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CURRENT STATE OF THE COMMUNITY STRUCTURE OF BENTHIC INVERTEBRATES IN THE BUKHTARMA RESERVOIR (IRTYSH RIVER BASIN)

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Abstract. This article presents the results of studies conducted in the river basins of the Bukhtarma Reservoir within the Irtysh River Basin as part of the scientific and technical program of the Ministry of Agriculture of the Republic of Kazakhstan "Comprehensive studies of water bodies for the conservation and sustainable use of aquatic biological resources based on the assessment of their potential and modeling of stock dynamics" (BR23591095). The paper presents current data on the taxonomic composition of the macrozoobenthos of the Bukhtarma Reservoir (Irtysh River Basin) under present-day environmental conditions for the period from 2021 to 2025. The taxonomic composition and dominant groups of benthic invertebrates were determined, and the interannual variability of the macrozoobenthos was analyzed. According to the results of the conducted studies, the zoobenthos in the investigated water area was represented by 29 taxonomic units. The maximum number of taxa was recorded in 2023 (21 taxa), after which a decline was observed in 2024–2025, with partial recovery. Oligochaete worms (*Oligochaeta gen. sp.*) made a significant contribution in terms of frequency of occurrence. Chironomids were distinguished by their contribution to the formation of zoobenthic species richness, crustaceans dominated in abundance, while mollusks showed variable distribution and moderate diversity during the study period.

Keywords: macrozoobenthos, taxonomic composition, structure, dynamics, benthic invertebrates, Bukhtarma Reservoir, Irtysh River Basin.

БҰҚТЫРМА СУ ҚОЙМАСЫНДАҒЫ БЕНТОС ОМЫРТҚАСЫЗДАР ҚАУЫМДАСТЫҚТАРЫ ҚҰРЫЛЫМЫНЫҢ ҚАЗІРГІ ЖАҒДАЙЫ (ЕРТІС БАССЕЙНІ)

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Аңдатпа. Мақалада Қазақстан Республикасы ауыл шаруашылығы министрлігінің "Су биологиялық ресурстарын сақтау және тұрақты пайдалану мақсатында су айдындарының әлеуетін бағалау және қор динамикасын модельдеу негізінде кешенді зерттеулер жүргізу" ғылыми-техникалық бағдарламасы (BR23591095) аясында Ертіс өзені алабындағы Бұқтырма су қоймасының өзен алаптарында жүргізілген зерттеулердің нәтижелері ұсынылған. Жұмыста 2021–2025 жылдар аралығындағы қазіргі экологиялық жағдайлардағы Бұқтырма су қоймасы макрозообентосының таксономиялық құрамы туралы заманауи деректер келтірілген. Түптік омыртқасыздардың таксономиялық құрамы мен басым топтары анықталып, макрозообентостың жылдар арасындағы өзгергіштігі талданды. Жүргізілген зерттеулер нәтижесінде зерттелген акваториядағы зообентос 29 таксономиялық бірлікпен ұсынылды. Таксондардың ең көп саны 2023 жылы тіркелді – 21 таксон, одан кейін 2024–2025 жылдары ішінара қалпына келумен қатар төмендеу байқалды. Кездесу жиілігі бойынша азқылтанды құрттар (*Oligochaeta gen. sp.*) елеулі үлес қосты. Хирономидтер зообентостың түрлік байлығын қалыптастырудағы үлесімен ерекшеленді, шаянтәрізділер саны бойынша басым болды, ал моллюскалар зерттеу кезеңінде өзгермелі таралуымен және орташа әртүрлілігімен сипатталды.

Түйін сөздер: макрозообентос, таксономиялық құрам, құрылым, динамика, түптік омыртқасыздар, Бұқтырма су қоймасы, Ертіс өзені алабы.

