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MACROZOOBENTHOS OF ARID WATERCOURSES OF KAZAKHSTAN: THE ILEK RIVER CASE

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ABSTRACT

The paper aims to study the quantitative characteristics, taxonomic composition and structure of the macrozoobenthos of the arid Ilek River (Kazakhstan). The topic is relevant to the global biodiversity preservation problem. The frequency of taxon occurrence, abundance, biomass and composition of macrozoobenthos were established. Informational indices of the dominance structure, diversity and evenness of species were calculated. The macrozoobenthos of the arid water bodies and rivers included 24 taxa. In terms of abundance and biomass, the Chironomidae were predominant. The study revealed an interconnection between the level of macrozoobenthos biomass and water mineralization. This information can be used in assessing the fodder base for fish, the saprobity and the anthropogenic impact in the Aktobe Region, in performing an ecological analysis of the said region, as well as in establishing the condition of the Ural River ecosystem.

Key words: macrozoobenthos, biodiversity, dominance structure, habitation conditions, hydrochemical regime

MACROZOOBENTHOS DI CORSI D'ACQUA ARIDI DEL KAZAKISTAN: IL CASO DEL FIUME ILEK

SINTESI

Gli autori hanno studiato le caratteristiche quantitative, la composizione tassonomica e la struttura del macrozoobenthos del fiume arido Ilek (Kazakistan). L'argomento è rilevante per la conservazione della biodiversità globale. Nello studio hanno valutato la frequenza dei taxa, l'abbondanza, la biomassa e la composizione del macrozoobentos. Sono stati inoltre calcolati diversi indici: di dominanza, diversità e uniformità delle specie. È risultato che i*l macrozoobentos dei corpi idrici e dei fiumi aridi comprende 24 taxa. In termini di abbondanza e biomassa hanno prevalso i Chironomidi. Lo studio ha inoltre rivelato un'interconnessione tra il livello della biomassa del macrozoobentos e la mineralizzazione dell'acqua. Queste informazioni possono venir utilizzate per valutare la base di foraggio per il pesce, la saprofagia e l'impatto antropogenico nella regione di Aktobe, nell'effettuare un'analisi ecologica della regione, nonché nello stabilire le condizioni dell'ecosistema del fiume Ural.*

Parole chiave: macrozoobentos, biodiversità, struttura dominante, condizioni abitative, regime idrochimico

INTRODUCTION

The preservation of biodiversity is a global problem. In the conditions of intensifying processes of aridification in most regions of Kazakhstan and in other Asian countries, this problem is of a most acute nature (Alpeysov *et al.*, 2017). One of the approaches to addressing such environmental issues is the study of communities of aquatic organisms, including macrozoobenthos (Rosenberg & Gelashvili, 2013).

Kazakhstan is a terminal territory for the drainage of many inland basins of Central Asia. The intensifying desertification processes and increased use of water reservoirs for economic needs create a scarcity of water resources. As a result, Kazakhstan risks compromising the biodiversity of the hydrobionts living in the reservoirs and watercourses of its arid zones, which will result in the degradation of the ecosystems of internationally important transboundary watercourses and lead to a violation of the basin principle of their use.

The Aktobe Region is the second largest of Kazakhstan. It is located in the western part of the country and occupies more than 300,000 km^2. The region borders Russia in the north and Uzbekistan in the south. Its largest rivers (Emba, Or, Ilek, Irgiz, Turgai) originate in the mountains of Mugodzhary and belong to the basin of the Caspian Sea. Endorheic rivers and lakes drying up in the summer are characterized by brackish waters.

