16 видов; 20%), хамефиты (1 вид; 1,25%) и нанофанерофиты (2 вида; 2,5%). Результаты исследований позволяют дополнить данные о флоре Северо-Казахстанской области, в частности Айыртауского района.

Ключевые слова: флора, биоразнообразие, систематический анализ, видовой состав, жизненные формы, экологические группы растений.

Introduction

Conservation of biodiversity of animal and plant species, communities, and ecosystems is an integral part of the Concept of Humanity's Transition to Sustainable Development. Within the framework of this problem, the protection of life on the Earth is recognized as not just the narrow task of certain groups but the task of all of the living human inhabitants of the Earth and a condition for their survival on the planet. According to the Concept of Conservation and Sustainable Use of Biological Diversity of the Republic of Kazakhstan until 2030, the problem of biodiversity conservation and its rational use has become one of the great world priorities, which is due to the need to preserve biodiversity to ensure the existence and further development of mankind in connection with the aggravation of the global anthropogenic crisis of the Biosphere. It is necessary to preserve and restore rare and endangered plant species [1].

According to the research conducted by N.V. Pavlov and colleagues in the period from 1956 to 1966, it was found that 5,631 species of vascular plants are found in the flora of Kazakhstan. These species belong to 126 families and 1022 genera [2].

According to Abdullina (1999), a list of vascular plants of Kazakhstan was compiled, which lists 5,658 plant species belonging to 159 families and 1,067 genera [3].

Over the past decade, scientific research has been conducted to expand the species diversity of plants in Kazakhstan by identifying new species [4, 5 ,6, 7, 8].

In addition, the scientists conducted a study using a thorough analysis of various sources of information, including literary sources, herbarium collections, databases and field observations, to identify unique species of vascular plants growing in the country. As a result of the study, it was found that 451 species of endemic plants live in the country, which is 7.97% of the total number of vascular plant species. These endemics include 139 genera and 34 families and are mainly found in the southern regions of Kazakhstan, especially in the mountainous areas of the Kazakh part of the Tien Shan, such as Karatau (123 species), Dzungarian Alatau (80 species), Zailiysky, and Kungeysky Alatau (50 species) [9].

In recent years, scientists have conducted studies of flora in the northern regions of Kazakhstan. According to the results of a systematic analysis of the flora of the territory of Zerendinsky district of Akmola region, 136 species of plants belonging to 108 genera and 41 families were identified. The gymnosperms (*Pinophyta*) were represented by 1 species, dicotyledons (*Magnoliopsida*) by 115 species, and monocotyledons (*Liliopsida*) by 20 species. The number of species was dominated by the families *Asteraceae* (25 species or 21.74%), *Rosaceae* (14

species or 12.17%), and *Fabaceae* (11 species or 9.56%). In the class *Liliopsidae*, the genus *Poaceae* (10 species or 50%) predominated by the number of species, with *Juncaceae* Juss. (4 species or 20%) in second place and *Liliaceae* Juss. (2 species or 10%) in third place. Polycarpic plants (80.88%) are more numerous than monocarpic plants (19.12%) [10].

Systematic analysis of weed plants in the flora of Zerendinsky district of Akmola region revealed 84 species belonging to 70 genera and 29 families. According to the number of species, the family *Asteraceae* Dumort. occupies the first place (18 species or 21.4%), followed by *Poaceae* Barnhart. (8 species, 9.5%), and then by *Fabaceae* Lindl. (7 species, 8.3%). Next were the families *Scrophulariaceae* Juss. (5 species), *Boraginaceae* Juss., and *Rosaceae* Juss. (4 species each), with other families having 3 to 1 species each [11, 12].

The family *Orchidaceae* Juss has been studied in the steppe, forest-steppe, and desert regions of the northern part of Kazakhstan (Pavlodar, North Kazakhstan, Kostanay, Akmola, Aktobe, West Kazakhstan, partially Karaganda, and East Kazakhstan regions). A total of 25 species belonging to 16 genera have been identified, eight of which are included in the Red Book of Kazakhstan (2014). Additionally, according to research, it is proposed to expand the number of protected orchids by adding nine species [13].

