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SPECIES DIVERSITY OF FOREST-STEPPE FLORA OF AKKOL DISTRICT OF AKMOLA REGION

This article presents the results of studies of species diversity of floristic complex of Akkol district. This district is located in the north-eastern part of Akmola region, Republic of Kazakhstan. The studied area is characterised by forest-steppe and steppe vegetation growing mainly on chernozem soil. The research was carried out in spring and summer during field expeditions. The standard methodology of ecological profiles was used to describe plant communities. Plots of 15x15 m were laid out. Then the spectrum of plant communities characteristic for each zone was determined. Geobotanical indices were determined at each site. The Drude scale was used to estimate abundance. The inventory revealed that the flora of the forest-steppe complex is represented by 138 species belonging to 87 genera and 30 families. There are 120 species of dicotyledonous plants, which is 87 %, and 18 species of monocotyledonous plants, which is 13 % of the total species diversity. The ratio of monocotyledons to dicotyledons is 1:6.6. Most genera in this floristic complex are represented by one species, respectively the average value is 1.5. The autochthonous tendency of flora formation in Akkol district of Akmola region is confirmed by the complete absence of endemic species in the studied area.

Key words: species diversity, steppe flora, forest flora, floristic complex, taxonomic composition

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[2]Қазақстан Республикасы экология және табиғи ресурстар министрлігі орман шаруашылығы және жануарлар дүниесі комитеті, Астана, Қазақстан
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Ақмола облысы Ақкөл ауданының орманды-дала флорасының түр алуандығы

Бұл мақалада Ақкөл ауданының флористикалық кешенінің түрлік әртүрлілігін зерттеу нәтижелері келтірілген. Бұл аудан Қазақстан Республикасы, Ақмола облысының солтүстік-шығыс бөлігінде орналасқан. Зерттелетін аймақ негізінен қара топырақты топырақта өсетін орманды-дала және дала өсімдіктерімен сипатталады. Зерттеулер 2024 жылдың вегетациялық кезеңінде көшпелі экспедициялар кезінде жүргізілді. Өсімдіктер қауымдастығын сипаттау кезінде экологиялық профильдердің стандартты әдісі қолданылды. Көлемі 15х15 м болатын алаңдар салынды, содан кейін әр аймаққа тән өсімдіктер қауымдастығының спектрі анықталды. Әр алаңда геоботаникалық көрсеткіштер анықталды. Молшылықты бағалау үшін Друде шкаласы қолданылды. Түгендеу барысында орманды-дала кешенінің флорасы 87 ұрпақ пен 30 отбасына жататын 138 түрден тұратындығы анықталды. Қосжарнақты өсімдіктердің 120 түрі бар, бұл 87 %, біржарнақты өсімдіктердің 18 түрі, бұл барлық түрлердің 13 % құрайды

Түйін сөздер: түрлердің әртүрлілігі, дала флорасы, орман флорасы, флористикалық кешен, таксономиялық құрамы

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Видовое разнообразие лесостепной флоры Аккольского района Акмолинской области

В данной статье приведены результаты исследований видового разнообразия флористического комплекса Аккольского района. Данный район расположен в северо-восточной части Акмолинской области, Республики Казахстан. Изучаемый участок характеризуется лесостепной и степной растительностью, произрастающей преимущественно на черноземной почве. Исследования проводились в вегетационный период 2024 года во время выездных экспедиций. При описании растительных сообществ применялась стандартная методика экологических профилей. Закладывались площадки размером 15х15 м. Затем определялся характерный для каждой зоны спектр растительных сообществ. На каждой площадке определялись геоботанические показатели. Для оценки обилия использовались шкала Друде. В ходе инвентаризации выявлено, что флора лесостепного комплекса представлена 138 видами, которые относятся к 87 родам и 30 семействам. Двудольных растений насчитывается 120 видов, что составляет 87 %, однодольных 18 видов, что составляет 13 % от всего видового разнообразия. Соотношение однодольных растений к двудольным растениям составляет 1:6,6. Большинство родов в данном флористическом комплексе представлено одним видом, соответственно среднее значение составляет 1,5. Автохтонная тенденция формирования флоры Аккольского района Акмолинской области подтверждается полными отсутствием эндемичных видов на исследованной территории.

Ключевые слова: видовое разнообразие, степная флора, лесная флора, флористический комплекс, таксономический состав

Introduction

The study of species diversity of the flora is currently of great scientific interest. The study of steppe flora of some poorly studied regions of Akmola region is the most actual [1-3].

