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The state of hydrobionts in the Tyub-Karagan Bay structure, Kazakhstan

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Abstract

Aim. The purpose of the research was to study the state of hydrobionts in the Tyub-Karagan Bay structure by season for a comparative analysis of their state with previous studies by the authors.

Material and Methods. The conditions of hydrobionts (phyto, zoo-plankton and macrozoobenthos) of the Tyub-Karagan Bay structure have been studied for three seasons. Studies were carried out by traditional methodology.

Results. The species composition of phytoplankton communities in spring was found to be less constant than in autumn; this is associated with heterogeneity in external conditions at the beginning of the growing season. The seasonal dynamics of zooplankton conformed to certain patterns. As a rule, from the beginning to the end of the growing season there was an enrichment of species composition and an increase in the quantitative indicators of zooplankton communities. The highest biomass was formed by bottom cenoses, where large mollusks play a leading role.

Conclusion. During the 2018 research period, species richness and species diversity of phytoplankton were at a high level. Representatives of two categories were observed most often. Blue-green dominated in number, while diatoms formed the basis of biomass. Species richness and species diversity of zooplankton was at a low or moderate level and most often constant. The seasonal dynamics of macrozoobenthos had common and specific features, depending on the research station location. Disproportionate changes in the quantitative indicators of bentonites are associated with a decrease in the average weight of individuals by autumn. This happened both through the strengthening of the role of small species and by an increase in the proportion of younger age stages in populations of bottom invertebrates.

Key Words
Gulf, phytoplankton, zooplankton, macrobenthos, population, biomass.

Состояние гидробионтов структуры Тюб-Караган, Казахстан

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Резюме
Целью исследований было изучение состояния гидробионтов в районе структуры Тюб-Караган по сезонам для сравнительного анализа состояния гидробионтов с предыдущими исследованиями авторов.
Материал и методы. Изучены состояния гидробионтов (фито- и зоопланктон и макрозообентос) структуры Тюб-Караган в трех сезонах. Исследования состояния гидробионтов проводились традиционным методом.
Результаты. Видовой состав фитопланктонных сообществ весной был менее постоянным, чем осенью, что связано гетерогенностью внешних условий в начале вегетационного сезона. Сезонная динамика зоопланктона подчинялась определённым закономерностям. Как правило, от начала к концу вегетационного сезона происходило обогащение видового состава и рост количественных показателей зоопланктонных сообществ. Наиболее высокую биомассу формировали донные ценозы, где ведущую роль играли крупные моллюски.
Заключение. В период исследований (2018 г.) видовое богатство и разнообразие фитопланктона находились на высоком уровне. В основном часто встречались представители двух отделов: сине-зеленые и диатомовые водоросли. Сине-зеленые доминировали по численности, а диатомовые формировали основу биомассы. Видовое богатство и разнообразие зоопланктона в период исследований на акватории находилось на низком или умеренном уровнях. Чаще всего видовой состав зоопланктона был постоянным. Сезонная динамика макрозообентоса имела общие и специфические черты, в зависимости от станции исследований. Непропорциональные изменения количественных показателей бентонитов связаны с уменьшением средней массы особей к осени. Это происходило как за счет усиления роли мелких видов, так и за счет увеличения доли младших возрастных стадий в популяциях донных беспозвоночных.

Ключевые слова
Залив, фитопланктон, зоопланктон, макрозообентос, численность, биомасса.

INTRODUCTION

Work by the authors in this research domain has been carried out since seismic survey operations in the region began, i.e. since the end of the 20th and beginning of the 21st century, and enough has been published as background to the study results reported here.

Phytoplankton are a plurality of microscopic plants (especially algae) living in marine and fresh waters and passively moving under the influence of water currents.

Phytoplankton includes protococcal algae, dinoflagellate diatoms, coccolithophorids, and other unicellular algae (often colonial), as well as cyanobacteria.

Phytoplankton are the primary producers of organic matter in these waters and serve as food for zooplankton and zoobenthos. Rapid reproduction of phytoplankton causes what is known as "water bloom".

Published studies of the state of phytoplankton in the study area [1-4] indicate that different types of algae prevail in numbers and biomass in different years.

Plankton plays an importance role in the nutritional balance of aquatic ecosystems, being fed upon by many fish species, whales and certain birds. This fact makes plankton an essential source of life for all aquatic ecosystems, seas, oceans, rivers and lakes alike. The impact of plankton on water resources is so great that it can even affect the chemical composition of water.

Phytoplankton, bacterioplankton and zooplankton compose a plankton structural formation. All these organisms are small, being at most tens of micrometres in size for algae and a few centimetres for zooplankton. On the other hand, many animals, even the largest freshwater daphnia, are much smaller and reach only 5 mm in size. The organisms that make up plankton are in a constant state of suspension in the water column. At night zooplankton rise to the surface layers in seas and oceans and filter out microscopic algae. In the morning, zooplankton sink to a depth of 300 metres or more.

The majority of planktonic organisms spend their whole lives in water columns and are not related to a solid substrate. However, inactive stages of many of these organisms in assemble in bottom waters in the winter period, where they shelter from unfavourable conditions. There are also some organisms which spend only part of their lives in the water column. An example is meroplankton (from the Greek "meros" meaning part). It appears that the larvae of many benthic organisms – sea urchins, stars, worms, mollusks, crabs, corals, etc. conduct a planktonic life, directed by currents and, eventually, find locations for further habitation. There they assemble at bottom level and do not abandon their places for the rest of their life cycle. This life strategy is due to the fact that bottom organisms have a disadvantage in comparison with plankton, as they move from place to place relatively slowly. However, thanks to this planktonic larval stage, they are drifted by currents over extensive areas, similar to the seeds of terrestrial plants which are transmitted long distances by the wind. The eggs and larvae of some fish also lead a planktonic lifestyle.

However, as noted previously, most planktonic organisms are real plankters. They are born and die in the water column, which contains bacteria, microscopic algae, various animals (protozoa, rotifers, mollusks, crustaceans, etc.).

Many planktonic crustaceans accomplish vertical migrations. At night they move up to the upper layer, where they eat algae. Closer to the morning they move to a depth of several hundred metres, where they are concealed from fish in these dark locations. Moreover, low temperatures reduce metabolism and consequently the energy rate for maintaining vital functions is lowered. At depths, the density of water is higher than at the surface and therefore organisms are in a state of neutral buoyancy, allowing them to exist in the water column with zero energy consumption.

Sea water may be coloured not only by algae but also by the presence of zooplankton. Most euphausiids are translucent and colorless but some are bright red. The red ones live in the colder northern and southern hemispheres and sometime make the whole sea seem red by accumulating in larger quantities.

The abundance of organisms available as food is very important for the intensive growth and development of larvae, as well as fish fry. It determines the degree of fish productivity.

The authors of the work have been studying hydrobionts in this region since the time seismic surveys have been conducted on this structure and many works have been published relating to the phenomena described here [3; 5-8].

The benthos is composed of organisms living at the bottom of water bodies and which are not able to swim in water for a long period of time. Systematically, it is divided into plant benthos (phytobenthos) and animal benthos (zoobenthos).

