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Macrophytes of the Floodplain swamps of the Akmola Region

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Abstract. This paper presents the results of the research on macrophytes of floodplain swamps of the coastal territories of the Aktastinka River and wetlands of Aktasty village, located in Arshalinsky district, Akmola region of the Republic of Kazakhstan. The inventory revealed the floristic composition of the Aktastinka village locality and the coastal territory. Along with species diversity, the main representatives of macrophytes of the bog flora were identified, represented by 8 hydrophytes – *Phragmites australis, Carex rostrata, Typha angustifolia, Ranunculus repens L., Triglochin maritimum L., Stratiotes aloides L., Utricularia vulgaris L., Lemna minor L.*, etc. In the flora of the study area, four types of plant communities were found, with the dominance of representatives of the following families: *Poaceae, Typhaceae, Cyperaceae, Ranunculaceae, Amaryllidaceae, Butomaceae, and Lentibulariaceae* spanning several kilometres. Comparative analysis of macrophyte floras at four different sites illustrated similarity between phytocenoses. The plant flora of the study area includes 105 species belonging to 65 general and 38 families. Dicotyledonous plants are represented by 78 species, monocotyledones plants by 27 species. The ratio of dicotyledons to annuals was 1:2.9. On average, each genus is represented by 2.3 species, species saturation of families is characterised by the average index, and is 9.5.

Keywords: macrophytes, hydrophytes, coastal plants, species diversity, floodplain marshes

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Introduction

The study of the flora of floodplain bogs is currently of great scientific interest. Especially relevant is the study of the species composition of individual, poorly studied areas. One of such areas is the vicinity of Aktasty village. At present, plant communities of river floodplains and floodplain bogs in the Akmola region are practically not studied. Waterlogging is a long-term process occurring under the influence of a number of abiotic, biotic, and anthropogenic factors. Of particular interest were macrophytes of floodplain marshes of the coastal territories of the Aktastinka River and the wetland of Aktasty village, situated in the Arshaly district of Akmola region of the Republic of Kazakhstan. According to the classification of Mirkin B.M., the studied floodplain swamps belong to the type of peaty undeveloped plain floodplains [1-5].

According to the results presented in the studies of a number of authors, soil changes occur in coastal areas during long-term natural processes. The process of waterlogging is affected by both natural and anthropogenic factors. Dynamic observations make it possible to identify the substitution of lowland soils for a waterlogged peat type [6-8].

Macrophytes (higher aquatic and coastal aquatic plants) play a crucial role in aquatic ecosystems in the formation of vegetation cover on the coast of rivers. A comprehensive study of the coastal macrophytes allows us to assess the potential of plants for further use of their indicative properties in biological analyses. The intense adaptive potential of plants allows them to spread over territories with a considerable area, forming coastal populations [9, 10]. The main relationship between aquatic macrophytes and the formation of organic substances, with subsequent formation of bottom sediments, is considered a result of metabolism and reactions at the ecosystem level. The dynamics of the modification of the species composition of macrophytes during aging and waterlogging of the lake is obvious [11-14]. Under the prolonged influence of anthropogenic factors, the cumulative effect of the intake of nutrients in the form of nitrogen and phosphorus exerts pressure on coastal zones, resulting in eutrophication [15-16].

According to the information presented in the studies of various authors, it was found that chemical factors had a greater effect on flooded macrophytes, while the composition of growing macrophytes and macrophytes with floating leaves was best explained by land use factors. The results of this study confirm the use of macrophyte communities as effective indicators of the ecological state of reservoirs [17-19].

For the first time, we carried out integrated studies of floodplain bogs of the coastal territories of the Aktastinka River and wetlands of Aktasty village, which enabled us to expand botanical knowledge, obtain data on taxonomic and cenotic diversity of the vegetation cover of floodplain bogs. A comprehensive study of both coastal and submerged macrophytes allows them to be used as natural bioindicators of the state of reservoirs. This approach is widely used in different countries [20-22]. Our research aimed to study species diversity of the vegetation cover and to identify the composition of the flora of vascular plants of the floodplain bogs of the Aktastinka River and wetlands in the vicinity of Aktasty village.