One of the actual aspects of studying species diversity of plants in natural habitats is continuous monitoring of species. At present, it is necessary to study the floristic list of plants, which has not been updated for several decades. To date, large-scale studies in Akmola region date back to the early 1980s, reflected in the works of T.A. Ten [4]. The literature review revealed scattered data devoted to the study of individual floristic groups of plants and ecological biotopes in different areas [5-7].

In-depth floristic researches of separate natu- ral regions acquire special urgency also in connec- tion with excessive and long-term exploitation of steppe pastures, leading in some cases to irrevers- ible changes of primordial biocenoses, reduction of areas and disappearance of rare plant species. For the rational use and conservation of plant wealth of a particular area it is extremely important to identify, if possible, the full composition of its flora. Studies of regional floras are of primary importance in this case, allowing to characterise the flora both qualitatively and quantitatively

The analysis of species diversity of the flora of the Akkol district allowed to reveal the features of its heterogeneous flora, which is the result of the impact of different floristic centres and different-age formation of individual taxa, as well as the impact on it sharp-continental climate. One of the important conditions for the study of a particular flora is the identification of floristic complexes. According to the classification of A. I. Tolmachev [1], a floristic complex formed on a certain territory and space with further dynamics of plant development combines elements of the main four directions:

1. Vestiges of a flora of a different type, preserved locally in a more or less unchanged state, preserved in the area in an unchanged state and to some extent not combined with the new conditions of the flora and its appearance (relict elements of the flora). These elements are much older than the present floristic complex;

2. Ancient core of the flora – species harmonising with the modern appearance of the flora and conditions of its development, representing earlier local flora, in which they could occupy a low-noticeable position, due to adaptation to specific habitat condi-

tions and formed in connection with its formation. Such species are partly older than the flora of the complex and do not always correspond to the moment of its formation.

3. Migratory elements that are of different ages, both in terms of the time of their origin and the period of their introduction into the flora. However, as its components, younger than species of the earlier categories.

4. Autochthonous neoplasms that emerged as second- and third-order derivatives. Such species are much younger than the time of the initial forma- tion of the flora.

The first two groups can be conventionally grouped into primary elements of the flora, the next two groups are secondary

The species diversity of the flora of the study area is strongly influenced external factors such as climate and water balance. Climate change is a regulating factor and the main cause of extinction, transformation and establishment of new floras. All this in the course of a long time has led to the extinction of some species and the formation of new ones. The complex of external influences caused progressive and regressive changes of habitats forming flora. In the course of evolution in Akkol district of Akmola region of Akmola region, a typical floristic complex was formed, represented by forest-steppe, meadow-steppe and grass-meadow flora [8]

The aim of this study is to investigate the species diversity of forest-steppe flora of Akmola region on the example of Akkol district.

Materials and methods of research

The main methods of field studies of the flora of Akkol district of Akmola region were generally accepted classical methods of botanical and floristic studies: field expeditions, in the field traditional route-reconnaissance for the study of plant communities and plant collection [9]. Collection and processing of herbarium material was carried out according to generally accepted methods [10-12]. Plant specimens were collected in clear, dry weather in herbarium folders with a description of collection sites, date and name of the collector. Drying and processing of herbarium sheets were carried out according to standard methods. Identifiers [13- 21] were used to determine the species affiliation of plants.

Standard methodology of ecological profiles was used to describe plant communities. Plots of 15x15 m were laid out. Then the spectrum of plant communities characteristic for each zone was determined. On each ecological profile, the main geobotanical indices were determined: vitality, abundance, and coverage area. The index of projective cover provides an indication of the overall connectivity of the vegetation cover, as well as of the proportion of participation of its constituent species. The Drude scale was used to estimate abundance [22, 23].

The results of the study and their discussion

Location of Akmola Region. Akmola region is located in the north-central part of Kazakhstan. The territory of the region is vast and makes up 146, 2 thousand square metres. The region includes two large cities of regional significance – Kokshetau and Stepnogorsk. There are eight cities of district subordination. The Akkol district under study is located in the north-eastern part of Akmola region.

The area of the territory is 9.4 thousand km², which is 6.43% of the total territory of the Region, the 6th district in terms of the size of the territory in the Region. Its length from north to south is 95 km, from west to east – 160 km. It borders: the north with Birzhan sal district, in the north-east, east with Stepnogorsk city administration, in the south-east with Ereimentau districtShortanda district, in the south with , in the west with Astrakhan districtdistrict, in the north-west with Bulandyn

The relief is plain-shallow-sloping, with altitudes ranging from 200 to 400 metres. The highest central part of the mountain Dombyraly, 471 m. The climate is continental. Winter is cold, long, aver- age temperature of January 17-18°C; summer, hot, short, average temperature of July 20°C. Annual precipitation is 350-400 mm. The territory of Akkol district is located within the steppe zone. Chernozem soils prevail.