In scientific literature, the problem of studying the ecological state of rivers based on the structure and quantitative characteristics of macrozoobenthos is well covered (Hakiki *et al.*, 2017; Kenderov *et al.*, 2017) in connection with environmental conditions, including water mineralization (Zinchenko *et al.*, 2014; Zinchenko *et al.*, 2017a). Bioindication properties of macrozoobenthos allow an evaluation of water quality (Pawhestri *el al.*, 2015; Shitikov *et al.*, 2004). Specific features of the formation of bottom community of organisms in artificial reservoirs, represented by numerous and diverse insects (Bakanov, 2003; Furey *et al.*, 2006) as well as by Oligochaeta and molluscs (Yakovleva & Yakovlev, 2011), are considered separately. Fragmentary information on the macrozobenthos of the Ilek River is provided in the reports of the Kazakh Research Institute of Fishery (Kazakhstan, Almaty) on the monitoring research of fishery water bodies.

Currently, the biodiversity of watercourses with a high level of mineralization is markedly understudied (Gallardo *et al.*, 2014; Zinchenko *et al.*, 2017b). The available information on the structure and composition of the macrozoobenthos of the Irgiz River (Balymbetov & Grishaeva, 2008; Petrakov, 2015; Seitkasymova, 2016), Jai'yq River (a tributary of the Ilek River) (Kenzhebaev *et al.*, 2017; Pilin & Alpeisov, 2017) and other water bodies of the basin of the Ural River in the territory of Kazakhstan (Pilin, 2012; Pilin & Oskina, 2017) in condi-

Tab. 1: Collected hydrobiological data, 2015-2017.
Tab. 1: Zbrani hidrobiološki podatki v obdobju 2015-2017.

Waterbody	Station	Coordinates/ reference points	Number of collected samples								
			2015			2016			2017		
			A	B	C	A	B	C	A	B	C
Aktobe Reservoir	AR-1.1	050º11'58,5" N - 057º20'54,7" E	1	1	-	1	1	-	2	1	1
	AR-1.2	050º13'59,1" N - 057º20'32,4" E	-	-	-	1	1	-	1	1	1
	AR-1.3	050º14'56,8" N - 057º21'44,4" E	-	-	-	1	-	-	2	1	1
	AR-2	050º22'37,1" N - 057º29'54,5" E	1	-	-	1	-	-	1	1	1
	AR-3	050º07'45,8" N - 057º35'58,7" E	1	-	-	1	-	-	1	1	1
Sazda River	S-1	050 º23'93,1" N - 057 º15'58,2" E	1	1	-	3	1	-	-		
	S-2	050 º23'62,3" N - 057 º15'13,6" E	2	-	-	1	2	-	-		
Ilek River	I-1	050º18'45,3" N - 057º13'23,3" E	1	1	-	2	1	-	1	1	1
	I-2	050º16'52,9" N - 057º15'46,1" E	-	-	-	2	-	-	1	1	1
	I-3	050º15'16,7" N - 057º19'38,2" E	-	-	-	2	-	-	1	1	1
	I-4	050º17'40,4" N - 057º15'35,3" E	-	-	-	-	-	-	1	1	1
Aktobe City	AC-1	050º17'71,5" N - 057º13'75,8" E			2	-	-	-	-	-	1
Kargala River	K-1	050º20'06,6" N - 057º21'11,8" E	-			1	-	-	2	-	1

Note: A - quantitative samples of macrozoobenthos, B - qualitative samples of macrozoobenthos, C - samples of insect imagoes caught with light traps.

tions of aridification indicate insufficient coverage of this problem in literature.

The study of the modern macrozoobenthos of arid reservoirs and rivers of the Aktobe Region is of interest as a source of additional information for integrated environmental monitoring research and preservation of biodiversity in Kazakhstan. Investigation of the state of macrozoobenthos in the Ilek River, which flows on the territories of Kazakhstan and Russia, is especially important, as it affects the ecological interests of both countries.

The aim of this study was to examine the quantitative characteristics, taxonomic composition and structure of macrozoobenthos of the arid Ilek River (Kazakhstan).