According to available literature data, some areas of Northern Kazakhstan require additional study of the species composition of plants. Therefore, the main purpose of our study is to conduct a comprehensive analysis of the species diversity of flora, study its life forms, and identify ecological groups of plants in the Aiyrtau district of the North Kazakhstan region.

Aiyrtau district (formerly Volodarsky) is a district in the North Kazakhstan region of Kazakhstan. The district was formed on the territory of the abolished Kokchetavsky district of the Akmola province of the Russian Soviet Federative Socialist Republic on January 17, 1928, and was named Volodarsky district. On March 16, 1944, the district was transferred from North Kazakhstan to the newly formed Kokchetav region. On May 4, 1993, Volodarsky district of the Kokchetav region of the Republic of Kazakhstan was renamed Aiyrtau district [14].

In 1997, the district, like all other districts of the abolished Kokshetau region, became part of the North Kazakhstan region [15].

Currently, it is one of the largest districts in the North Kazakhstan region. The climate is sharply continental and belongs to the West Siberian climatic region of the temperate zone. Winters are cold and long, and summers are relatively hot, with clear, often arid weather prevailing. The average temperature in January is -18.6°C, in July +19.0°C. The lowest air temperatures are about -48°C (Bulaevo station, 1968), and the highest is about +41°C (Sergeevka city, 2014). The duration of the period with average daily temperatures above 0°C is an average of 125 days. The average date of temperature transition after 0°C is April 10-15, and after +5°C – April 22-25 [16].

The length of the day varies from 7 to 17 hours throughout the year. During the year, up to 78 cloudless days are observed in the northern regions of the region, and up to 41 in the southern regions. The sunshine duration per year is 1900-2000 hours [16].

The average annual precipitation is 350 mm, of which 80-85% falls in the warm season (April-October). The snow cover lies for about 5 months – from November to March, and by the end of winter, it has an average thickness of 25 cm [16].

The territory of the Aiyrtau district of the North Kazakhstan region is located within the forest-steppe zone in the zone of the forest-steppe strip with birch-spike forests and pine forests. Vegetation is represented by the following types: forest communities; steppe communities; meadow vegetation.

This study's purpose was to investigate the species composition of the flora and life forms and to determine the ecological groups of plant species of the Aiyrtau district of the North Kazakhstan region.

Materials and methods

The species composition of plants was studied by conducting route surveys according to the method of specific floras by A. I. Tolmachev (1986) [17]. Plants were collected from June to August. Herbarium materials were collected and processed according to the generally accepted method of A. K. Skvortsov (1977) [18].

To identify plant species and describe them, the following works were used: "Flora of Kazakhstan" (1956-1966) [1] and "Flora of Kazakhstan" by M. S. Baytenov in two volumes (1999, 2001) [19].

The Latin names of species and genera of weed plants were written according to the work of S. K. Cherepanov (1995) [17]. The study of plant life forms was carried out according to I. G. Serebryakov (1962) [18] and C. C. Raunkiaer [19].

In the study of ecological groups concerning moisture, the works of G.H. Poplavskaya (1948) [20] and A.P. Shennikov (1950) [21] were used.

Results and discussion

According to the results of own field studies, the list of plant species growing on the territory of the Aiyrtau district of the North Kazakhstan region was compiled, and 80 species from 60 genera and 22 families were found (Table 1).

The first place in the total number of species is occupied by the families *Asteraceae* (20 species or 25%), the second place is occupied by the families *Amaranthaceae* and *Fabaceae* (8 species or 10%), and the third place is occupied by the families *Polygonaceae (*5 species or 6.25%).

The families *Poaceae* and *Brassicaceae* are represented by 4 species each (5%); 3 species (3.75%) from the families *Apiaceae, Lamiaceae,* and *Scrophulariaceae*; from the families *Boraginaceae, Geraniaceae, Lythraceae, Orobanchaceae, Plumbaginaceae, Plantaginaceae*, and *Rosaceae* – 2 species each (2.5%); and from the remaining families – 1 species each (1.25%).