In contrast to planktonic organisms, benthic animals and plants do not need to lower their weight, so many of them, especially those living in coastal areas, are characterized by structural strength and often heavy deposits of lime. There are a quite large number of organisms, mainly crustaceans and worms, which can move up the water column during the breeding period or for food. Some species which spend a long period in water can lead both benthic and planktic lifestyles and belong to the group of planktobenthos or bentoplankton.

The structure of benthic organisms mainly depends on the nature of the substrate on which they live, as well as on light, wave strength, etc. Therefore, there are strong differences in the structure of similar forms living on soft ground or on stones, in the surf zone or at depth, in full light or in the dark. In relation to the substrate, benthic organisms are divided into the groups described below [9].

Attached organisms (sessile benthos). The bulk of plant benthos is comprised of attached forms; e.g. flowering plants which usually are secured into soft ground with the help of rhizomes and a large number of algae which attach to a solid substrate with their rhizoids. Among sessile zoobenthic organisms are sponges, hydroids, corals, sea lilies, worms, bryozoans, bivalve mollusks, barnacle crayfish, ascidia and a number of other animals. The general body shape of attached animals is usually elongated. Very often they are colonial organisms, such as sponges, hydroids, corals and bryozoans, which form colonies by budding. Their organs of motion are usually reduced or change their function.

Attached animals, despite their lack of movement, easily spread due to the formation of free-floating larval stages carried by currents. Animals can lead a sedentary lifestyle only in the aquatic environment, as only in it can they get the food they need in the form of water-borne plankton or organic detritus descending from above.

Lying organisms. Animals lying on soft ground have a very wide and low body. Many flat forms are found among bottom fish, for example flatfish, as well as cephalopods. Some crabs, bivalves, sea urchins and other animals also have a flat body shape, some having outgrowths located in the same plane.

Burrowing organisms. Animals buried in the ground, the totality of which is called infauna, as opposed to epifauna, are represented mainly by attached and freely moving organisms and are found in many groups of the animal world, mainly among worms, sea urchins, holothurii, gastropods and bivalves, crustaceans, insect larvae and a number of other groups. Many animals immerse themselves in the ground for protective purposes. They live in passages or tubes, often strengthened by secretions; the length of the passages sometimes being several times the length of the organism itself. Some animals move freely in the ground, absorbing it to extract the organic matter in it or actively seeking prey.

Burrowing in the ground is associated with a number of changes in the structure of animals. The irregular sea urchins which are buried in the sand are devoid of the Aristotle's lantern; their needles being turned into digging organs. The shell of mollusks living in the soil becomes smooth, thin, not tightly closed; a well-developed leg lacks a byssus gland; long siphons, often exceeding the length of the animal itself, are used to communicate with the external environment.

Boring organisms. Dense sedimentary rocks, those of limestone, sandstone, slate and even granite, as well as marble, concrete, brick, wood and mollusk shells are drilled or bored by such organisms. Marine boring organisms include certain algae, sponges, worms, mollusks and crayfish. Drilling organisms usually never leave their home, increasing their volume as they grow; therefore, they are essentially prisoners. Food comes from small planktonic organisms and organic detritus suspended in water. The presence of free-swimming larval forms, however, allows the wide spread of drilling organisms.

Free-moving organisms (vagile benthos). Many animals move along the bottom with the help of variously arranged limbs; echinoderms have ambulacral legs, a leg serves as an organ of movement for mollusks and protozoa move with the help of cilia or pseudopodia. Some plants, such as bottom diatoms, also have the ability to move.

The development of benthos is determined by the nature of the grouns, the availability of food and the speed of the current. Zoobenthos organisms respond slightly to short-term changes in water quality.

On pure sand, the zoobenthos contains numerous worms, cryptochiron larvae, midge larvae, etc. With silting of a sandy bottom, large oligochaetes, mollusks develop and with silting of a clay bottom, a biocenosis forms consisting of mollusks, amphipods, shell crustaceans, numerous larvae of tendipids, etc. The temperature of water has a great influence on the life of the zoobenthos – it determines its growth, development, reproduction, metabolism and biological cycles. In winter, the abundance of the zoobenthos is insignificant but when the water temperature rises above 10°C the reproduction of most bottom invertebrate species begins.

MATERIAL AND METHODS

The object of the study was the region of the Tyub-Karagan Bay. As in previous years, studies were carried out from three sides of the Tyub-Karagan structure at equal distances from the perimeter. Unlike in previous years, no studies were conducted in the summer of 2018.

Phytoplankton samples were taken from the surface layer of water and fixed with 4% formalin. They were then concentrated by the sedimentary method [10-12]. In laboratory conditions, samples were processed by generally accepted methods [13-15] and the following were determined: species composition, species abundance – million cells per cube m., biomass – mg per cubic metre of algae.

Zooplankton samples were taken from the surface layer of water using an Apstein net and fixed with 4% formalin. Then they were concentrated by the sedimentary method [10-12] and sent for processing to an accredited laboratory. In laboratory conditions, samples were processed according to generally accepted methods [13-15], the taxonomic composition, abundance (species per 1 m^3) and biomass (mg. per 1 m^3) of zooplankton were determined.

Macrozoobenthos samples were taken from the sea bottom with a Peterson bottom grab and fixed with 4% formalin. They were then concentrated by the sedimentary method [10-12]. In the laboratory samples were processed by conventional methods [13-15] to the taxonomic composition, abundance (species per 1 m^2) and biomass (mg. per 1 m^2).

RESULTS

State of phytoplankton

The results are shown in Table 1 and in Figs. 1 and 2. Table 1 shows the species composition of phytoplankton by season for the studied period.

As can be seen from this table, the research recorded 37 species in winter, 31 species in spring and 67 species in autumn, of which 21 species were first detected by studies undertaken in the previous two years, such as dinophytic, euglenozoic, myozoic, ochrophytic and cyanobacteria. The number of species encountered from winter to spring decreased but by autumn increased more than twice, due to new species. Moreover, four were found only during the autumn study period. Briefly, they are as follow:

- Cyanobacteria – a blue-green algae, or cyanene which is a category of large gram-negative bacteria capable of photosynthesis accompanied by oxygen evolution.
- Ochrophyte algae or ochrophytes (lat. *Ochrophyta*) – a category of unicellular, colonial and multicellular algae.
- Euglenozoans (lat. *Euglenozoa*) – a type of unicellular protists, which includes a variety of free-living species, as well as a number of parasites including those that cause human diseases. The group consists mainly of monophyletic taxa.
- Miozoa – a taxonomic type within the supertype *Alveolata* (Alveolates) (lat. *Alveolata*) or Alveolobionts,

which is a prototype (*Protista*), uniting a number of taxonomic groups, including ciliates, sporozoans, and dinoflagellates.

Table 2-3 shows the average abundance and biomass of the main phytoplankton groups recorded in 2018.

Figures 1 and 2 provide diagrams of the average abundance and biomass of phytoplankton in the research area for the study period.

As can be seen from the table and Figure 1, over the studied period, it outnumbered cyanobacteria with 53.6% in numbers, and diatoms over 72% in Figure 2.