MATERIAL AND METHODS

The hydrobiological research of the Ilek River, its tributaries (the rivers Sazda and Kargala) and the Aktobe Reservoir, which is fed by their waters, was carried out in the period between 2015 and 2017. In sampling macrozoobenthos for quantitative research, in which the density of distribution of organisms per unit of bottom area was relevant, 37 samples were collected using a Peterson bottom grab. An additional 18 samples were collected using a scraper net in sampling macrozoobenthos for quantitative research, in which the density of distribution of organisms per unit of bottom area was not relevant. To obtain more comprehensive information on the taxonomic composition of the Chironomidae (Diptera) and Trichoptera, the capture of insect imagoes with light traps was performed for 13 samples, using entomological scoop nets. The entire volume of hydrobiological material was collected from 13 stations (Table 1). The coordinates of the stations were determined by means of a GARMIN 64s GPS navigator.

To collect the hydrobiological material in the reservoir at a depth of over 0.8 m, we used the Petersen bottom grab with a bottom capture area of 0.025 m^2. For rivers with stony beds or bottoms overgrown with vegetation, a scraper net with netting made of gauze sieve with 10 holes per 1 cm^2 was used. The netting was stretched on a semi-circular metal frame with a diameter of 400 mm, the depth of the netting was 700 mm, the length of the handle 1,200 mm. Collection of samples by bottom grab and scraper net was carried out at least twice per each station. The macrozoobenthos samples were labelled and fixed with an aqueous solution of formaldehyde (10%).

For the capture of insect imagoes, an entomological scoop net made of gauze sieve with 0.25 mm wide holes at a quantity of 24 per 1 cm^2 was used in all reservoirs. The diameter of the scoop net was 300 mm, the depth of the netting 700 mm, the length of the handle 200 mm. Insects were collected from the scoop net after every 10 strokes and placed in 300 ml and 500 ml plastic containers (Zinchenko & Shitikov, 1999; Sharapova & Falomeeva, 2006; Krasheninnikov, 2011). When catching insects with light traps, 10 repetitions were made at each station. The macrozoobenthos samples were labelled and fixed with a solution of ethyl alcohol (70%) for further processing.

The taxonomic composition of the macrozoobenthos was determined using MBS-10 and MS-300 microscopes according to specific determinants (Tsalolikhin, 1995; Ivanov, 2011; Kenderov *et al.*, 2017; Krasheninnikov, 2011; Malicky, 1986; 2004; Morse, 2013; Olah & Ito, 2013). For each quantitative sample, the abundance and biomass were calculated for taxa adjusted to 1 m^2 of the water body bottom, followed by summation over groups (Oligochaeta, Chironomidae, Trichoptera, Crustacea). The organisms were weighed on torsion (from 0 to 1000 mg) and pharmacy scales. The frequency of occurrence was calculated as the ratio of the number of samples in which a certain species was present to the total number of samples.

To describe the structure of the macrozoobenthos, informational indices were calculated. The dominance index (Basyuni *et al.*, 2018) depended on the frequency of occurrence, abundance and biomass of the taxa according to Equation 1:

$$D_i = 100\ p_i \sqrt{N_i B_i} / \sqrt{N_s B_s}, \qquad (1)$$

wherein p_i is the frequency of occurrence of the taxon i; N_i is the abundance of the taxon i in the sample; B_i is the biomass of the taxon i in the sample; N_s is the total number of organisms in the sample; B_s is the total biomass of the organisms in the sample.

The diversity of communities that reflects the number of species and their share in the total quantitative characteristics was estimated according to the Shannon-Wiener index using Equation 2 (Basyuni *et al.*, 2018):

$$H = -\sum p_i \lg_2 p_i, \qquad (2)$$

wherein H is the diversity index, bits/spec, bits/g; p_i is the specific abundance (or biomass) of the taxon i; $p_i = N_i/N_s$ or B_i/B_s; N_i is the number of each taxon i; N_s is the total number of all taxa; B_i is the biomass of each taxon i; B_s is the total biomass of all organisms.