Table 1 – Taxonomic composition of plant species of the flora of the Aiyrtau district

Family	Number of genera	% of the total number of genera	Number of species	% of the total number of species
Asteraceae Dumort	15	25,00	20	25,00
Amaranthaceae Juss.	8	13,32	8	10,00
Fabaceae Lindl.	6	10,00	8	10,00
Polygonaceae Juss.	2	3,33	5	6,25
Poaceae Barnhart.	3	5,00	4	5,00
Brassicaceae Burnett.	3	5,00	4	5,00
Plantaginaceae Juss.	2	3,33	4	5,00
Apiaceae Lindl.	3	5,00	3	3,75
Lamiaceae Lindl.	2	3,33	3	3,75
Scrophulariaceae Lindl	2	3,33	3	3,75
Boraginaceae Juss	2	3,33	2	2,50
Rosaceae Juss.	2	3,33	2	2,50
Geraniaceae Juss.	1	1,67	2	2,50
Plumbaginaceae Juss.	1	1,67	2	2,50
Orobanchaceae Lindl	1	1,67	2	2,50
Lythraceae Lindl	1	1,67	2	2,50
Crassulaceae DC.	1	1,67	1	1,25
Gentianaceae Lindl	1	1,67	1	1,25
Alismataceae DC.	1	1,67	1	1,25
Onagraceae Lindl	1	1,67	1	1,25
Urticaceae Juss.	1	1,67	1	1,25
Cyperaceae J. St. Hill.	1	1,67	1	1,25

As a result of the study, it was revealed that the main genera of plants are *Achillea* L. (4 species, 5%), *Polygonum* L., and *Plantago* L. (3 species each, 3.75%), *Setaria* P.Beauv., *Lathyrus* L., *Melilotus* Mill., *Leonurus* L., *Lepidium* L., *Erigeron* L., *Artemisia* L., *Limonium* Mill., *Geranium* L., *Veronica* L., *Odontites* Zinn., *Rumex* L., and *Lythrum* L. (2 species each, 2.5%). The remaining 44 genera consist of 1 species each (1.25%) (Fig. 1).

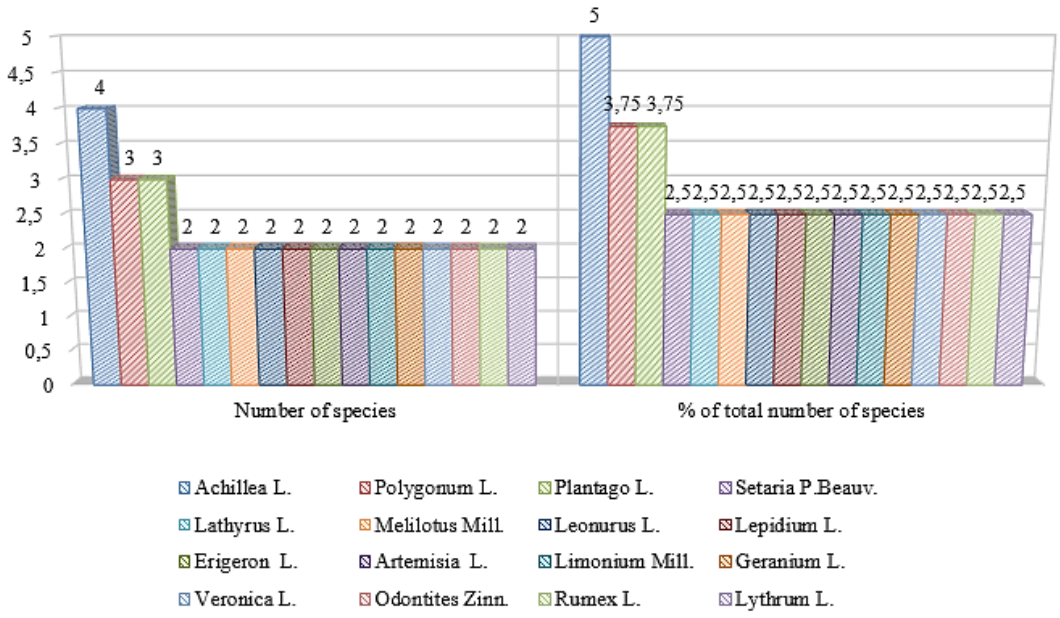

Figure 1 – The main genera of the flora of the Aiyrtau district

The flora of the Aiyrtau district of the North Kazakhstan region has a diverse range of plants adapted to different moisture levels. Among them, a wide range of species was identified, from plants that can survive in low humidity conditions (xerophytes) to those that prefer large amounts of moisture (hydrophytes, hygrophytes, hygromesophytes).