СОВРЕМЕННОЕ СОСТОЯНИЕ СТРУКТУРЫ СООБЩЕСТВ ДОННЫХ БЕСПОЗВОНОЧНЫХ ВОДОХРАНИЛИЩА БУКТЫРМА (ЕРТИССКИЙ БАССЕЙН)

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Аннотация. В статье представлены результаты исследований, проведённых в бассейнах рек Бухтарминского водохранилища в пределах бассейна реки Иртыш, в рамках научно-технической программы Министерства сельского хозяйства Республики Казахстан "Комплексные исследования водоёмов в целях сохранения и устойчивого использования водных биологических ресурсов на основе оценки их потенциала и моделирования динамики запасов" (BR23591095). В работе приведены современные данные о таксономическом составе макрозообентоса Бухтарминского водохранилища (бассейн реки Иртыш) в современных экологических условиях за период 2021–2025 гг. Определены таксономический состав и доминирующие группы донных беспозвоночных, а также проанализирована межгодовая изменчивость макрозообентоса. По результатам проведённых исследований зообентос исследованной акватории был представлен 29 таксономическими единицами. Максимальное число таксонов было зарегистрировано в 2023 г. – 21 таксон, после чего в 2024–2025 гг. наблюдалось снижение с частичным восстановлением. Существенный вклад по частоте встречаемости внесли малощетинковые черви (*Oligochaeta gen. sp.*). Хирономиды отличались вкладом в формирование видового богатства зообентоса, ракообразные доминировали по численности, тогда как моллюски характеризовались изменчивым распределением и умеренным разнообразием в течение исследуемого периода.

Ключевые слова: макрозообентос, таксономический состав, структура, динамика, донные беспозвоночные, Бухтарминское водохранилище, бассейн реки Иртыш.

Introduction. The study of the structure of benthic invertebrate communities is an important area of hydrobiological research, since macrozoobenthos plays a key role in the functioning of aquatic

ecosystems. Benthic organisms participate in the processes of organic matter transformation, serve as an important link in trophic chains, and act as indicators of the ecological state of water bodies. Analysis of the composition, abundance, and distribution of benthic communities makes it possible to assess the level of anthropogenic impact, the degree of eutrophication, and the overall condition of the aquatic environment.

Studies of benthic invertebrates acquire particular significance under reservoir conditions, where specific conditions for the existence of hydrobionts are formed under the influence of the hydrological regime, seasonal dynamics, and human activities. Changes in the structure of macrozoobenthos reflect ecosystem transformation processes and can be used to assess the biological potential of a water body.

The present study was carried out within the framework of the scientific and technical program "Comprehensive studies of water bodies for the conservation and sustainable use of aquatic biological resources based on the assessment of their potential and modeling of stock dynamics" (BR23591095). The aim of the study is to investigate the structure of benthic invertebrate communities in the reservoir, identify the features of their spatial distribution, and assess the current state of benthic communities as one of the components of aquatic biological resources.

The Bukhtarma Reservoir, located in the Irtysh River Basin (East Kazakhstan), is a significant fishery water body of the region and serves as a model system for studying the structure and dynamics of benthic communities.

The Bukhtarma Reservoir was formed as a result of the impoundment of the Irtysh River (1960) in a narrow section of the mountain valley, 12 km downstream from the confluence with the Bukhtarma River. Its initial parameters at full storage were: surface area – 1,660 km², volume – 26.099 km³, length along the straightened fairway – 240 km, and maximum depth – 70 m. The reservoir extends in a latitudinal direction between 83° and 84° E longitude and 40°50′–49°40′ N latitude. It crosses three climatic zones: forest-steppe, steppe, and desert-steppe. The climate of these zones is sharply continental. According to morphometric and hydrological characteristics, the reservoir is divided into three distinct parts: lake-river, mountain-valley, and mountain. The mountainous deep-water part includes the section of the reservoir from the dam to the Narym expansion. It is bounded on the northern side by the spurs of the Altai Mountains and on the southern side by the Kalba Mountains. Accordingly, the bottom relief and the degree of shoreline indentation are complex. The drainage network is well developed and includes about 40 small mountain springs and streams (11–40 km). An exception is the Bukhtarma River (398 km), which provides about 40% of the annual runoff at the cross-section of the Bukhtarma Hydroelectric Power Station dam. The bays are predominantly deep-water and relatively small in area. In general, the littoral zone in this part of the reservoir is poorly developed; the zone with depths up to the 4-m isobath accounts for 14%, while depths from 4 to 10 m account for 13.5%. The middle, mountain-valley part crosses the mountain-steppe and partly the desert-steppe zones. Its length, including the Narym expansion, up to the conventional boundary at the Kaznakov ferry crossing, is about 105 km; its width ranges from 2 to 9 km, and the maximum depth is 37 m. The flooded valley, compared with the mountainous part, is not characterized by a complex relief, and the shoreline is only slightly indented. The right bank, bounded by the Narym range, is relatively steep, rocky, and composed of pebble-sandy deposits. The left bank, adjoining the spurs of the Kalba Mountains and the Kyzyl-Kum sands, is more gently sloping and sandy. Depths along the longitudinal profile vary from 37 to 15 m. The zone with depths up to 10 m accounts for 31% of the total area. The vegetation surrounding the reservoir is predominantly xerophytic, and the shores are open. The lake-river part belongs to the desert-steppe zone, includes the section of the reservoir from Cape Korzhun to the Kaznakov ferry crossing. In the lake-river zone, the shores are gently sloping and, in the lower Irtysh area, partially adjoin the hilly sands of the Kyzyl-Kum and the spurs of the Narym range. In the northwestern part of the Zaysan Depression, the shallow Torangy Bay is formed, with an area of up to 20 thousand hectares. The full-flowing mountain river Kurchum flows into this zone and, together with the Bukon River entering from the left bank, forms the Kurchum–Bukon floodplain waters, covering an area of about 30 thousand hectares.