The Pielou evenness index was calculated according to Equation 3 (Furey, 2006):

$$I = H/\lg_2 S, \qquad (3)$$

wherein S is the number of taxa; $0 \leq I \geq 1$.

The calculations and statistical processing of the obtained data were carried out using Excel 2017 and STATISTICA 2015 programs. The data are presented as average values +/- standard deviations.

STUDY AREA

The study covered water bodies that belong to the ecosystem of the transboundary Ural River in the terri-

Tab. 2: The taxonomic composition of the macrozoobenthos of the Ilek River, its tributaries (the Kargala, the Sazda) and the Aktobe Reservoir, 2015-2017.
Tab. 2: Taksonomska sestava makrozoobentosa na reki Ilek, njenih pritokih (Kargala, Sazda) in v zadrževalniku Aktobe v obdobju 2015-2017.

Taxon Name	Ilek	Kargala	Sazda	Aktobe Reservoir
Vermes				
Annelida				
Oligochaeta				
Tubificidae				
Tubificidae gen. sp.	+	+	+	+
Naididae				
Naididae gen. sp.	-	-	+	+
Arthropoda				
Insecta				
Diptera				
Chironomidae				
Tanypus punctipennis Meigen, 1818	+	-	+	+
Ablabesmyia gr. *lentiginosa* Fries, 1823	-	-	-	+
Ablabesmyia gr. *monilis* Linne, 1758	-	-	-	+
Procladius sp.	-	-	-	+
Chironomini gen. sp.	+	+	+	+
Parachironomus gr. *pararostratus* Lenz, 1938	-	-	-	+
Cryptochironomus gr. *defectus* Kieffer, 1921	-	-	-	+
Lipiniella arenicola Shilova, 1961	+	+	+	+
Chironomus plumosus Linne, 1758	+	+	+	+
Limnochironomus sp.	-	-	+	+
Endochironomus sp.	+	-	+	+
Tanypus sp.	+	+	+	+
Diamesa sp.	-	-	-	+
Ceratopogonidae				
Ceratopogon sp.	+	+	+	+
Trichoptera				
Ecnomidae				
Ecnomus tenellus Rambur, 1842	+	+	-	+
Limnephilidae				
Limnephilus sp.	+	+	-	+
Limnephilus stigma Curtis, 1834	-	-	-	+
Odontoceridae				
Odontoceridae gen. sp.	+	-	-	+
Lepidostomatidae				
Lepidostomatidae gen. sp.	-	+	-	+
Leptoceridae				
Athripsoides sp.	-	+	-	-
Phryganeidae				
Phryganea sp.	+	-	+	-
Crustacea				
Amphipoda				
Gammaridae				
Dikerogammarus sp.	+	-	-	-
Note: »+« - taxon was found in the reservoir; »-« - taxon was not found in the reservoir.				

tories of Kazakhstan and Russia (Evseeva, 2010; Evseeva & Kushnikova, 2017), which is important for the basin approach in the use of this river (Sivokhip, 2016; Wolf *et al.*, 2003).

The Ilek River originates in the western slope of the Mugodzhary Mountains. Its length in the territory of the Aktobe Region is 257 km. The riverbed is meandering, with steep or abrupt banks (2-4 m), its width increasing downstream from 15 to 50 m (in some places, up to 170 m). The bottom is loamy, less often sandy-loamy with pebbles, in shallow water silty (Dzhubanova, 2008).

The Kargala River is the right tributary of the Ilek River, 114 km long and with a constant drainage. Its riverbed is meandering, well developed, its width expanding downstream from 20 to 200 m. In the upper and middle reaches, the banks are about 1-2 m high, sloping, while in the lower reaches they are 3-4 m high, steep, abrupt. The bottom of the reaches is stony or clayey, sometimes silty; it is stony or stony-sandy on slopes.