In general, the largest share of the total composition of the flora of the study region is occupied by mesophytes, which is 53.75%. Additionally, about 12.5% of plants are xerophiles, including xeromesophytes and xerophytes. About 20% of species are adapted to excessive moisture conditions, including hydrophytes, hygrophytes, and hygromesophytes. Transitional groups of mesohygrophytes and mesoxerophytes account for 13.75% (Fig. 2).

Life forms are distinctive external manifestations of organisms, shaped by developmental biology and the internal structure of their organs, influenced by soil and climatic conditions as adaptations to their environment. The exploration of life forms and their dynamics holds paramount significance in understanding the patterns of adaptation among populations and individual organisms to specific environmental conditions.

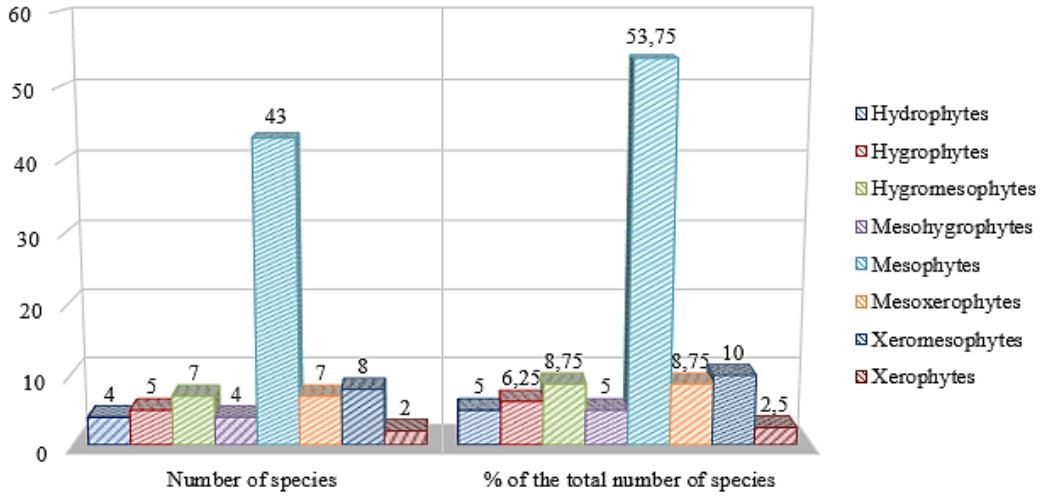

Figure 2 – Ecological groups of plants of the Aiyrtau district

During the research, life forms of plants were determined. It was found that the flora of the study area includes semi-shrubs – 2 species, herbaceous plants – 78 species, including polycarpic grasses (53 species, 66.25%) and monocarpic grasses (25 species, 31.25%) (Fig. 3).

Semi-shrubs include *Eurotia ceratoides* L. and *Rubus idaeus* L.; perennial herbaceous plants include *Achillea millefolium* L., *Sanguisorba officinalis* L., and *Cichorium intybus* L.; biennials include *Melilotus officinalis* (L.) Pall., *Erigeron acris* L., and *Cynoglossum officinale* L.; and annuals include *Setaria viridis* (L.) P.Beauv., *Lepidium ruderale* L., and *Erigeron canadensis* L..

C. Raunkiaer divided all plants into 5 types of life forms, which he also called biological types. Each of C. Raunkiaer's life form types is further subdivided into 3-15 subtypes characterized by different characters and arrangement of shoots, protection of buds, and other morphological features. The plants studied include 2 species of nanophanerophytes (2.5%), 1 species of chamaephytes (1.25%), 50 species of hemicryptophytes (62.5%), 16 species of cryptophytes (20%), 11 species of therophytes (13.75%) (Fig. 4).