Materials and research methods

The research objects were macrophyte plants growing in the floodplains of the Aktasinka River, as well as in wetlands in the vicinity of Aktasty village. Location geodata: Kazakhstan, Akmola region, Arshaly district, Aktasty village 50.752216, 72.211137 (Figure 1).

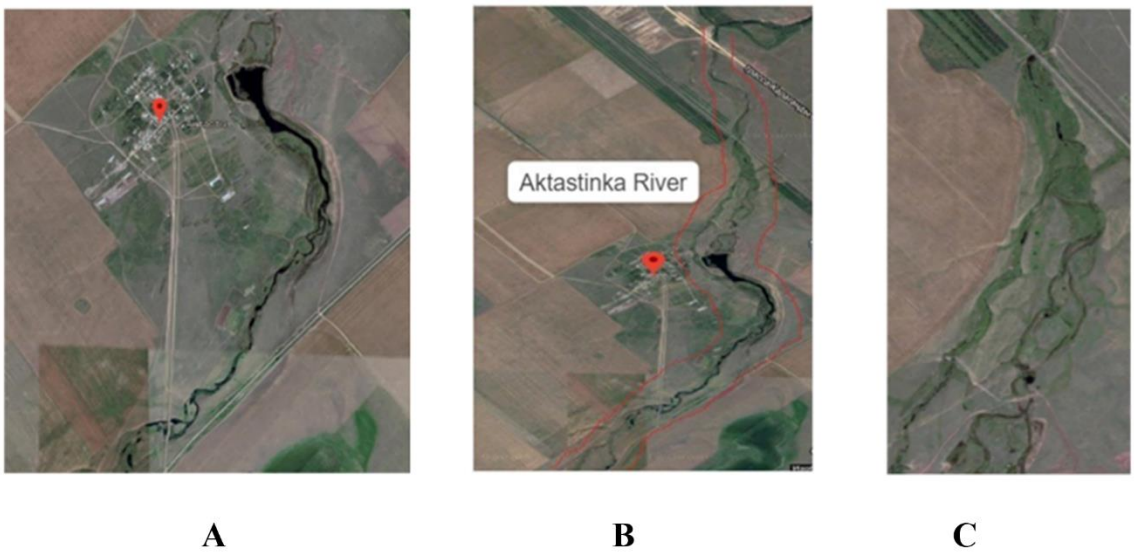

Figure 1. Satellite images: **A –** Aktasty village; **B –** Aktastinka river**; C –** Swampy area №1

Research methods

The flora composition was analyzed during expedition trips in spring and summer during 2023-2024. Field studies were conducted by route-reconnaissance and semi-stationary methods described in the methodological instructions of Darabayeva B.E. et al [23]. During the expeditions, plants were identified, and herbarium specimens were collected to clarify the species affiliation of macrophytes. The study was guided by multi-volume identifiers and well-known summaries [24-25]. The species affiliation of macrophytes of floodplain bogs were determined by using locally assigned identifiers [26-27]. Sample plots were laid in the most homogeneous and typical areas of facies [28]. The description of bog plots was carried out within natural boundaries; the size of the areas was 10 x 10 m. Areas № 1-4 were investigated by laying out profiles, and route diagrams were drawn up. In determining species affiliations, the study was coordinated by well-known identifiers and multi-volume summaries. The area and place of occurrence of each species were clarified based on our field study using satellite images and Google Maps.

The work uses statistical analysis methods to assess the species and taxonomic diversity of macrophytes. Shannon and Simpson indices for biodiversity characteristics, as well as the coefficient of species saturation of genera and families, are calculated. Phytocenoses were compared using cluster analysis, which took into account the degree of their similarity.