The Sazda River is the left tributary of the Ilek River, only 40 km long and with a constant drainage. Its riverbed widens downstream from 15 to 50 m. The banks are 2-4 m high, gently sloping, sometimes abrupt; in the estuary, they are reduced to 1-1.5 m. The bottom of the riverbed is sandy.

The Aktobe Reservoir stands out among the investigated water bodies. This is an artificial perennial reservoir with seasonal drops in the water level (Balymbetov & Grishaeva, 2004). The favourable conditions it provides for the development of hydrobionts are determined by various factors, including anthropogenic ones (hydrological regime, pollution of the environment, etc.), as well as internal processes of interaction among ecosystem components. The Aktobe Reservoir, which occupies an area of 3,570 hectares, is fed by the water from the Ilek River.

RESULTS

During the 2015-2017 research period, the depths of macrozoobenthos sampling sites varied from 0.2 to 0.8 m on the rivers Ilek, Kargala and Sazda, and from 0.5 to 3.2 m at the Aktobe Reservoir. The average water temperature in spring reached up to +21.2 °C in the rivers and up to +20.3 °C in the reservoir. In spring, the water was characterized by transparency to the bottom in sandy areas and by considerable muddiness in silty areas.

The most common bed types in the rivers are sand, gray silt and small pebbles. At the Aktobe Reservoir, the riverbed types include sand, gray, brown and black silt, stones and ground, densely overgrown with aquatic plants.

In the spring of 2017, the water in all the investigated reservoirs was characterized by a slightly alkaline reaction. The water mineralization in the rivers Ilek, Kargala and Sazda was up to 100-200 mg/dm^3. The water mineralization in the coastal zone of the Aktobe Reservoir did not exceed 100 mg/dm^3 (Erkeeva, 2017b).

During the 2015-2017observation period, the macrozoobenthos of the Ilek River, its tributaries (the Kargala and the Sazda) and the Aktobe Reservoir was represented by two families of Annelida (Oligochaeta) and nine families of Arthropoda (Insecta, Crustacea) (Table 2).

The Insecta class was the most diverse. It included two orders - Diptera with two families (Chironomidae, Ceratopogonidae) and Trichoptera with six families (Ecnomidae, Odontoceridae, Lepidostomatidae, Phryganeidae, Leptoceridae, Limnephilidae). The Chironomidae family had the highest number of identified invertebrate taxa.

The highest frequency of occurrence (81.5 %) in the examined rivers and the reservoir was recorded for Oligochaeta, which mainly included representatives of the Tubificidae family. The frequency of occurrence of Chironomidae larvae averaged 72 %. In terms of abundance and biomass, the Chironomidae were the dominant group: the highest percentages were recorded in the Aktobe Reservoir – 66.15 and 91.38%, respectively.

In the Ilek River, the maximum abundance of macrozoobenthos was recorded in 2016 – 420 spec/m^2 (Table 3). In 2015, the macrozoobenthos of the Sazda River had the largest biomass – 5.2 mg/m^2. In 2015 and 2017, the highest abundance of macrozoobenthos was ascertained in the Aktobe Reservoir – 912 spec/m^2 and 14.2 mg/m^2, respectively.

The dynamics of the Shannon-Wiener and Pielou indices (Table 4) showed that the maximum diversity and evenness of macrozoobenthos in the rivers and in the Aktobe Reservoir were recorded in the summers of 2015 and 2016.

Tab. 3: The abundance and biomass of the macrozoobenthos of the Ilek River, its tributaries (the Kargala, the Sazda) and the Aktobe Reservoir, 2015-2017.
Tab. 3: Abundanca in biomasa makrozoobentosa na reki Ilek, njenih pritokih (Kargala, Sazda) in v zadrževalniku Aktobe v obdobju 2015-2017.