The Altai Branch of LLP "RPCF" pays particular attention to the study of macrozoobenthos

in the Bukhtarma Reservoir, since benthic organisms are one of the main components in the diet of most fish species inhabiting the reservoir. The results of these studies have been published in numerous works. In 2009, the monograph "Successions of biocenoses of the Bukhtarma Reservoir" was published, which, among other things, summarized the results of benthos studies conducted during the period 1961–2008 [Devyatkov, 2009:95].

It is a deep-water reservoir with a maximum depth of 70 m, which, according to its morphometric and hydrological characteristics, is divided into three parts: lake-river, mountain-valley, and mountain. The reservoir was formed in 1960 as a result of the impoundment of the Irtysh River.

Materials and Methods of Research. The material for this publication was based on data obtained from comprehensive hydrobiological studies conducted in the Bukhtarma Reservoir during the period from 2021 to 2025. Hydrobiological samples were collected annually at seven permanent stations: Altaika, Vasilyevskaya Ferry Crossing, Bolshenarym Bay, Kara-Dzhurga, the mouth of the Kurchum River, Oiran, and the mouth of the Bukon River, located in the northern, central, and southern parts of the reservoir. The stations were selected taking into account the need to cover the main ecological zones of the reservoir, including areas affected by river runoff, bay water areas, and open sections of the water body. Sampling was carried out in two biotopes: the nearshore zone (littoral) and the offshore deep-water zone (profundal), which made it possible to characterize the spatial distribution of hydrobiological indicators in different parts of the reservoir.

The studies were conducted in accordance with generally accepted methods [Sharapova, 2018: 42]. Zoobenthos samples were collected using a Petersen grab sampler with a sampling area of 0.025 m²; organisms were washed from stones into the water, concentrated through gas sieves No. 38GG–52GG (500–375 μm), and fixed in 4% formalin.

Nectobenthos samples were collected using an ichthyoplankton cone net 2 m in length with an inlet opening area of 0.3 m².

The collected material was processed under laboratory conditions to determine species composition, total community abundance, total biomass, dominant taxa composition, as well as the abundance and biomass of the main groups and species of zoobenthos and nectobenthos. A total of 60 quantitative zoobenthos samples and 45 nectobenthos samples were collected and processed during the period from 2021 to 2025. Organisms were identified using currently accepted identification keys [Zhadin, 1952:376; Chernovskij, 1949: 186; Pankratova, 1983: 296; Pankratova, 1977:154; Calolihin et al., 1995: 628; Kutikova & Starobogatov, 1977: 512; Calolihin, 2000:993; Calolihin, 2001: 824].