Results

Aktasty village is located in the east of Astana city, 60 km away. It belongs to Arshaly district, Akmola region, bordering Ermentau district to the east, Karagandy region to the south, and the city of Astana to the west and north. The village lies within a dry-steppe zone with a continental climate. Winters are cold and prolonged, with an average January temperature of -17°C, while summers are moderately hot, averaging 20°C in July. The average annual precipitation is 300-350 mm. The Aktastinka River flows nearby, discharging into the Ishim River, with small branches, gullies, and ravines along its course. Swampy areas are also present (Figure 2).

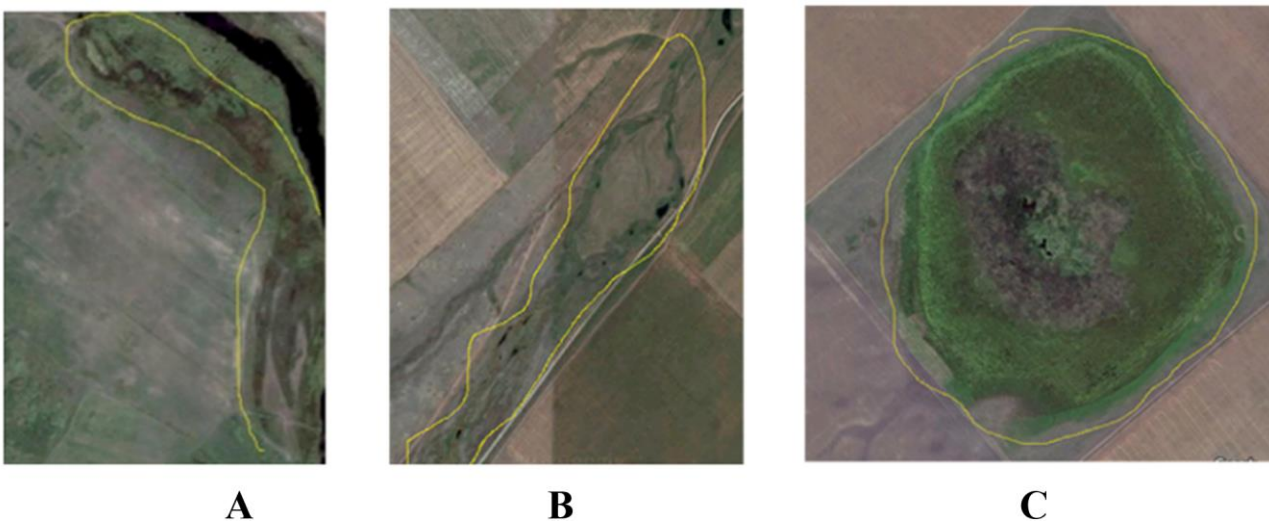

Figure 2. A – Wetland site № 2; **B –** Wetland site № 3; **C –** Wetland site №4

Dark-chestnut soils dominate the territory, most of which were ploughed during the development of virgin and fallow lands. The most widespread plant species include feather grass, wormwood, fescue, astragalus, burnet, and spurge. The area is characterized by the presence of floodplain bogs, which are formed due to spring floods and subsequent swamping, belonging to the lowland type. These bogs have a rich mineral content, supporting high species diversity.

In the course of expeditions, it was stated that this area is characterised by a floodplain type of bogs, which arise as a result of spring floods of the Aktastinka River and subsequent swamping of the resulting floodplains, belonging to the lowland type. As a rule, floodplain bogs have a rich mineral content, which determines a high species diversity of flora. The study of macrophytes in floodplain marshes is a multifaceted process involving a variety of research methods to fully understand their influence on the marsh ecosystem. Macrophytes, or aquatic plants, play a key role in the biodiversity and functioning of aquatic ecosystems, including wetlands. They provide shelter and food for various animal species and also perform water purification and bank stabilisation functions [28].