Year	Ilek	Kargala	Sazda	Aktobe Reservoir
	Abundance (spec/m^2)			
2015	227*	-	120±23	912±97
2016	420±68	268*	184±42	710±63
2017	348±73	223*	-	817±92
Average	332±56	245±23	152±32	813±58
Biomass (g/m^2)				
2015	2.2*	-	5.2±0.9	12.6±2.2
2016	2.6±0.5	2.4*	4.6±1.0	10.2±1.8
2017	3.2±0.8	1.7*	-	14.2±3.2
Average	2.7±0.3	2.1±0.4	4.9±0.3	12.3±1.2
Note: * - the data were collected from a single station.				

DISCUSSION

In the studied rivers and reservoir, the following types of bed resulted the most common: gray silt, sand with gray silt deposits, and black silt with sapropel in areas with abundant vegetation. In the springs of the 2015-2017 period, the maximum density of invertebrates was observed for gray silt and sand with gray silt deposits: most often Diptera (Chironomidae, Trichoptera), less often Oligochaeta, and sporadically other representatives of the macrozoobenthos, for a total of 24 taxa.

In the previous period of study, from 2005 to 2009, a wider representation of benthic invertebrates was observed, namely 30 taxa. The macrozoobenthos included Oligochaeta, as well as Nematoda, Hirudinea, Hydracarina, larvae of Diptera (Chironomidae), Ephemeroptera, Trichoptera and Coleoptera, with the greatest diversity in the vegetation zone. On gray silt and silty sand, we found representatives of the order Trichoptera belonging to the families Lepidostomatidae, Ecnomidae, Leptoceridae and Odontoceridae. During the 2009-2012 (Smirnova, 2012; 2016) and 2015-2017 examination periods, we also observed representatives of other taxa of the Trichoptera order, including, in particular, *Ecnomustenellus; Limnephilus stigma; Limnephilus* sp.; *Athripsodes* sp.; *Phryganea* sp.; *Odontoceridae gen.* sp., and *Lepidostomatidae gen.* sp. In terms of species occurrence and quantitative characteristics, larvae of Diptera (Chironomidae) and Trichoptera were predominant, which is typical of arid rivers and reservoirs with variable filling levels (Kenzhebaev *et al.*, 2017; Pilin & Alpeisov, 2017; Pilin & Oskina, 2017). As a rule, the macrozoobenthos of brackish and highly mineralized rivers is represented by a taxonomically stable community of organisms that are resistant to changes in water salinity. Rivers in arid zones are characterized by certain species specificity; for example, Diptera (Chironomidae) are abundantly represented in the diverse silted biotopes of the Ilek River with its tributaries and the rivers of the saline lake Elton basin (Russia) (Orel (Zorina) *et al.*, 2014; Zinchenko, 2017), while Trichoptera (Malicky, 1986) are abundantly represented in the arid rivers of Iran and Afghanistan.

The study revealed an ambiguous relationship between quantitative characteristics of the macrozoobenthos in the Aktobe Reservoir and the influence of the Ilek River on its hydrological and hydrochemical conditions. For instance, a decrease in the water level in 2004 led to an increase in the total content of dissolved salts, whereas a reduction in its surface area caused the desiccation of the coastal zone and the death of shallow and coastal macrophytes, which constituted a biotope for mass representatives of macrozoobenthos. At the same time, in the composition of benthic invertebrates, the share of molluscs *Theodoxus pallasi* as well as that of the amphipod *Dikerogammarus aralensis* decreased. The decrease in the diversity of these groups of invertebrates led to a decrease in the total biomass of macrozoobenthos by an order of magnitude in comparison with the previous year (Balymbetov & Grishaeva, 2004).

Tab. 4: The dynamics of diversity and Evenness indices in the macrozoobenthos community of the Ilek River, its tributaries (the Kargala, the Sazda) and the Aktobe Reservoir, 2015-2017.

Tab. 4: Dinamika indeksov pestrosti in enakomernosti porazdelitve makrozoobentoške skupnosti v reki Ilek, njenih pritokih (Kargala, Sazda) in v zadrževalniku Aktobe v obdobju 2015-2017.