Taxonomic composition of flora. According to the results of long-term field studies in Akmola region on the territory of Akmola district we have identified the following types of landscape vegetation: steppe, typechak-pollen, desert-steppe, mixed grass-meadow, forest-steppe, deciduous-forest and shrub vegetation.

In general, the vegetation cover is characterised by complexity and mosaicism. The flora of vascular plants in the forest-steppe floristic complex includes 138 species belonging to 87 genera and 30 families. The overwhelming majority of species belong to flowering plants, of which 120 species (87 %) are dicotyledonous and 18 species (13 %) are unicotyledonous. The ratio of monocotyledonous plants to dicotyledonous plants is 1:6.6. The numerical ratio of the flora of Akkol district is 30:87:138. On aver-

age, there are 1.5 species per genus, which is due to the large number of genera represented by only one species. The autochthonous tendency of floristic complex development on the example of Akkol district is practically not expressed, which is confirmed by the absence of endemic species.

Figure 1 – Location map of Akkol district, Akmola region

The leading position in the species diversity of the flora is occupied by families containing from 3 to 17 species. The greatest species richness is characterised by *Asteraceae, Rosaceae, Poaceae, Fabaceae, Ranunculaceae, Brassicaceae, and Cyperaceae*. The 7 leading families account for more than half of the total species diversity. Other families are represented by 1-3 species.

At the level of genera in the floristic complex of Akkol district the following genera are most richly represented: *Artemisia* (8 species), *Agropy- ron, Stipa, Poa, Avena, Festuca, Hordeum, Allium, Achillea, Aster* (5-3 species) other genera contain 1-2 species each. Steppe flora of the Akkol district was formed as a result of long-term aggregation of different florogenetic complexes with different ecological origin.

As presented in Table 1, the greatest species diversity in the floristic complex of Akkol district is characterised by the families *Asteraceae* (26; 18.8%), *Rosaceae* 24; 17.4%), *Fabaceae* (17; 12.3%), *Poaceae* (14; 10.1%), *Brassicaceae* (13; 9.4%), *Ranunculaceae*, and *Cyperaceae* (9; 6.5%), *Chenopodiaceae* (8; 5.8%).

Table 1 – The largest families of the floristic of the Akkol district complex

№	Families	Number of Genera	Number of Species	% of Total Species
1	*Asteraceae*	18	26	18,8
2	*Rosaceae*	11	24	17,4
3	*Poaceae*	9	17	12,3
4	*Fabaceae*	9	14	10,1
5	*Brassicaceae*	11	13	9,4
6-7	*Ranunculaceae*	8	9	6,5
6-7	*Cyperaceae*	7	9	6,5
8	*Chenopodiaceae*	5	8	5,8

The first two families are the most diverse in terms of species composition and in total represent 50 species or 36.2% of the studied floristic complex. The contribution of *Poaceae* family is 17 species or 12, 3 %, *Fabaceae* 14 species or 10,1 %.

During the inventory of species composition of the floristic complex of the steppe zone, the greatest biodiversity was revealed for 12 dominant genera presented in Figure 2. These genera belong to the families: *Asteraceae, Poaceae, Amaryllidaceae* and others.