The macrophyte flora of the study area includes 105 species, classified into 65 genera and 38 families. Dicotyledonous plants dominate with 78 species, while monocotyledons account for

27 species. The ratio of dicotyledons to annuals is 1:2.9. The flora consists mainly of herbaceous polycarpic plants (75 species, 71.4% of the total). Herbaceous monocarpics are less common, making up 28.6% (30 species). The floristic spectrum includes five main subclasses: *Liliopsida, Ranunculidae, Caryophyllidae, Rosidae,* and *Asteridae* from the class *Magnoliopsida.*

In the course of the research, the flora of floodplain bogs of four study sites was described. The flora is understood as a system of the population of all plants growing in a given area. On average, each genus is represented by 2.3 species, and the species richness of families is characterized by an average of 9.5. The floristic spectrum of the floodplain flora of the neighbourhood of Aktasty village and the Atastinka River is represented by 5 main subclasses: *Liliopsida, Ranunculidae, Caryophyllludae, Rosidae*, and *Asteridae* from the class *Magnoliopsida.* Depending on the frequency of occurrence and abundance of individuals, the coastal macrophytes of the study sites were subdivided into six major groups according to O. Drude's scale, as shown in Table 1.

Table 1

The Most common families of Floodplain swamps of Aktasty village

№	Families	Number of genera	Number of species	Frequency of occurrence of the species according to O. Drude's scale
1.	*Equisetaceae*	1	1	Sol.
2.	*Nymphaeaceae*	1	2	Sp.
3.	*Typhaceae*	2	5	Cop.2
4.	*Caryophyllaceae*	2	3	Cop.2
5.	*Poaceae*	5	8	Soc.
6.	*Asteraceae*	5	7	Cop.
7.	*Fabaceae*	3	4	Cop.3
8.	*Limoniaceae*	1	2	Cop.3
9.	*Lamiaceae*	2	3	Cop.1
10.	*Chenopodiaceae*	2	2	Cop.3
11.	*Rosaceae*	3	7	Cop.1
12.	*Alliaceae*	2	3	Cop.3
13.	*Apiaceae*	2	4	Cop.3
14.	*Liliaceae*	3	4	Cop.2
15.	*Ranunculaceae*	2	3	Cop.2
16.	*Polygonaceae*	2	3	Cop.2
	Overall	37	61	

1 group *Cop.* 1 – abundant growth of representatives of families *Lamiaceae* and *Rosaceae.* 2 group *Cop.* 2 – abundant growth on the studied plots, there are many individuals of these families: *Typhaceae, Caryophyllaceae, Liliaceae, Ranunculaceae, Polygonaceae.* 3 group *Cop.* 3 – plants grow abundantly, but do not provide background *Fabaceae, Limoniaceae, Alliaceae, Apiaceae.* 4 group *Socails – (Soc.)* – plants interlocking with their above-ground parts, forming

a continuous background. This group is represented by 8 species of the *Poaceae* family. Growing in large quantities, they form continuous thickest several kilometres long; 5 groups – *Sol.* Plants are rare, single specimens. This group is characterised by a single representative of the family *Equisetacea*. 6 group *Sp.* – Rarely occur, scattered in small numbers – 2 species of the family *Nymphaeaceae.*

Autochthonous tendencies in the development of floodplain flora are practically not expressed, as evidenced by the absence of endemic species and the complete absence of polymorphic genera. From the data of macrophytes of floodplain bogs of the study area, the most frequently occurring species are represented by the following families *Poaceae* (8 species), *Asteraceae* (7 species), *Rosaceae* (7 species), *Typhaceae* (5 species), and three families are represented by four species such as *Fabaceae, Apiaceae,* and *Liliaceae.*

Analysis by life forms demonstrated that the studied flora is represented mainly by herbaceous polycarpics – 75 species, which is 71.4 % of the total identified flora. It is typical for temperate floras. Herbaceous monocarpics play a much smaller role in the composition of the floodplain macrophyte flora. Monocarpics are represented by 30 species, accounting for 28.6 %, respectively.