Results and Discussion. Results and Discussion. According to the results of hydrobiological studies, 29 taxa belonging to the groups Mollusca, Vermes, Hirudinea, Mysidacea, Amphipoda, Ephemeroptera, Odonata, and Diptera were recorded in the macrozoobenthos of the Bukhtarma Reservoir during 2021–2025. The greatest taxonomic diversity was observed in Diptera, represented predominantly by the family Chironomidae. Among the mollusks, 8 taxa were recorded (Table 1).

Table 1. Taxonomic composition of the macrozoobenthos of the Bukhtarma Reservoir in 2021-2025

Taxon	Frequency of occurrence, %				
	2021 August	2022 August	2023 August	2024 June	2025 May
Mollusca					
Cincinna depressa C. Pfeiffer	-	+	-	-	25
Viviparus viviparus (Linnaeus)	-	33	8	8	8
Lithoglyphus naticoides C. Pfeiffer	33	57	17	8	25
Lymnaea ovata (Draparnaud)	-	-	8	-	-
Anisus sp.	-	-	8	-	-
Sphaerium sp.	-	-	8	-	-

Taxon	Frequency of occurrence, %				
	2021 August	2022 August	2023 August	2024 June	2025 May
Pisidium sp.	-	-	33	-	-
Euglesa sp.	-	-	8	-	-
Total number of taxa: 8	**1**	**3**	**7**	**2**	**3**
Oligochaeta					
Oligochaeta gen. sp.	92	57	8	100	75
Total number of taxa: 1	**1**	**1**	**1**	**1**	**1**
Hirudinea					
Piscicola geometra (Linnaeus)	-	8	8	8	17
Total number of species: 1	**-**	**1**	**1**	**1**	**1**
Mysidacea					
Paramysis lacustris (Czerniavsky)	-	75	92	17	17
P. intermedia (Czerniavsky)	-	67	100	17	17
Total number of species: 2	**-**	**2**	**2**	**2**	**2**
Gammaroidea					
Gmelinoides fasciatus (Stebbing)	17	25	33	-	33
Micruropus possolskii Sowinsky	-	25	42	-	8
Total number of species: 2	**1**	**2**	**2**	**-**	**2**
Ephemeroptera					
Ephemera orientalis McLachlan	-	-	-	-	8
Total number of species: 1	**-**	**-**	**-**	**-**	**1**
Odonata					
Orthetrum cancellatum Linnaeus	-	-	8	-	-
Total number of species: 1	**-**	**-**	**1**	**-**	**-**
Diptera sp.					
Diptera sp.	-	8	-	-	-
Total number of taxa: 1	**-**	**1**	**-**	**-**	**-**
Ceratopogonidae					
Ceratopogonidae sp.	-	-	8	-	-
Total number of taxa: 1	**-**	**-**	**1**	**-**	**-**
Chironomidae					
Endochironomus albipennis (Meigen)	8	25	-	-	17
Glyptotendipes gripekoveni Kieffer	17	8	17	-	8
Cryptochironomus gr. defectus	8	-	67	-	17
Procladius sp.	8	-	-	17	8
Micropsectra sp.	-	-	17	-	-
Tanitarsini sp.	17	-	-	-	-
Chironomus ex gr. plumosus	58	25	-	42	42
Chironomus sp.	8	-	8	8	-
Parachironomus sp.	-	-	-	-	8

Taxon	Frequency of occurrence, %				
	2021 August	2022 August	2023 August	2024 June	2025 May
Orthocladiinae sp.	-	25	33	-	8
Chironomini sp.	-	-	8	8	25
Total taxa: 11	**7**	**4**	**6**	**4**	**8**
Total: 29	**10**	**14**	**21**	**10**	**18**

Note - The symbol "+" indicates species identified in qualitative samples.

During the study period, the number of recorded taxa varied from 10 to 21. The maximum taxonomic richness was recorded in 2023 (21 taxa), while the minimum was observed in 2021 and 2024 (10 taxa each). In 2025, an increase in the number of identified taxa to 18 was observed, which may indicate the recovery of the structural diversity of the benthic community.