Table 1. Species composition of phytoplankton in the 2018 seasons [16]
Таблица 1. Видовой состав фитопланктона по сезонам в 2018 г. [16]

Taxonomic composition Таксономический состав	**Number of species / taxa** Количество видов / таксонов		
	Winter Зима	**Spring** Весна	**Autumn** Осень
Bacillariophyta / Диатомовые	31	18	42
Dinophyta / Динофитовые	2	7	-
Chlorophyta / Зеленые	3	2	4
Chrysophyta / Золотистое	1	4	-
Cyanobacteria / Цианобактерии	-	-	9
Euglenozoa / Эвгленозои	-	-	1
Miozoa / Миозои	-	-	10
Ochrophyta / Охрофитовые	-	-	1
Total / Всего	37	31	67

Table 2. Average abundance of the main groups of phytoplankton in 2018, mln.cl/m^3
Таблица 2. Среднее значение численности основных групп фитопланктона за 2018 г., млн.кл/м^3

Stations Станции	**Bacillariophyta** Диатомовые	**Dinophyta** Динофитовые	**Chlorophyta** Зеленые	**Chrysophyta** Золотистое	**Cyanophyta** Сине-зеленые	**Euglenophyta** Эвгленовые	**Miozoa** Миозои	**Ochrophyta** Охрофитовые	**Cyanobacteria** Цианобактерии	**Euglenozoa** Эвгленозои	**Total** / Всего
1	39,1	33,5	0,0	0,0	0,1	0,0	4,5	0,1	31,1	0,0	108,4
2	13,2	77,7	0,6	0,0	0,00	0,0	5,4	0,1	278,8	0,6	376,4
3	24,6	92,0	5,5	0,0	0,3	0,0	1,1	1,1	216,7	0,0	341,3
4	72,0	47,8	0,0	0,0	1,6	0,0	3,9	0,6	23,9	0,0	149,8
5	69,0	92,0	0,6	0,0	0,00	0,0	2,9	0,1	105,0	0,0	269,6
6	40,2	75,0	1,2	0,0	0,05	0,0	5,5	0,6	101,7	0,0	242,25
7	36,6	11,6	10,0	0,0	0,69	0,0	0,6	0,0	118,3	0,0	177,79
8	40,0	78,5	0,0	0,0	0,00	0,0	3,8	0,6	303,4	0,0	426,3
9	27,1	155,1	3,9	0,0	0,00	0,0	2,8	0,0	66,7	0,0	255,6
Average Среднее	40,2	73,7	2,4	0,0	0,3	0,0	3,4	0,3	139,4	0,1	259,8

Table 3. Average biomass of the main groups of phytoplankton in 2018, gr/m^3
Таблица 3. Среднее значение биомассы основных групп фитопланктона за 2018 г., г/м^3

Stations Станции	**Bacillariophyta** Диатомовые	**Dinophyta** Динофитовые	**Chlorophyta** Зеленые	**Chrysophyta** Золотистое	**Cyanophyta** Сине-зеленые	**Euglenophyta** Эвгленовые	**Miozoa** Миозои	**Ochrophyta** Охрофитовые	**Cyanobacteria** Цианобактерии	**Euglenozoa** Эвгленозои	**Total** / Всего
1	508,1	31,7	0,0	0,0	0,0	0,00	118,9	1,4	0,5	0,0	660,6
2	53,43	76,1	4,3	0,0	0,0	0,00	57,4	1,4	5,6	8,8	207,03
3	253,4	88,1	1,3	9,7	0,1	0,00	2,8	15,5	1,9	0,0	372,8
4	626,2	49,4	0,6	7,6	0,5	0,00	128,7	8,0	0,2	0,0	821,7
5	247,5	88,1	0,2	0,0	0,0	0,00	31,9	1,4	0,9	0,0	370,0
6	259,7	72,8	0,6	0,0	0,0	0,00	52,9	8,0	0,9	0,0	394,9
7	196,7	8,8	1,9	0,0	0,2	0,00	3,0	0,0	6,2	0,0	225,8
8	296,1	74,0	7,3	0,0	0,0	0,00	40,8	8,0	4,8	0,0	431,0
9	371,2	151,2	0,9	0,0	0,0	0,00	50,5	0,0	1,6	0,0	575,4
Average Среднее	324,5	71,2	2,0	0,2	0,1	0,00	54,1	4,9	2,5	1,0	460,5

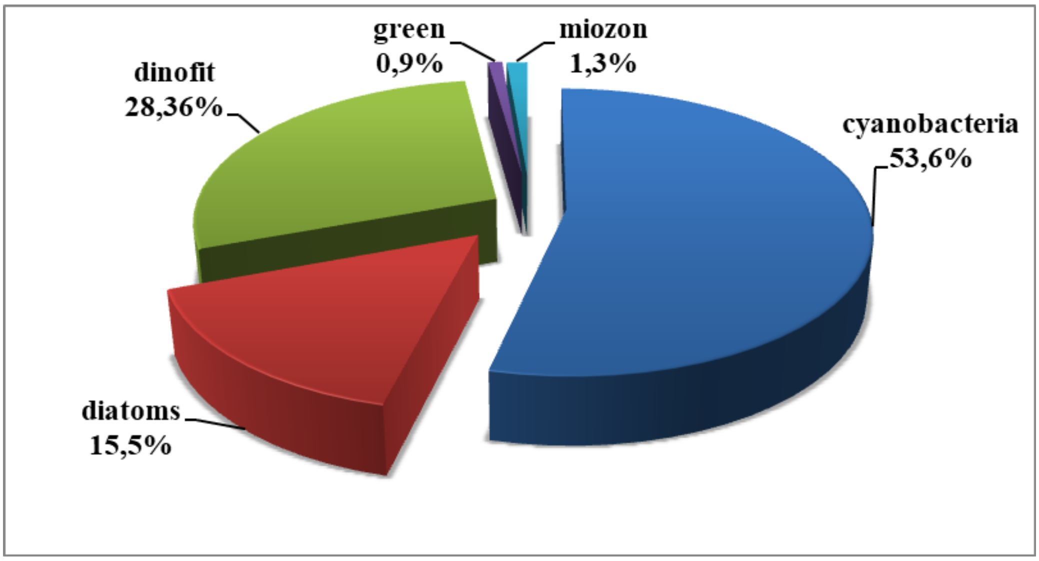

Figure 1. The number of the main groups of phytoplankton in 2018, in % ratio
Рисунок 1. Численность основных групп фитопланктона за 2018 г., в % соотношении

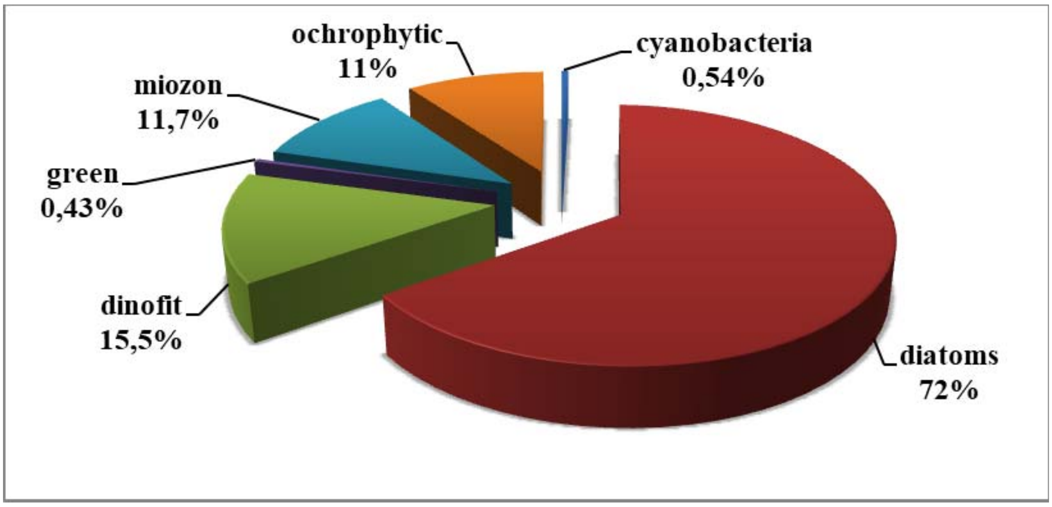

Figure 2. Biomass of the main groups of phytoplankton for 2018, in % ratio
Рисунок 2. Биомасса основных групп фитопланктона за 2018 г., в % соотношении