Of the total number of identified macrophytes of floodplain bogs, 8 species of vascular plants are the most common. Their location is marked with dots on the map shown in Figure 3. These species are often found and form a continuous background on the coastal territory of representatives of the *Poaceae* family, in particular, *Phragmites australis, Cyperaceae (Carex rostrata), and Typhaceae* Juss. *(Typha angustifólia), Ranunculaceae (Ranunculus repens L*), *Juncaginaceae (Triglochin maritimum L), Hydrocharitaceae* Juss. *(Stratiotes aloides L.;), Lentibulariaceae Utricularia vulgaris L.; Araceae – Lemna minor L.*

Figure 3. map-scheme of disturbution of floodplain macrophytes along the Aktastinka River and in wetlands: *1 - Phragmites australis; 2 - Carex rostrata; 3 - Typha angustifolia; 4- Ranunculus repens* L.*; 5 - Triglochin maritimum* L.*; 6 - Stratiotes aloides* L.*; 7 - Utricularia vulgaris* L.*; 8 - Lemna minor* L

Coastal macrophytes in the study sites were categorized into six groups according to O. Drude's scale, ranging from abundant species (Lamiaceae, Rosaceae, Typhaceae, Poaceae) to rare species (Equisetaceae, Nymphaeaceae). The most frequently occurring families include Poaceae (8 species), Asteraceae (7 species), Rosaceae (7 species), and Typhaceae (5 species). The most common macrophyte species were identified along the Aktastinka River and in wetlands, including Phragmites australis, Carex rostrata, Typha angustifolia, and Ranunculus repens.

Discussion

The study of macrophytes in floodplain marshes is a complex process requiring various research methods to understand their role in the ecosystem. Macrophytes play a critical role in biodiversity and ecosystem functionality, providing shelter and food for numerous species, contributing to water purification, and stabilizing riverbanks.

The high mineral content of floodplain bogs significantly influences the floristic composition, resulting in a diverse plant community. The predominance of herbaceous polycarpic plants is typical for temperate ecosystems, as these species are well adapted to periodic flooding and nutrient-rich soils. The absence of endemic species suggests a lack of significant autochthonous development, with the local flora influenced by broader regional patterns.

Along with the main bog macrophytes, other species were also observed, however, they were less frequent and formed small patches. The following species can be referred to them:

1. Inula britanica L. Stems 0.8-3.5 m tall, erect, glabrous, filamentous up to inflorescence, with hollow creeping rhizome. Leaves 05-0.25 cm wide, stiff, glaucous or pale green, glabrous, sometimes covered with sparse long hairs on the underside, sharply scabrous along the edges. Tongues are in the form of a border of short, dense hairs. Anthers 1,5-2,5 mm long. Frequency of occurrence: Copiosae

2. Ranunculus polyanthemos L. Stem erect, ribbed, simple. Leaves linear-lanceolate. The corms are 3-4(5) cm in diameter, in a loose shield. The wrapper is multi-rowed, with equally acute, bent leaflets. Uvular flowers are yellow. Tongues and teeth of tubular flowers are densely covered with golden glands on the outside. Frequency of occurrence Cop. 1

3. Typha angustifiolia Perennial rhizomatous plant. The plant reaches a height of 2.5 m. Leaves are linear at the base of the stem. Flowers are small, unisexual, with perianth. The inflorescence is a head-like, long-cylindrical cob. It usually grows in temperature climates, preferring moist areas. Frequency of occurrence: Cop.2

4. Butomus umbellatus L. The rhizome is creeping, thick. Flower stalks 40-100 cm tall, smooth, stout. Leaves long, linear, triangular at the base, 4 above, flat, 5-10 mm wide, erect, shorter than the stem. Inflorence is umbrella-shaped with numerous large pinkish flowers, on pedicels of unequal length. At the base of the umbrella, there are 3 covering triangular-lanceolate leaflates. Frequency of occurrence: Cop.2