Year	Ilek	Kargala	Sazda	Aktobe Reservoir
Shannon-Wiener indices, bits/spec				
2015	0.7*	-	1.3±0.1	1.5±0.1
2016	1.3±0.03	1.1*	1.4±0.04	1.6±0.04
2017	0.5±0.03	0.7*	-	0.6±0.04
Pielou Evenness indices				
2015	0.8*	-	0.8±0.2	0.8±0.04
2016	0.8±0.02	0.8*	0.8±0.03	0.9±0.02
2017	0.4±002	0.6*	-	0.6±0.04
Note: * - the materials were collected from a single station.				

The natural hydrochemical background of the watercourses of the Aktobe Region of Kazakhstan is affected by anthropogenic factors, especially cattle grazing, melioration works, drainage regulation, exploitation of mineral deposits, etc. During the study period in May 2015, the depth of the Aktobe Reservoir was 0.5-0.8 m at the site of water sampling, whereas the water temperature was up to +21.2 °C. The water showed a slightly alkaline reaction and the concentration of dissolved oxygen was up to 10.3 mg/dm^3. During the post-flood period, the low concentration of carbon dioxide and low mineralization corresponded to low-mineralized waters (Petrakov, 2015).

In May 2017, the chemical composition of the Ilek River, its tributaries (the Sazda and the Kargala) and the Aktobe Reservoir was characterized by a slightly elevated level of hardness, in particular, 4.8, 4.9, 5.3 and 7.2 mg-eq/L, and an iron content of 0.13, 0.12, 0.22 and 0.40 mg/dm^3, respectively (Erkeeva, 2017a; 2017b). In the period of high water, the level of the Ilek River increased abnormally because of the large influx of melt water. For the first time in the last 25 years, the Aktobe Reservoir was filled to its maximum capacity. The flooding of coastal areas resulted in soil washout and destruction of the macrozoobenthos structure.

As the drainage volume of the Ilek River into the Aktobe Reservoir increased in May 2017, the water salinity dropped to 100 mg/dm^3, whereas its average value in spring during the 2004-2008 (Balymbetov & Grishaeva, 2004; 2008) and 2011-2016 (Petrakov, 2015; Grishaeva & Erekeeva, 2017) study periods was 550 mg/dm^3. In May 2017, the minimum abundance and biomass of the macrozoobenthos over the periods of 2004-2008 (Balymbetov & Grishaeva, 2004; 2008) and 2015-2016 were recorded. The dominant group in the composition of the macrozoobenthos was Chironomidae (D_{Ch} = 79%). Between 2015 and 2017, despite a decline in the biomass of the macrozoobenthos, the Aktobe Reservoir was mesotrophic-eutrophic, the Ilek River and Kargala River were oligotrophic, the Sazda River mesotrophic.

Similar results were obtained from studies of the macrozoobenthos of the saline rivers of the Prieltonie, an arid zone in the south of Russia, where Chironomidae larvae formed the basis of the benthic zoocoenosis. Its quantitative characteristics consistently changed under the influence of hydrological and hydrochemical regimes of the watercourses. At the same time, the detected patterns of change in the structure of the aquatic ecosystem depended not only on the faunistic composition of the hydrobionts, but also on the type of water body, water expenditure, flowage, turbidity, flow velocity and other hydrological, hydrophysical and hydrochemical features (Choi1 *et al.*, 2013; Gallardo *et al.*, 2014; Zinchenko *et al.*, 2017).

The small depths of rivers in the arid zone result in the instability of their functioning under conditions of seasonal and climatic fluctuations. As extreme habitats, they are unique and represent hydro-ecosystems of the highest biological productivity in the dry landscapes of the intracontinental arid zones of Eurasia (Gallardo *et al.*, 2014; Zinchenko *et al.*, 2014), including Kazakhstan, Southern Russia, Central Asian countries, East and Northeast China, Korea, Iran, and Afghanistan (Choi *et al.*, 2013; Malicky, 1986), all located far from the oceans.