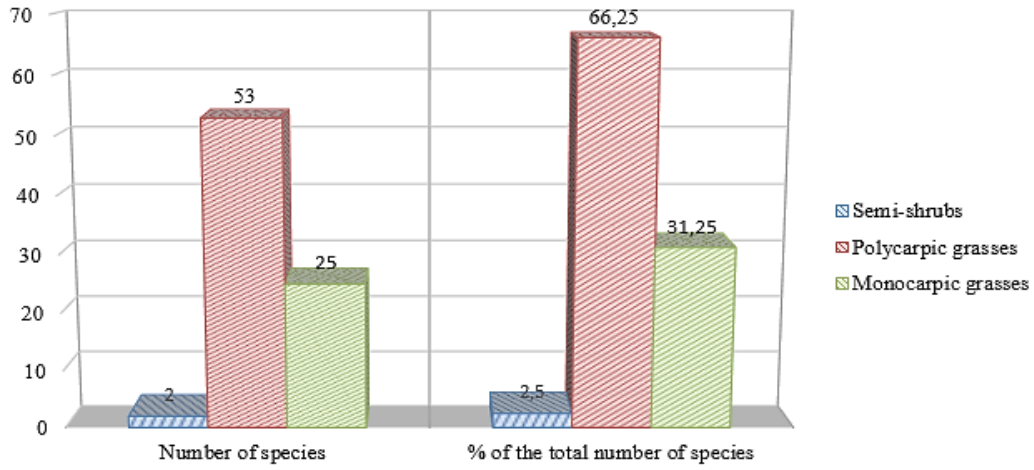

Figure 3 – Life forms of plants of the Aiyrtau district

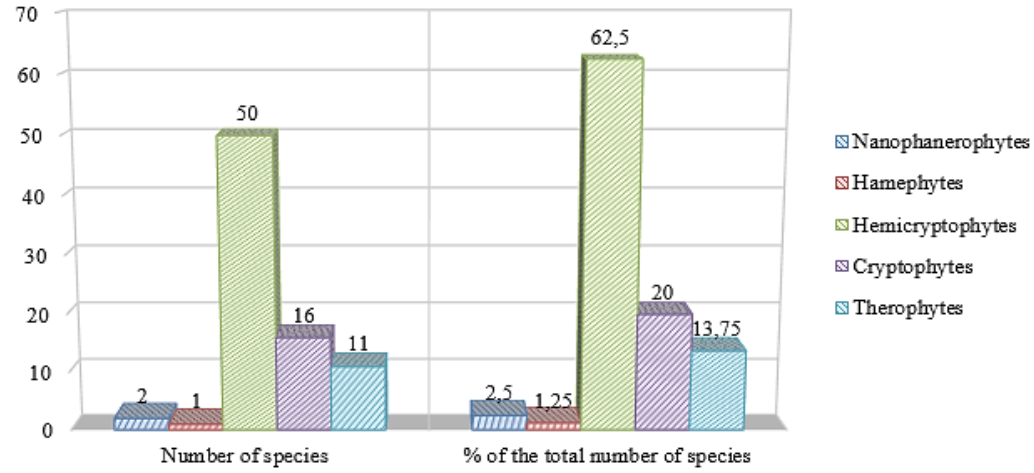

Figure 4 – Classification of plant life forms according to C. Raunkiaer of the Aiyrtau district

Nanophanerophytes include *Eurotia ceratoides* L. and *Rubus idaeus* L.; hemoptytes include *Artemisia austriaca* Jacq.; hemicryptophytes include *Phlomoides tuberosa* (L.) Moench, *Plantago major* L., and *Tanacetum vulgare* L.; cryptophytes include *Bromus inermis* Leyss., *Cirsium arvense* (L.) Scop.;

and therophytes include *Lepidium ruderale* L., *Amaranthus retroflexus* L., and *Urtica urens* L.

Conclusion

In the flora of the Aiyrtau district of the North Kazakhstan region, 80 species of plants belonging to 22 genera and 60 families are revealed. The largest share by ecological groups of plants is occupied by mesophytes, accounting for 53.75%. It was found that, depending on the life forms of plants, semi-shrubs include 2 species, and herbaceous plants comprise 78 species. According to the system of C. Raunkiaer, hemicryptophytes predominated.

Thus, the list of species composition of plants in the territory of the North Kazakhstan region was compiled.

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