State of zooplankton
Like the early years, samples were taken from three sides at equal distances from the Tyub-Karagan structure; during the study period, 27 samples were taken and processed. The results are shown in Tables 4-6 and for clarity, diagrams 3 and 4 are provided.

Table 4. Species composition of zooplankton by season for 2018 [16]
Таблица 4. Видовой состав зоопланктона по сезонам за 2018 г [16]

Taxonomic composition Таксономический состав	**Number of species / taxa** Количество видов / таксонов		
	Winter Зима	**Spring** Весна	**Autumn** Осень
Rotatoria / Коловратки	1	1	2
Copepoda / Веслоногие рачки	4	5	3
Cladocera / Ветвистоусые рачки	-	4	-
Others / Прочие	2	4	9
Total taxa / Всего таксонов	7	14	14

As you can see from this table, the number of species increases from winter to autumn, except for copepods, whose number of species decreases by autumn, and branchy crustaceans which were found only in spring. The maximum number of other species was found in autumn - 9 species. In winter, in the region studied, 7 species of zooplankton were found; from the rotifers group and copepods, *Synchaetavorax*, *Acartiatonsa* were found respectively. In spring, most often met was *Podonpolyphemoides* from the group of branched crustaceans. In autumn, as in winter, *Acartiatonsa was* often found from the copepods group, as well as from the group of other *Cirripediagen.* sp. and *Hedistedi versicolor.* In spring and autumn, up to 14 species of Rotatoriaplankters were found – 0.4%, Copopeda – 0.94%, Cladocera – 0.22%, others – 98.8%.

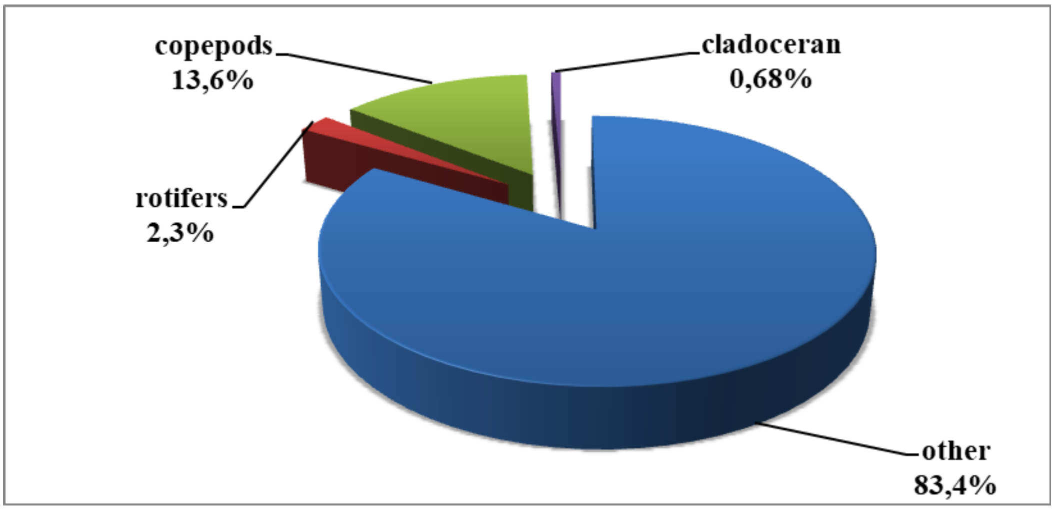

Figure 3. The number of main groups of zooplankton in % ratios by season for 2018
Рисунок 3. Численность основных групп зоопланктона в % соотношений по сезонам за 2018 г.

Table 5. The number of main groups of zooplankton by season for 2018, species/m^3
Таблица 5. Численность основных групп зоопланктона по сезонам за 2018 г., экз/м^3

Stations / Станции	***Rotatoria*** Коловратки			***Copepoda*** Веслоногие рачки			***Cladocera*** Ветвистоусые рачки			**Others** Прочие			**Total** / Всего
	winter зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**Spring** весна	**autumn** осень	**Winter** зима	**Spring** весна	**autumn** осень	
1	17	265	18	929	38	3079	0	173	0	17	1872	2970	
2	-	0	0	-	20	110	0	80	0	-	240	116960	
3	303	430	0	364	319	2790	0	141	0	30	1493	4448	
4	64	249	0	282	255	4086	0	206	0	19	6729	6337	
5	32	2021	0	227	76	2955	0	82	0	6	1762	11239	
6	11	1164	0	119	35	2216	0	146	0	11	3231	3706	
7	225	702	7	322	14	3434	0	232	0	90	5948	5352	
8	112	227	0	39	34	3106	0	278	0	11	1770	7362	
9	6	553	0	243	39	2335	0	122	0	17	6374	3734	
Average by seasons Среднее по сезонам	96	622	2,8	316	99	2679	0	156	0	25	3269	15674,2	
Average for the year Среднее за год		174,4			1031,3			52			6322,7		7580,4

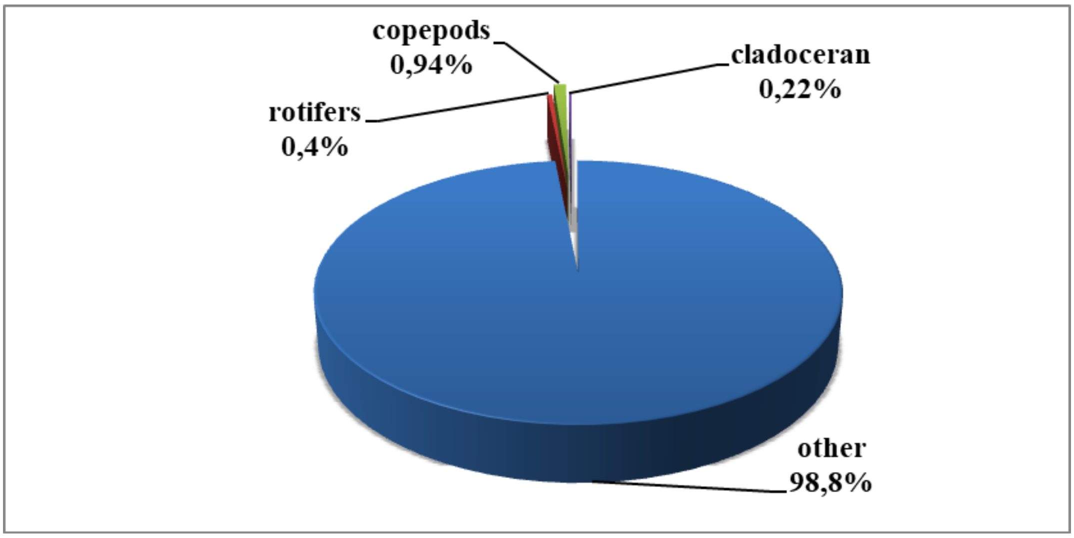

Figure 4. Biomass of the main groups of zooplankton in % ratio by season for 2018
Рисунок 4. Биомасса основных групп заопланктона в % соотношении по сезонам за 2018 г.