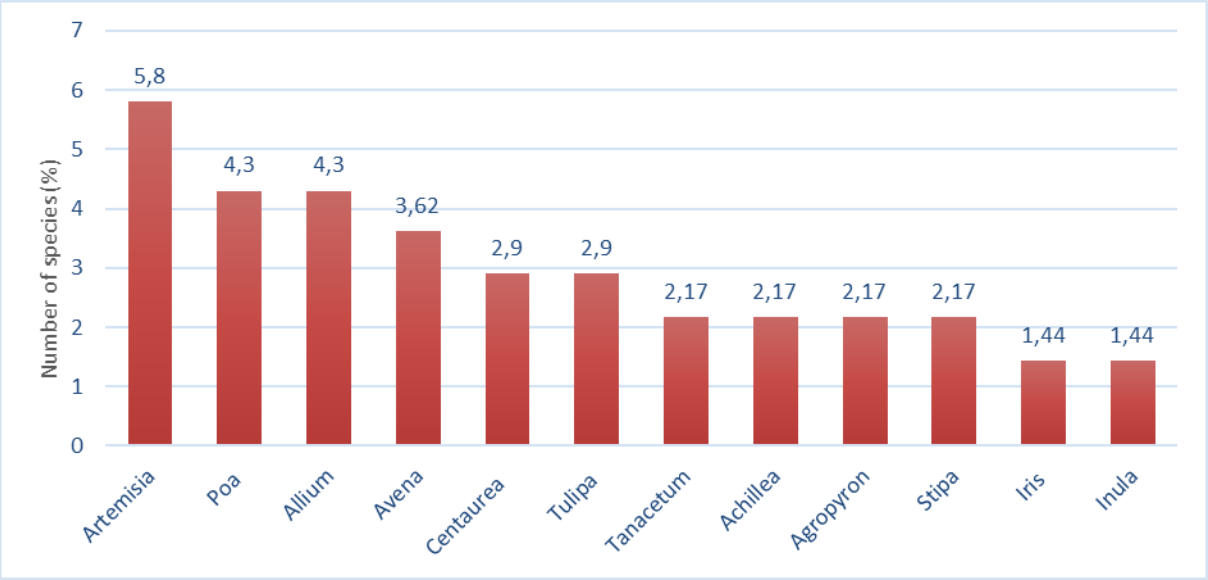

Figure 2 – Species diversity of dominant genera of the steppe zones of Akkol district

Thus, the maximum species diversity is characteristic for genus Artemisia, represented by 8 species or 5.8%; two genera *Poa* and *Allium*, represented by 6 species of steppe plants or 4.3%; genus Avena 5 species or 3.62%; equal contribution to the species diversity of the flora made two species *Centaurea* and *Tulipa* 4 species each, which is 2.9% of the total flora. The following equal contribution to the formation of flora of Akkolsky area falls on four genera – *Tanacetum, Achillea, Agropyron and Stipa*, each genus is formed by 3 species or 2.17%; the smallest species assortment is established for genera *Iris* and *Inula* on 2 species on the studied sites or 1.44%

The forest zone of the studied area is characterised by a great diversity of representatives of the following families: *Rosaceae, Fabaceae, Lamiaceae, Caryophyllaceae, Chenopodiaceae, Boraginaceae, Apiaceae, Liliaceae and Ranunculaceae.*

According to the figure, the maximum amount of species diversity in the forest zone of the floristic complex of Akkol district is represented by the following genera:

Filipendula – this genus is represented by 8 species or 5,79 %; 7 species or 5 % is characterised by the genus *Rosa*, the genera *Ranunculus* and *Astragalus* are represented by 6 species, which makes 4,34 %; the genus Gagea in the forest-steppe zone is represented by 4 species, making 2,89 % of the total number of species diversity; same number of species is characteristic for genera *Sanguisorba, Euphorbia* and *Spirea* with 3 species in one genus or 2,17 %; the following three genera *Convolvus, Eringium* and *Cerasus* have 2 species in their genera, that makes 1,44 % from the total assortment of species.

The conducted research allowed to identify the most frequently occurring plant species growing in the floristic complex of Akkol district, Akmola region, Akmola region. The analysis of sites revealed the most frequently occurring mesophytic species for the forest zone – *Rosa majalis herrm., rosa canina L., Ranunculus acris L., R. repens L., Filipendula ulmaria (L.) Maxim, Fragaria vesca, Potentilla anserina L., Sanguisorba officinalis L.* and other species.