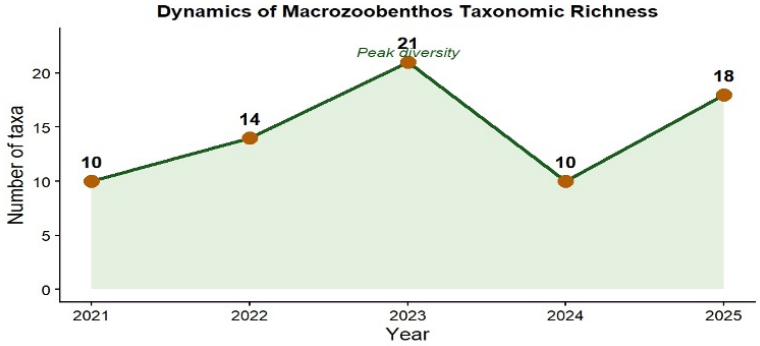

Figure 1. Dynamics of macrozoobenthos taxonomic richness in the Bukhtarma Reservoir during 2021-2025

The basis of the macrozoobenthos during different years of the study was formed by Oligochaeta and Chironomidae, which were characterized by a high frequency of occurrence.

The most stable components of the reservoir benthic communities throughout the entire study period were oligochaete worms (Oligochaeta gen. sp.). Their frequency of occurrence in the samples reached 100% in 2024.

The greatest species diversity was observed among Chironomidae larvae, which included 11 taxa. Chironomidae were characterized by high species diversity and variable frequency of occurrence during 2021–2025. The most stable and dominant taxon after oligochaetes was Chironomus ex. gr. plumosus (25-58%). A pronounced increase in the frequency of occurrence of Cryptochironomus grp. defectus o 67% was recorded in 2023. Individual taxa, Micropsectra sp. and Parachironomus sp., occurred relatively rarely.

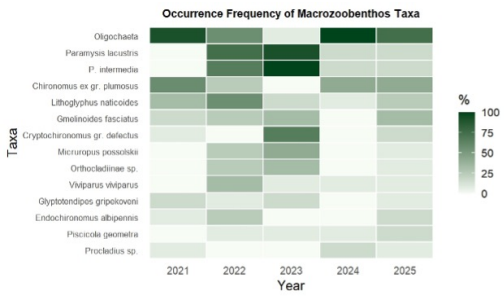

Figure 2. Interannual variation in macrozoobenthos occurrence frequency in the Bukhtarma Reservoir during 2021-2025

Analysis of the frequency of occurrence showed the stable presence of oligochaetes and a number of chironomids, whereas mysids and individual mollusks were characterized by pronounced interannual variability.

Only in 2022–2023 did representatives of Mysidacea, *P. lacustris* and *P. intermedia*, occupy a dominant position (75–100%); however, their occurrence was episodic in nature. These species were not recorded in 2021, whereas in 2024–2025 their frequency of occurrence in the samples sharply decreased to 17%.

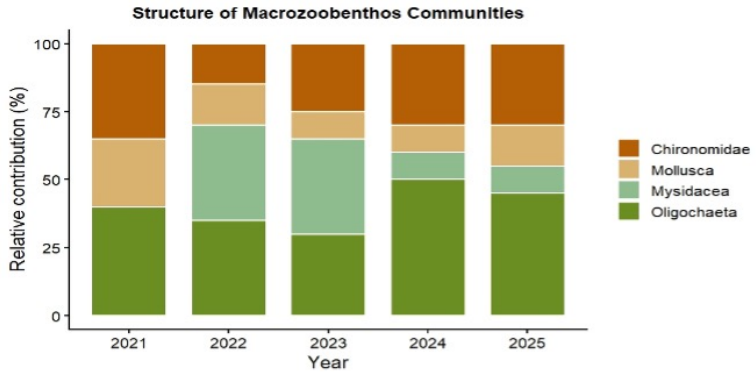

Figure 3. Relative contribution of major macrozoobenthos groups in the Bukhtarma Reservoir during 2021-2025

In addition, two species of Mysidacea, two species of Gammaroidea, and one representative of Oligochaeta were identified. Representatives of Hirudinea, larvae of Ephemeroptera and Odonata, as well as Ceratopogonidae, were encountered less regularly and were recorded as single occurrences.