Table 6. Biomass of the main groups of zooplankton by season for 2018, mg/m^3
Таблица 6. Биомасса основных групп заопланктона по сезонам за 2018 г., мг/м^3

Stations / Станции	***Rotatoria*** Коловратки			***Copepoda*** Веслоногие рачки			***Cladocera*** Ветвистоусые рачки			**Others** Прочие			**Total** / Всего
	winter зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	
1	0,01	0,21	0,01	1,97	0,06	11,01	-	3,06	0,00	0,00	5,30	350,22	
2	-	0,00	0,00	-	2,58	0,54	-	0,28	0,00	-	0,43	2672,98	
3	0,24	0,34	0,00	5,21	1,48	20,21	-	2,55	0,00	0,23	3,46	1309,84	
4	0,05	0,20	0,00	1,71	1,30	16,00	-	9,71	0,00	0,01	18,73	1211,96	
5	0,03	1,62	0,00	0,98	0,41	25,42	-	1,45	0,00	0,00	8,85	3840,06	
6	0,01	0,93	0,00	1,20	0,16	8,26	-	3,15	0,00	0,01	22,18	1861,40	
7	0,18	0,56	0,00	2,45	0,02	9,46	-	2,71	0,00	0,91	34,36	15,59	
8	0,09	0,18	0,00	0,10	0,37	9,64	-	4,82	0,00	0,00	8,37	1365,50	
9	0,00	0,44	0,00	1,99	0,72	5,34	-	2,82	0,00	0,07	33,86	806,63	
Average by seasons Среднее по сезонам	0,08	0,50	0,00	1,95	0,79	11,77	-	3,39	0,00	0,15	15,06	1492,69	
Average for the year Среднее за год		0,19			4,83			1,13			502,6		508,6

From Table 2 it can be seen that the maximum number of rotifers was found as indicated above and that their number increases from winter to spring (in spring at station 5 2021 species/m^3 were detected, the lowest abundance at station 8 being 227 species/m$^{3)}$. The maximum number of copepods was detected in autumn at station 4 – 4086 specimens/m^3, the smallest abundance recorded being 110 specimens/m^3 at station 2. A large number of vegetable crustaceans as rotifers were identified in the spring - at station 8, 278 specimens/m^3, and at station 2-80 specimens/m^3. On the contrary, at station 2, the maximum abundance of other types of extra-plankters was found to be 116,960 specimens/m^3.

Other species prevailed in biomass (Table 5), the maximum biomass being detected at station 5 with a value of 3840.06 mg/m^3 and at station 2, which revealed the maximum abundance, biomass was inferior with a value of 2672.98 mg/m^3.

State of Macrozoobenthos

Bottom sediment is a storage zone for pollutants. In this regard, in our opinion, the study of the state of bottom organisms is necessary, which we conduct annually accordingly.

In this area, macrozoobenthos occurs in five main groups; worms, mollusks, crustaceans, insect larvae and others. Worms mainly predominate in numbers and mollusks in biomass [3, 17-23].

The main indicator of the significance of individual taxa in productivity in these waters is their frequency of occurrence. Out of the total species diversity in the zoobenthos, only a few, the most massive, can be distinguished with a frequency of occurrence of at least 30%: in the autochthonous complex among mollusks – *Hypanis angusticostata*, among crustaceans – *Niphargoides similis*, *N. macrurus*, *Dikerogammarus haemobaphes*, *Corophium nobile*, *Pterocuma pectinata* and *Stenocuma graciliodes*; from the Mediterranean – mollusks *Abra ovata* and the polychaete worm *Nereis diversicolor.*

Table 7. The species composition of macrozoobenthos by the 2018 seasons [16]
Таблица 7. Видовой состав макрозообентоса по сезонам в 2018 г. [16]

Taxonomic composition Таксономический состав	**Number of species / taxa** Количество видов / таксонов		
	Winter Зима	**Spring** Весна	**Autumn** Осень
Vermes / Черви	7	6	6
Mollusca / Моллюски	5	5	4
Crustacea / Ракообразные	12	15	7
Insect larva / Личинки насекомого	2	1	1
Others / Прочие	1	1	1
Total taxa / Всего таксонов	27	28	19

From this table it can be seen that the number of species decreases from spring to autumn, i.e. if in the summer 28 species were found, by autumn 19 species remained.

In winter, there were often found: worms – *Hypaniolakowalewskii*; mollusks – *Abra ovata*; larval insects *Chironomusalbidus.* In spring there were often found worms – *Hedistediversicolor worms*; mollusks – *Abra ovata* and *Cerastodermalamarcki*; crustaceans – *Stenogammarus (Stenogammarus) similis*; larval insects – *Chironomusalbidus*. In autumn there were often found: worms – *Oligochaetagen* sp.; mollusks – *Oligochaetagen* sp.; larval insects – *Chironomusalbidus.*

As we can see from Table 8, for the studied period worms predominated in number with 3702 specimens/m^2, then mollusks with 1013 specimens/ m ^{2} with insect larvae being third in number with 352 specimens/m^2. This is typical for this region in many stations, the number of organisms being higher in the winter than in the autumn season. It is very rare to find other species of organisms in individual stations. In terms of biomass, worms fell to second place with 19443 mg/m^2 giving way to mollusks in top place at 81536 mg/m^2 and crustaceans in third at 13916 mg/m^2.

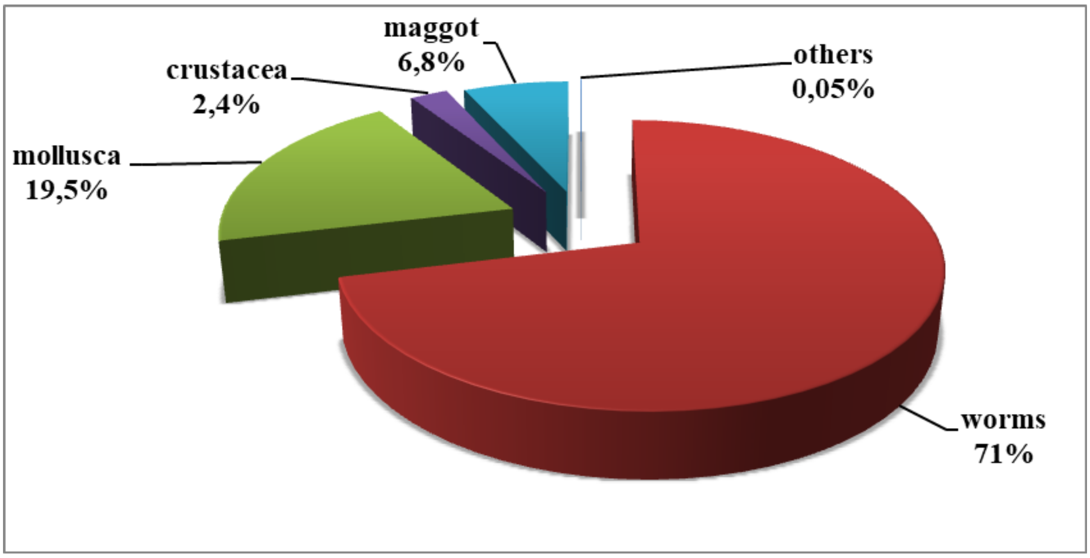

Figure 5. The average number of major macrozoobenthos groups in % ratio for 2018
Рисунок 5. Средняя численность основных групп макрозообентоса в % соотношении за 2018 г.