5. Hydrocharis morsus-ranae L. Branched, unrooted, floating stems with long-petioled, rosette-like leaves floating on the water surface. Their lamina is rounded, broadly heart-shaped at the base, with two bracts. The perianth consists of three ovate pale green ovate sepals with dirty purple veins and three rounded white petals; Frequency of occurrence: Cop.3

6. *Equisetum fluviatile Riverside horsetail,* or Equisetum fluviatile, is a species of plant in the horsetail family. It typically grows in moist soils, including riverbanks, lakes, and marshes. Frequency of occurrence: Sol.

7. *Nymphaea candida J. Presl & C. Presl* (White water lily) White water lily, or Nymphaea candida, is a species of plant in the lily family. It usually grows in freshwater bodies, such as lakes and ponds, with deep and clear waters. Frequency of occurrence: Sp.

The categorization of macrophytes according to O. Drude's scale highlights the varying degrees of abundance and distribution of plant species. The dominance of Poaceae, Asteraceae, and Rosaceae families suggests their ecological significance in these floodplains. The presence of rare species such as Equisetum fluviatile and Nymphaea candida indicates specific microhabitats that support specialized flora.

Overall, the study confirms that the floodplain flora of the Aktastinka River is highly diverse, shaped by hydrological and soil conditions. The findings contribute to the broader understanding of floodplain ecosystems, emphasizing the importance of conservation efforts to maintain biodiversity and ecological balance in these wetland habitats

Conclusion

Thus, a comprehensive study of the species diversity of macrophytes growing along the Akastinka River and in the wetlands of Aktasty village was carried out. The species composition of vascular plant flora was revealed, and taxonomic and typological analyses were carried out. Four types of dominant plant communities were identified for the study area: reed, cattail-sedge, buttercup-onion, flowering rush-bladderwort, and other phytocenoses are represented by scattered patches.

Floristic composition of the local flora of Aktastinka village and coastal territory is characterised by rich species diversity of 105 species belonging to 65 genera and 38 families. The number of floodplain macrophytes totalled 15 taxa, 8 of which the main taxa forming continuous thickets during recent research: *Phrágmites austrális, Carex rostrata; Týpha angustifólia, Ranunculus repens* L., *Triglochin maritimum* L., *Stratiotes aloides* L., *Utricularia vulgaris* L., *Lemna minor* L. and 7 taxa that do not form continuous thickets and grow in the study area. Submerged macrophytes are represented by Nymphaea Candida J. Presl & C. Presl, *Lemna minor* L., Hydrocharis morsus-ranae L., *Týpha angustifólia.*

In **conclusion,** further research on macrophytes in floodplain bogs is necessary for a better understanding of their role and impact on the ecosystem. This will assist to ensure the sustainability and biodiversity of these unique natural complexes for future generations. Observations have shown that macrophytes growing on the coastal territory of the Aktastinka River for a long time lead to the replacement of dense soils with loose ones. Constant or periodic waterlogging of the soil surface is the main cause of land swamping.

Author Contributions

B.Z.G. – approval of the final version; **B.Z.G**. – responsibility for all aspects of the work; **B.Z.G**. – ensuring the integrity of all parts of the article; **D.A.D. –** significant contribution to the concept

and design of the study; **D.A.D., S.K.M.,** and **G.G.A** – data collection; **D.A.D., S.K.M.**, and **G.G.A –** analysis and interpretation; **M.Y.H.** – development of the research concept; M.Y.H. and **Zh.M.Zh.** – formulation of key objectives and goals; **A.G.M. and I.Z.I.** – preparation and editing of the text; **A.G.M.** and **I.Z.I.** – participation in the scientific design of the study; **S.K.N.** and **G.G.A** – conducting research; **A.N.Ye. –** composition of the article and design development; **Zh.M.Zh. –** formation of the idea.