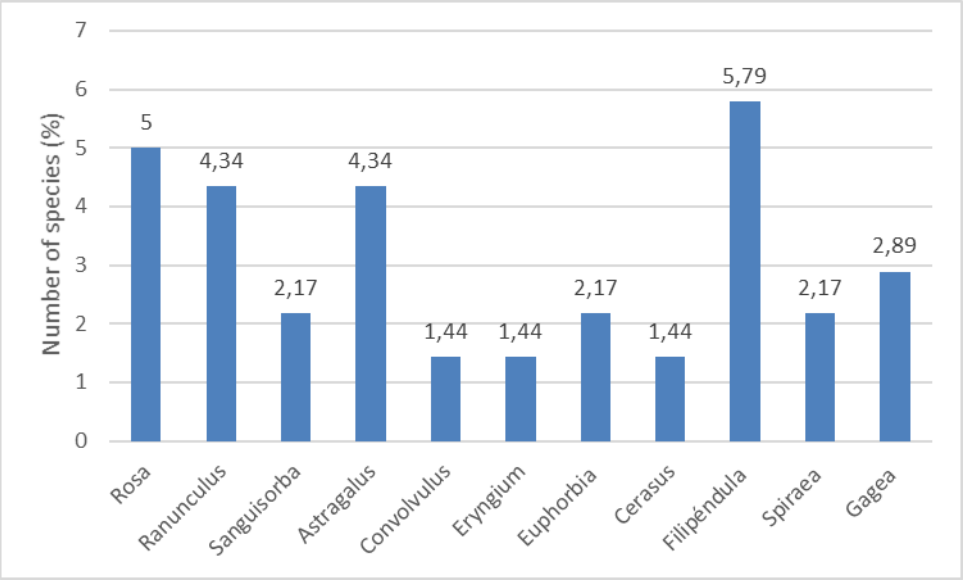

Figure 3 – Species diversity of dominant forest genera zones of Akkol district

The steppe zone is characterised by xerophytes growing abundantly, forming continuous covers such *Artemisia absinthium* L., A. *vulgaris* L., A. *cina* Berg., A. *nitrosa* Weber ex Stechm., *Stipa capillata* L., *Stipa pennata* L., *Agropyron repens* (L.) Beauv.

Plant species (*Filipendula vulgaris, Sanguisorba officinalis, Spiraea crenata, Cerasus fruticosa, Eryngium foetidum. Euphorbia milii*, etc.) included in the above genera make a significant contribution to the formation of forest-steppe zone of the study area (Table 2).

Life forms. Analysis of life forms of plants of Akkol district showed that forest-steppe floristic complex is characterised by dominance of herbaceous plants (121 species – 87.7 %), most of which are herbaceous polycarpic (103 species – 74.6 %), which is typical for temperate floras. Herbaceous monocarpics are represented by a smaller number of representatives (18 species – 13%). The assortment of shrubs and bushes is quite diverse, totalling 12 species – 8.7 %, the woody life form is represented by 5 species – 3.6 %.

Table 2 – Frequency of occurrence of dominant species in steppe and forest-steppe zone of Akkol district

№ п/п	Symbol according to O. Drude	Abundance Characteristics	Main Representatives of the Steppe Zone	Main Representatives of the Forest Zone
1	*Socialis (Soc.)*	Plants forming a continuous cover, merging with their aerial parts to create a general background	*Stipa pennata, Stipa lessingiana, Elytrigia repens*	*Filipéndula vulgáris*
2	*Copiosae (Cop.)*	Plants occurring in large quantities, but their aerial parts do not merge	*Serratula cardunculus (Pall.) Schischk, Artemisia annua L., Artemisia vulgaris L., Artemisia pontica L., Artemísia absínthium*	*Sanguisorba officinalis, Spiraea crenata*
3	*Cop.3*	Very abundant, but does not form a background	*Polygonum aviculare L., Poa annua L.,*	*Cerasus fruticos*a
4	*Cop.2*	Abundant, with many individuals of this species	*Ranunculus polyanthemos L., Poa pratensis L.*	*Prunus cerasus, Gagea lutea*
5	*Cop.1*	Abundant	*Rosa canina L., Rosa majalis Herrm., Rumex confertusWilld., Salix acutifoliaWilld, Salix alba L., Salvia stepposa Des.-Shost., Avena sativa*	*Eryngium campestre L.*

Continuation of the table

№ п/п	Symbol according to O. Drude	Abundance Characteristics	Main Representatives of the Steppe Zone	Main Representatives of the Forest Zone
6	*Sparsae (Sp.)*	Plants occur occasionally, scattered, in small numbers	*Inula britannica L., Potentilla anserina L., Potentilla bifurca L., Pulsatilla orientali-sibirica Stepanov., Pulsatilla patens., Avena strigose, Avena byzantica K. Koch.*	*Eryngium foetidum., Euphorbia milii* *Rubus saxatilis*
7	*Solitaria (Sol.)*	Plants occur rarely, as isolated individuals	*Iris halophila Pall., Potentilla humifusa Willd. ex Schltdl.*	*Rubus saxatilis*
8	*Unicum (Un.)*	Species represented by a single specimen within the sample plot	*Psylliostachys suworowii (Regel) Roshkova.*	*Equisetum arvense* L.

Conclusion

As a result of long-term research we have revealed the species composition of floristic complex of Akkol district of Akmola region. Taxonomic analysis of the flora was carried out, forest and steppe flora of the study area was characterised. In general, the vegetation cover is characterised by complexity and mosaicism. The flora of vascular plants in the forest-steppe floristic complex includes 138 species belonging to 87 genera and 30 families. The overwhelming majority of species belong to flowering plants, of which 120 species (87 %) are dicotyledonous and 18 species (13 %) are unicotyledonous. The ratio of monocotyledonous plants to dicotyledonous plants is 1:6.6. The numerical ratio of the flora of Akkol district is 30:87:138. On average, there are 1.5 species per genus, which is due to the large number of genera represented by only one species. The autochthonous tendency of floristic complex development on the example of Akkol district is practically not expressed, which is confirmed by the absence of endemic species.

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