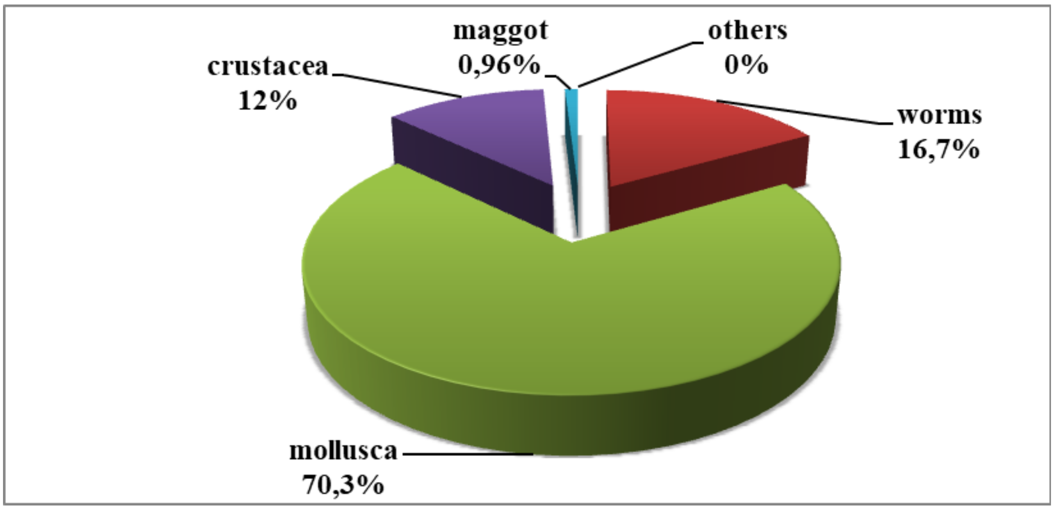

Figure 6. The average biomass of the main macrozoobenthos groups in % ratio for 2018
Рисунок 6. Средняя биомасса основных групп макрозообентоса в % соотношении за 2018 г.

Table 8. The number of major macrozoobenthos groups by the 2018 seasons, species/m^2
Таблица 8. Численность основных групп макрозообентоса по сезонам 2018 г., экз/м^2

Stations / Станции	**Vermes** Черви			**Mollusca** Моллюски			**Crustacea** Ракообразные			**Insect larva** Личинки насекомого			**Others** Прочие			Total / Всего
	winter зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	
1	5440	2290	2527	140	1040	240	150	140	63	1090	700	380	0,00	0,00	0,00	
2	-	1370	380	-	0,00	0,00	-	440	20	-	0,00	0,00	-	0,00	0,00	
3	7560	7260	1190	720	1170	147	550	390	63	330	410	63	0,00	0,00	3	
4	3970	6730	1287	680	840	133	700	3240	207	570	280	120	0,00	20	0,00	
5	7990	4990	1593	1160	1810	87	430	850	7	940	100	70	0,00	0,00	0,00	
6	4830	6290	1160	460	610	183	1570	4400	100	1480	360	33	0,00	0,00	0,00	
7	3430	5290	2263	280	50	160	450	1900	150	80	0,00	77	0,00	0,00	0,00	
8	4650	1940	373	6740	5160	767	540	230	3	290	200	103	0,00	0,00	0,00	
9	6600	1920	1080	1280	1860	193	1160	1120	50	560	360	247	50	0,00	0,00	
Average Среднее	3702 / 71%			1013 / 19,5%			127 / 2,4%			352 / 6,8%			2,8 / 0,05%			5196,8

Table 9. Biomass of the main groups of macrozoobenthos by the 2018 seasons, mg/m^2
Таблица 9. Биомасса основных групп макрозообентоса по сезонам 2018 г., мг/м^2

Stations / Станции	**Vermes** Черви			**Mollusca** Моллюски			**Crustacea** Ракообразные			**Insect larva** Личинки насекомого			**Others** Прочие			Total / Всего
	winter зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	**winter** зима	**spring** весна	**autumn** осень	
1	23710	21398	8162	4600	25270	13211	120	190,00	2048	2630	2430	137	0,0	0,0	0,0	
2	-	23,20	9	-	0,00	0,00	-	532,00	10	-	0,00	0,0	0,0	0,0	0,0	
3	33054	22982	5265	80970	147670	11950	12399	5706,0	4883	370	1580	45	0,0	0,0	1,0	

4	32930	37563	6963	69790	46795	8333	4470	138978	3109	1440	1030	63	0,0	0,6	0,0
5	32257	26990	3721	32850	251750	15837	3576	41240	1	1280	350	40	0,0	0,0	0,0
6	25670	18973	4942	61130	48677	13870	87710	39355	962	10140	1555	32	0,0	0,0	0,0
7	35753	42132	8646	48050	10125	16907	6287	2650	3932	60	0,00	33	0,0	0,0	0,0
8	39170	23500	1862	473210	542460	38950	166	1730	2	560	670	85	0,0	0,0	0,0
9	27690	7526	2785	35730	93440	9100	670	560	15	1270	1960	180	30,0	0,0	0,0
Average Среднее	19443 / 16,7%			81536 / 70,3%			13916 / 12%			1117 / 0,96%			1,36 / 0%		116013

CONCLUSION

It follows from the above that:

The species richness and species diversity of phytoplankton of the water areas studied were generally at a high level during the 2018 research period. The species composition of phytoplankton communities in spring was less constant than in autumn, due to the heterogenicity of external conditions at the beginning of the growing season.

The quantities of phytoplankton varied significantly over the seasons and years. Various types of algae dominated, depending on local habitat conditions. Throughout the water areas studied, mass algae species belonged to two categories - blue-green and diatomic. The species in the first category dominated in number, whiles the species in the second category formed the basis of the phytoplankton biomass.

The seasonal dynamics of phytoplankton were subject to certain patterns. As a rule, from the beginning to the end of the growing season there was enrichment of species composition, increase of diversity and growth of quantitative indicators of phytoplankton communities.

The species richness and species diversity of zooplankton of the areas studied during the 2018 research period was at a low or moderate level. Species composition of zooplankton communities was most often constant. A certain heterogeneity of the composition of plankton invertebrate species in spring reflected the heterogeneity of temperature conditions.