CONCLUSIONS

In the spring-summer periods during the 2015-2017 time frame, the macrozoobenthos of the investigated rivers and the Aktobe Reservoir included 24 taxa consisting of three groups: Anellida (Oligochaeta), Crustacea (Amphipoda), Insecta (Diptera, Trichoptera). The highest frequency of occurrence was observed for the Oligochaeta (81.5%) and Diptera (Chironomidae) (72%). The maximum values with regard to the abundance and biomass of the Diptera (Chironomidae) (664 spec/m^2 and 8.2 g/m^2, respectively), as well the highest diversity (1.6±0.04 bits/spec) and evenness (0.9 ± 0.02) of species were observed in the Aktobe Reservoir. During the observation period, the trophic level of the reservoir was characterized as mesotrophic-eutrophic. The value of the biomass of river zoobenthos characterized the Ilek and Kargala Rivers as oligotrophic, and the Sazda River as a mesotrophic watercourse.

In general, the Chironomidae larvae were dominant in the benthic community of invertebrates of the investigated rivers and reservoir – the value of their dominance index reached 79%. The diversity and evenness of zoobenthos species were at a low level, which is typical of water bodies and watercourses of arid zones with high anthropogenic impact.

An ambiguous relationship was established between the biomass of macrozoobenthos and the water salinity of the Aktobe Reservoir, which depended on the volume of river drainage. The decrease in the biomass of macrozoobenthos with an increase in the river drainage into the reservoir may be due to the destruction of existing biotopes – ground and aquatic vegetation.

The obtained hydrobiological data indicate a typically low level of fodder base for bottom-feeders and a low trophicity that is characteristic of arid watercourses. A gradual reduction in the species diversity of zoobenthos, the predominance of the larvae of secondary aquatic insects under conditions of an unstable hydrological regime, and anthropogenic impact are leading to a degradation of aquatic ecosystems. The loss of species diversity results in a reduced functionality of the ecosystem, an invasion of new species and a significant change in the biomass production.

The theoretical significance of the obtained information about the structure of the macrozoobenthos of the Ilek River is related to the progressive desertification of the territory of Kazakhstan, a Central Asian country. Desertification is a major global ecological and socioeconomic problem. The study of the condition of the macrozoobenthos of water bodies and watercourses of arid zones should be continuous, as the data obtained could importantly contribute to the formation of a global database on the status of the biodiversity of aquatic ecosystems.

The practical significance of the present research results lies in the possibility of their application to the development of a scientific foundation for a rational use and protection of biological resources in arid countries.

MAKROZOOBENTOS ARIDNIH VODNIH TELES V KAZAHSTANU: PRIMER REKE ILEK

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POVZETEK

Članek obravnava kvantitativne značilnosti, taksonomsko sestavo in strukturo makrozoobentosa na primeru aridne reke Ilek (Kazahstan). Pričujoča tematika je pomembna z vidika problematike ohranjanja globalne biodiverzitete. Avtorji so raziskovali frekvenco pojavljanja taksonov, abundanco, biomaso in strukturo makrozoobentosa. Izračunali so dominanco, pestrost in enakomernost pojavljanja. Makrozoobentos aridnih vodnih teles in rek je sestavljalo 24 taksonov, med katerimi so v abundanci in biomasi prevladovale ličinke trzač (Chironomidae). Raziskava je pokazala povezavo med stopnjo biomase makrozoobentosa in mineralizacijo. Ti izsledki so lahko uporabni za krmo za ribe, za ugotavljanje saprobnih razmer in antropogenih vplivov v regiji Aktobe, pri ekoloških analizah omenjene regije in tudi za opredelitev ekološkega stanja v uralskem rečnem ekosistemu.

Ključne besede: makrozoobentos, biodiverziteta, dominanca, okoljske razmere, hidrokemični režim

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