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this work.

Compliance with ethical standards

This article does not contain a description of studies performed by the authors involving people or using animals as objects.

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Аңдатпа. Бұл жұмыста Қазақстан Республикасының Аршалы ауданы аумағында орналасқан Ақтасты өзені жағалауы аумақтарының және Ақтасты ауылының сулы-батпақты жерлерінің жайылмалы батпақтарының макрофиттерін ұзақ мерзімді зерттеу нәтижелері келтірілген. Түгендеу барысында Ақтасты ауылының елді мекені мен жағалау аумағының флористикалық құрамы анықталды, оның құрамына 65 тұқымдас пен 38 тұқымдасқа жататын 105 түр кірді. Түрлердің алуан түрлілігімен қатар батпақты флора макрофиттерінің негізгі өкілдері 8 гидрофит – Phragmites australis, Carex rostrata арқылы анықталды; *Typha angustifolia, Ranunculus repens* L., *Triglochin maritimum* L., *Stratiotes aloides* L., *utricularia vulgaris* L., *lemna minor* L. және т.б. Зерттеу аймағының жергілікті флорасында өсімдіктер қауымдастығының төрт түрлі фитожүйелері құрылды олардын ішінде басым тұқымдастар: *Poaceae, Typhaceae, Cyperaceae, Ranunculaceae, Amaryllidaceae, Butomaceae, Lentibulariaceae.* Төрт түрлі учаскедегі макрофитті флораларды салыстырмалы талдау фитоценоздардың ұқсастығын көрсетті. Зерттелетін аймақтағы тамырлы өсімдіктердің таксономиялық құрамына 65 жалпы және 38 тұқымдастарға жататын 105 түр кіреді. Қосжарнақты өсімдіктер 78 түрден, біржарнақтылар 27 түрден тұрады. Қосжарнақтылардың біржылдықтарға қатынасы 1:2,9 құрады. Орташа алғанда, әрбір тұқым 2,3 түрден тұрады, тұқымдастардың түрлік қанықтылығы орташа көрсеткішпен сипатталады және 9,5 құрайды.

Түйін сөздер: макрофиттер, гидрофиттер, жағалаудағы өсімдіктер, түрлердің әртүрлілігі, жайылма батпақтар

Макрофиты пойменных болот Акмолинской области

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Аннотация. В данной статье представлены результаты многолетних исследований макрофитов пойменных болот прибрежных территорий реки Актастинка и заболоченных участков села Актасты, расположенного в Аршалынском районе Акмолинской области Республики Казахстан.

В ходе инвентаризации выявлен флористический состав окрестностей села Актастинка и прибрежной территории, составивший 105 видов, относящихся к 65 родам и 38 семействам. Наряду с видовым разнообразием определены основные представители макрофиты болотной флоры, представленные 8 гидрофитами – Phragmites australis, Carex rostrata; *Typha angustifolia, Ranunculus repens* L.*, Triglochin maritimum* L.*, Stratiotes aloides* L.*, Utricularia vulgaris* L.*, Lemna minor* L. В локальной флоре изучаемого участка установлены четыре типа растительных сообществ с доминированием представителей следующих семейств: *Poaceae, Typhaceae, Cyperaceae, Ranunculaceae, Amaryllidaceae, Butomaceae, Lentibulariaceae* протяженностью несколько километров. Сравнительный анализ флор макрофитов на четырех разных участках показал схожесть фитоценозов. Таксономический состав флоры сосудистых растений на исследуемом участке насчитывает 105 видов, относящихся к 65 родам и 38 семействам. Двудольные растения представлены 78 видами, однодольные 27 видами. Соотношение двудольных к однодольным составило 1:2,9. В среднем каждый род представлен 2,3 видами, видовая насыщенность семейств характеризуется средним показателем и составляет 9,5.

Ключевые слова: макрофиты, гидрофиты, прибрежные растения, видовое разнообразие, пойменные болота

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