In the space-time aspect, the quantitative values of zooplankton varied significantly. The dominant position in zooplankton was occupied by a limited set of typical Caspian species, including *Brachionus quadridentatus* rotifers, copepods *Calanipeda aquae-dulcis*, *Acartia tonsa*, facultative plancters – clam larvae and cirripedia.

The seasonal dynamics of zooplankton were subject to certain patterns. As a rule, from the beginning to the end of the growing season there was enrichment of species composition and growth of quantitative indicators of zooplankton communities.

An undisturbed structure of species dominance characterized the zooplankton of Tyub- Karagan Bay in all seasons. The seasonal dynamics of species dominance structure indicated a weakening of eutrophication processes from spring to autumn throughout the water areas studied.

The seasonal dynamics of zooplankton in 2018 were most often characterized by the same direction, which indicated the influence of a single factor complex on the structure of plankton communities.

The highest biomass was formed by bottom cenoses in the studied area, where large clams played a leading role.

The seasonal dynamics of the macrozoobenthos had common and specific traits, depending on the research station. Inversely proportionate changes in zoobenthos quantities are associated with a decrease in the average mass of individuals in autumn. This occurs both through the increase in the role of small species and by an increase in the proportion of younger age stages in populations of bottom invertebrates.

REFERENCES

1.Kenzhegaliev A., Abilgazieva A.A., Shakhmanova A.K. Phytoplankton state in the area of the Tyub-Karagan Bay. Sodruzhestvo [Commonwealth]. 2016, no. 4, pp. 5-8. (In Russian)

2.Kenzhjegalyev A., Abylgazieva A., Shakhmanova A., Kulbatyrov D. Dynamics of the condition of phytoplankton near the Tub-Karagan bay. Vestnik AUNG [AOGU Bulletin]. 2017, no. 2, pp. 59-64.

3.Kenzhegaliev A., Abilgazieva A.A., Shahmanova A.K., Kulbatyrov D.K. State of hydrobionites at TyubKaragan gulf. Neft' i gaz [Oil and gas]. 2018, no. 2, pp. 132-143. (In Russian)

4.Kenzhegaliyev A., Abylgazieva A.A., Shakhmanova A.K. Condition of hydrobionts in Tub-Karagan bay. HERALD TarSU of a name of M.Kh. Dulati «Nature and problems of anthroposphere» international science journal. 2016, no. 3, pp. 65-72.

5.Kenzhegaliev A. Influence of engineering geological research works on zooplankton organisms of the sea. Bulletin ASTU [Vestnik AGTU]. 2008, no. 3, pp. 169-170. (In Russian)

6.Kenzhegaliev A., Mukhanalieva S.M., Kenzhegalieva D.A. The impact of seismic work on aquatic organisms of the sea. Vestnik AING [AOGI Bulletin]. 2009, no. 2, pp. 159-162. (In Russian)

7.Kenzhegaliev A., Abilgazieva A., Shahmanova A., Kulbatyrov D. [State dynamics of zooplankon in the gulf region of Tyub-Karagan]. In: *Voprosy tekhnicheskikh nauk: novyye podkhody v resheniy aktual'nykh problem* [Questions of technical sciences: new approaches to solving urgent problems]. Kazan, 2017, iss. 4, 132 p.

8.Kenzhegaliev A., Abilgazieva A.A., Shakhmanova A.K., Kulbatyrov D.K., Urazgalieva M.K., Kulynbay E. Seasonal zooplankton states in the Tub-Karagan Bay area for 2016-2017. *Trends in science and education*, 2018, no. 44-6, pp. 42-45. (In Russian) DOI: 10.18411/lj-11-2018-153

9.Loginova E.V., Lopukh P.S. *Gidroekologiya* [Hydroecology]. Minsk, BSU Publ., 2011, 300 p. (In Russian)

10. Kiselev I.A. *Metody issledovaniya planktona. Zhizn' presnykh vod SSSR* [Plankton research methods. In the book The Life of Fresh Water of the USSR]. Moscow, Academy of Sciences of the USSR Publ., 1956, vol. 4, no. 1, pp. 183-265. (In Russian)

11. *Rukovodstvo po metodam gidrobiologicheskogo analiza poverkhnostnykh vod i donnykh otlozheniy* [Guide to methods of hydrobiological analysis of surface waters and bottom sediments]. Leningrad, Gidrometeoizdat Publ., 1983, pp. 78-86. (In Russian)
12. *Sostoyaniye bioraznoobraziya v Kazakhstanskoy chasti Kaspiyskogo morya. Natsional'nyy doklad Respubliki Kazakhstan* [The state of biodiversity in the Kazakhstan part of the Caspian Sea. National Report of the Republic of Kazakhstan]. Atyrau, 2000, pp. 26-36. (In Russian)
13. *Metodicheskiye ukazaniya k izucheniyu bentosa yuzhnykh morey SSSR* [Guidelines for the study of benthos of the southern seas of the USSR]. Moscow, VNIRO Publ., 1983, 13 p. (In Russian)
14. *Metodika izucheniya biogeotsenozov vnutrennikh vodoyomov* [Methodology for the study of biogeocenoses of inland waters]. Moscow, Nauka Publ., 1975, 240 p. (In Russian)
15. *Metodicheskoye posobiye pri gidrobiologicheskikh rybokhozyaystvennykh issledovaniyakh vodoyomov Kazakhstana (plankton, zoobentos)* [Methodological guide for hydrobiological fisheries studies of water bodies of Kazakhstan (plankton, zoobenthos)]. Almaty, 2006, 27 p. (In Russian)
16. *Morskoy monitoring vozdeystviya. Otchet o NIR (zaklyuchit.). TOO «Kazakhstanskoye Agentstvo Prikladnoy Ekologii».* [Marine impact monitoring. Report on research (final). Kazakhstan Agency of Applied Ecology LLP]. Almaty, 2018, 326 p. (In Russian)
17. Kenzhegaliev A., Mukhanalieva S.M., Kalimanova D.Zh. Species diversity of zoobenthos and its changes in the eastern part of the northern Caspian. Vestnik AING [AOGI Bulletin]. 2008, no. 2, pp. 175-180. (In Russian)
18. Kenzhegaliev A. Influence of engineering geological exploration works on zoobenthos organisms of the sea. Vestnik AING [AOGI Bulletin]. 2008, no. 6, pp. 204-206. (In Russian)
19. Kalimanova D.Zh., Kenzhegaliev A. Characterization of bottom communities in the area of exploratory drilling (Kashagan test site). Poisk. Seriya estestvennykh i tekhnicheskikh nauk [Search. Series of natural and technical sciences]. 2009, no. 2, pp. 16-17. (In Russian)
20. Kenzhegaliyev A., Orazbaev B.B., Zhumagaliev S.Z., Kenzhegaliyeva D.A. Researches of an ecological condition of hydrobiological communities of the Kazakhstan sector of the Caspian Sea in preparation of oil and gas fields for development. Bezopasnost' zhiznedeyatel'nosti [Life Safety]. 2013, no. 10, pp. 39-44. (In Russian)
21. Kenzhegaliyev A., Abylgazieva A.A., Shahmanova A.K. State of macrozoobenthos in the gulf Tub-Karagan. Sciences of Europe, 2016, no. 7-1, pp. 103-105. (In Russian)
22. Kenzhegaliev A., Abilgazieva A., Shahmanova A, Kulbatyrov D., Saginayev A. Dynamics of the state of macrobenthos in the gulf of Tub-Karagan. 5th Annual International Conference on Material Science and Environmental Engineering, MSEE. China. December 15th-17th, 2017, pp. 38-42. DOI: 10.1088/1757-899X/301/1/012116
23. Kenzhegaliev A., Abilgazieva A.A., Shakhmanova A.K., Kulbatyrov D.K., Urazgalieva M.K., Kulynbay E. Macrozoobenthos states in the region of the Tyub-Karagan Bay of the Caspian Sea. Unitet-Journal. 2018, no. 23, pp. 31-35. (In Russian)