The biodiversity of taxa varied from year to year, which is typical of reservoirs with an unstable hydrological regime. The number of taxa recorded in the samples ranged from 10 in 2021 and 2024 to 21 in 2023 (Table 1).

The greatest taxonomic diversity of macrozoobenthos was recorded in 2023 (21 taxa), while the minimum was observed in 2021 and 2024 (10 taxa each). In 2025, a repeated increase in the number of recorded taxa to 18 was observed.

Similar to Mysidacea, representatives of Hirudinea and Gammaroidea demonstrated sporadic distribution. The representative of Hirudinea – P. geometra was encountered relatively rarely, from 2022 to 2024, its frequency of occurrence remained stable at 8%, while in 2025 an increase to 17% was recorded. The episodic occurrence of a number of taxa may indicate interannual variability in ecological conditions.

Representatives of Gammaroidea – *G. fasciatus* and *M. possolskii* were recorded during 2021–2025, with the exception of 2024. The maximum frequency of occurrence was recorded in 2023 *(M. possolskii 42%)*, whereas in 2025 *G. fasciatus* maintained stable values (33%), while the frequency of occurrence of *M. possolskii* decreased to 8% (Table 1).

A substantial proportion of the structure of benthic communities was also formed by mollusks, represented by 8 taxa.

Mollusks, during the study period under consideration, demonstrated variable distribution and moderate diversity. In this respect, the year 2023 was indicative, when seven taxa were recorded due to the appearance of several additional forms. In subsequent years, a reduction in taxonomic diversity was observed. A stable species was L. naticoides, the frequency of occurrence of which in the samples varied from 33 to 57%, being recorded almost every year. The remaining mollusk representatives, Sphaerium sp., Pisidium sp., Euglesa sp., L. ovata, and Anisus sp., were characterized by low frequency of occurrence, which may indicate the instability of their populations. In general, the structure and abundance of the mollusk community in the Bukhtarma reservoir are characterized by relative variability.

Monitoring the state of mollusks within the community is particularly important, considering that some species, including representatives of the genus Bithynia, serve as intermediate hosts

of the trematode Opisthorchis felineus, the causative agent of opisthorchiasis *[Sidorov, 2011:63]*. Their absence in recent years indicates unfavorable conditions for mass reproduction. From an epizootiological point of view, this is a positive factor, as it reduces the likelihood of the formation of natural foci of opisthorchiasis in this fishery reservoir.

Previously, these mollusks were recorded sporadically. During the first half of the 1990s, representatives of this genus were not recorded in the reservoir, however, in 2005, after a long absence, *Bithynia leachii* was detected in the mountain-valley part of the Bukhtarma Reservoir *[Biological basis…, 1995:103; Altajskoe otdelenie…, 2002:171]*.

Conclusion. The dynamics of the macrozoobenthos of the Bukhtarma Reservoir during 2021–2025 demonstrate changes in taxonomic diversity and in the proportion of dominant taxa. The maximum number of taxa was recorded in 2023 (21 taxa), after which a decline was observed in 2024–2025, with partial recovery. Throughout the entire study period, oligochaetes were consistently present, with the frequency of occurrence of Oligochaeta gen. sp. ranging from 92 to 100%. Chironomidae were represented quite broadly and accounted for up to 39% of all recorded taxa.

Hirudinea, Mysidacea и Gammaroidea were characterized by irregular occurrence and were absent in certain years of observation. Representatives of *Ceratopogonidae, Odonata, Ephemeroptera* were recorded as single occurrences and were registered only once during the entire study period (2021–2025). The highest frequency of occurrence of these groups did not exceed 8%, indicating their rare occurrence in the macrozoobenthic community of the Bukhtarma Reservoir.

Similarly, the representatives demonstrated sporadic distribution.

Mollusks demonstrated high intraspecific and interannual variability in taxonomic composition. *L. naticoides* proved to be a relatively stable species, whereas the remaining taxa were low in abundance and sporadic.

Analysis of the obtained data confirms the dynamic nature of macrozoobenthic communities and emphasizes their ecological significance. Representatives of benthic hydrobionts serve not only as a food resource for benthophagous fish, but also as indicators of the presence of intermediate hosts of fish diseases, particularly certain mollusk species.

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