БИБЛИОГРАФИЧЕСКИЙ СПИСОК

1.Кенжегалиев А., Абилгазиева А.А., Шахманова А.К. Состояние фитопланктона в районе залива Тюб-Караган // Содружество. 2016. N 4. С. 5-8.
2.Kenzhjegalyev A., Abylgazieva A., Shakhmanova A., Kulbatyrov D. Dynamics of the condition of phytoplankton near the Tub-Karagan bay // Вестник АУНГ. 2017. N 2. С. 59-64.
3.Кенжегалиев А., Абилгазиева А.А., Шахманова А.К., Кулбатыров Д.К. Состояние гидробионтов в Тюб-Караганском заливе // Нефть и газ. 2018. N 2. С. 132-143.
4.Kenzhegaliyev A., Abylgazieva A.A., Shahmanova A.K. Condition of hydrobionts in Tub – Karagan bay // HERALD TarSU of a name of M.Kh. Dulati «Nature and problems of anthroposphere» international science journal. 2016. N 3. P. 65-72.
5.Кенжегалиев А. Влияние инженерно-геологических изыскательских работ на зоопланктонные организмы моря // Вестник АГТУ. 2008. N 3. С. 170-172.
6.Кенжегалиев А., Муханалиева С.М., Кенжегалиева Д.А. Воздействия сейсмических работ на гидробионты моря // Вестник АИНГ. 2009. N 2. С. 159-162.
7.Kenzhegaliev A., Abilgazieva A., Shahmanova A., Kulbatyrov D. State dynamics of zooplankon in the gulf regionof Tyub-Karagan // Сборник научных трудов по итогам международной научно-практической конференции «Вопросы технических наук: новые подходы в решений актуальных проблем», Казань, 2017. Вып. 4. 132 с.
8.Кенжегалиев А., Абилгазиева А.А., Шахманова А.К., Кулбатыров Д.К., Уразгалиева М.К., Кулынбай Е. Состояния зоопланктона по сезонам в районе залива Тюб-Караган за 2016-2017 гг. // Тенденции развития науки и образования. 2018. N 44-6. С. 42-45. DOI: 10.18411/lj-11-2018-153
9.Логинова Е.В., Лопух П.С. Гидроэкология: курс лекций. Минск: БГУ, 2011. 300 с.
10. Киселев И.А. Методы исследования планктона // Жизнь пресных вод СССР. Москва: изд-во АН СССР, 1956. Т. 4. Вып. 1. С. 183-265.
11. Руководство по методам гидробиологического анализа поверхностных вод и донных отложений. Ленинград: Гидрометеоиздат, 1983. С. 78-86.
12. Состояние биоразнообразия в Казахстанской части Каспийского моря. Национальный доклад Республики Казахстан. Атырау, 2000. С. 26-36.
13. Методические указания к изучению бентоса южных морей СССР. Москва: ВНИРО, 1983. 13 с.
14. Методика изучения биогеоценозов внутренних водоёмов. Москва: Наука, 1975. 240 с.
15. Методическое пособие при гидробиологических рыбохозяйственных исследованиях водоёмов Казахстана (планктон, зообентос). Алматы, 2006. 27 с.
16. Морской мониторинг воздействия. Отчет о НИР (заключит.) / ТОО «Казахстанское Агентство Прикладной Экологии». Алматы, 2018. 326 с.
17. Кенжегалиев А., Муханалиева С.М., Калиманова Д.Ж. Видовое разнообразие зообентоса и его изменения восточной части северного Каспия // Вестник АИНГ. 2008. N 2. С. 175-180.
18. Кенжегалиев А. Влияние инженерно-геологических изыскательских работ на зообентосные организмы моря // Вестник АГТУ. 2008. N 6. С. 204-206.

19. Калиманова Д.Ж., Кенжегалиев А. Характеристика донных сообществ на акватории разведочного бурения (полигон Кашаган) // Поиск. Сер. естеств. и техн. наук. 2009. N 2. С. 16-17.
20. Кенжегалиев А., Оразбаев Б.Б., Жумагалиев С.Ж., Кенжегалиева Д.А. Исследования экологического состояния гидробиологических сообществ Казахстанского сектора Каспийского моря в период подготовки нефтегазовых месторождений к разработке // Безопасность жизнедеятельности. 2013. N 10. С. 39-44.
21. Кенжегалиев А., Абилгазиева А.А., Шахманова А.К. Состояние макрозообентоса в районе залива Тюб-Караган // Sciences of Europe. 2016. N 7-1. С. 103-105.
22. Kenzhegaliev A., Abilgazieva A., Shahmanova A, Kulbatyrov D., Saginayev A. Dynamics of the state of macrobenthos in the gulf of Tub-Karagan // 5th Annual International Conference on Material Science and Environmental Engineering, MSEE. China. December 15th-17th, 2017. P. 38-42. DOI: 10.1088/1757-899X/301/1/012116
23. Кенжегалиев А., Абилгазиева А.А., Шахманова А.К., Кулбатыров Д.К., Уразгалиева М.К., Кулынбай Е. Состояния макрозообентоса в районе залива Тюб-Караган Каспийского моря // United-Journal. 2018. N 23. С. 31-35.

AUTHOR CONTRIBUTIONS

Akimgali Kenzhegaliev analysed and processed the collected data and wrote the manuscript. Assylbek Sh. Kanbetov collected previously published materials on the north-eastern part of the Caspian Sea, analysed them and prepared the manuscript. Ainagul A. Abilgazieva and Aiauzhan K. Sakhmanova collected material from the previous year on heavy metal contamination of the area of artificial islands of the Kashagan field. Dauren K. Kulbatyrov collected previously published materials on the north-eastern part of the Caspian Sea, analysed them and prepared the manuscript. All authors are equally responsible for plagiarism, self-plagiarism and other ethical transgressions.

КРИТЕРИИ АВТОРСТВА

Акимгали Кенжегалиев проанализировал собранные данные, обработал их и написал рукопись. Асылбек Ш. Канбетов собрал ранее опубликованные материалы по северо-восточной части Каспийского моря, проанализировал, оформил рукопись. Айнагуль А. Абилгазиева собрал материал последнего года по состоянию фитопланктона в районе залива Тюб-Караган. Аяужан К. Шахманова собрал материал последнего года по по состоянию зоопланктона в районе залива Тюб-Караган. Даурен К. Кулбатыров собрал ранее опубликованные материалы по северо-восточной части Каспийского моря, проанализировал, оформил рукопись. Все авторы в равной степени несут ответственность за плагиат, самоплагиат и другие неэтические проблемы.

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The authors declare no conflict of interest.

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