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SPECIES COMPOSITION, DISTRIBUTION AND ECOLOGY (SANITARY-HYDROBIOLOGICAL CHARACTERISTICS) OF MACROZOOBENTHOS IN AZERBAIJAN RIVERS

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Abstract. The article studies samples of macrozoobenthos in the hydrobiological scheme of the rivers of Azerbaijan. During the study period, 431 species of macrobenthic organisms were recorded from rivers. 72% of the organisms found are aquatic insects. Of the registered species, 54 species belong to chironomid larvae, 45 species to Trichoptera, 36 species to Coleoptera and Odonata, larvae, and 30 species to mollusks. The maximum number of species on the rivers of the regions was recorded in the Kura River (172). The number of species in the rivers of other regions varied between 84-144 species.

Keywords: *macrobenthos, biomass, region, fauna, saprobity, species.*

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1. Introduction

The territory of the Republic of Azerbaijan is in the Alpine-Himalayan fold belt, in the south-east of the Caucasus, near the contact zone of the continents of Europe and Asia, in the west of the Caspian Sea. The total altitude of the area decreases from 4466 m to -27 m from the mountains located in the border areas to the center of the republic and the Caspian Sea. The area of this mountain and plains is 86.6 thousand km^2, 42% of which are plains up to 200 m, and the other part is the foothills and mountains. The average height of the area is 657 m (Ahmadzade *et al*., 2016).

The Republic of Azerbaijan is located between the geographical coordinates of 44- and 52-degrees eastern longitude and 38- and 42-degrees northern latitude.

The Republic of Azerbaijan is bordered by the Russian Federation to the north, the Republic of Georgia to the northwest, the Republic of Armenia and Turkey to the west, and the Islamic Republic of Iran to the south.

Azerbaijan has an abundant river network, mainly consisting of Kura-Aras basin. The water in those basins is used for various purposes, including hydropower generation, irrigation, recreation, navigation, tourism, drinking water supply, irrigation, and other purposes. At the same time, rivers are used in the development of poultry and fisheries. In Azerbaijan and Georgia, more than 80% of agricultural production comes from irrigated lands, where the role of the Kura and Aras waters is crucial. The Kura and Aras rivers and their main tributaries are formed from transboundary waters and flow into the Caspian Sea through the borders of neighbouring countries (Iran, Turkey, Georgia, and Armenia). Thus, all the environmental disasters of the South Caucasus are transported to the territory of Azerbaijan and from there to the Caspian Sea (Mammadov, 2012).

Given the great economic role of rivers, the study of macrozoobenthos, an important component of hydro-fauna, is of great scientific and practical importance. Macrozoobenthic organisms form the main link in the food chain in the ecosystem, forming the basis of the diet of fish and waterfowl. Macrozoobenthic organisms play an important role in the formation of biological productivity of water bodies. Most of them are natural biofilters and are involved in the biological treatment of water. Most species are biological indicators of organisms, indicating the degree of contamination of water with organic matter.

Benthos is an ecological group of organisms characterized by a connection with the bottom of water bodies as a substrate on which (epibenthos) or inside which (endobenthos) organisms spend their lives. According to the degree of mobility of zoobenthos, forms are distinguished vagal (wandering), sedentary (lying on the ground without moving), sessile (attached), burrowing and drilling. Organisms of microbenthos (<0.1 mm), meso (meio) benthos (0.1-2 mm) and macrobenthos (2 mm) are distinguished by size.

The bottom populations of different soils in different zones of the reservoir are often considered biocenoses. It is possible, however, that such systems should not be equated with real biocenoses but considered smaller subdivisions. The mass of water above these types of soil should not be attributed to the same local ecosystem: in any case, the boundaries of biotopes in it do not correspond to the boundaries of soils. Some authors for different soils of one zone use the expression "locations" (statia) as a subdivision of a biotope. Since the concept of "biocenosis" (= community) presupposes the relationship between organisms and between them and the inanimate environment, the existence of this relationship is usually difficult to prove, many authors prefer to talk about "groupings" or "complexes" of benthos (as well as plankton). Nevertheless, in the domestic literature, the terms “biocenosis” and “community” are still more often used in relation to benthos.

2. Material and methods

Macrozoobenthos samples were taken in river sections with different hydrological characteristics: rapids (shallow rocky or rocky area in the riverbed with a sharp drop in water level and increased flow rate) and rocky river rifts, where the depths ranged from 0.10 to 0.50 m, and the current velocity from 0.10 to 0.15 m/s, and reach areas with depths from 0.1 to 4.0 m and flow rates from 0.005 to 0.5 m / s. The rapids are characterized by stony (pebble or boulder, often with a small amount of sand) soils without soft precipitation; reaches are distinguished by significant sedimentation, soft (silty or clay) soils.

The collected material was fixed with 4% formalin solution and 70% ethanol solution. The weight of organisms inevitably changes during fixation. At the same time, formalin (4%) does not affect the weight as significantly as other substances used to preserve samples - ethanol, ethylene glycol, propylene glycol, ethyl acetate (Knapp, 2012). Ethyl alcohol (70%), in addition to water, can remove lipids from tissues, which leads to large weight loss, reaching 30-35% (Mährlein *et al*., 2016). The differences between these fixatives in the ability to reduce the weight of organisms should be considered when analysing the results. In our work, we avoided comparing the data obtained using different fixators with each other.

Species names (except for Mollusca) are given in accordance with the current European system based on the Fauna Europea database (De Jong *et al*., 2014). The names of the species Gastropoda and Bivalvia are given in accordance with the work (Vinarski & Kantor, 2016).

3. Results

Macrozoobenthos has great role in the rivers. Macrobenthic organisms play an important role in the formation of biological productivity of water bodies. At the same time, hydrobionts are natural biofilters of river basins. In addition to being an indicator of the degree of pollution of water with organic matter, it forms a link in the food chain in the ecosystem.

431 species of benthic organisms belonging to 25 systematic groups were found in the rivers of Azerbaijan. Hydrozoa - 2, Oligochaeta - 22, Hirudinea - 9, Mollusca - 30, Amphipoda - 12, Ostracoda - 9, Mysidacea - 3, Isopoda - 1, Branchiopoda - 1, Decapoda - 6, Hydrocarina - 11, Branchiura - 2, Plecoptera - 13, Odonata - 36, Ephemeroptera - 32, Hemiptera - 27, Coleoptera - 36, Trichoptera - 45, Diptera - 16, Chironomidae - 54, Culicidae - 15, Simulidae - 21, Ceratopagonidae - 22, Aranei - 1, and Lepidoptera - 3. 72% of the species identified are aquatic insects. Chironomid larvae account for 13% of the total fauna and Trichoptera for 10%.

The development of macrobenthic organisms varied by region. The distribution of benthic organisms has been studied in the Kura basin, Aras and its left branches, in the water basins of Nakhchivan AR in the north-western, north-eastern, southern regions of the Greater Caucasus, Absheron-Gobustan, Karabakh volcanic plateau, western basins.

172 species of benthic organisms belonging to 22 systematic groups were registered from the Kura River (Aliyev, 2014). Of the species identified, 20 species belong to Trichoptera, 17 species belong to mollusks, 14 species to dragonfly larvae (Odonata), 15 to Oligochaeta, and 16 species to Ephemeroptera larvae. The remaining groups are represented by 1-14 species (Table 1).

121 species of macrobenthic organisms were recorded in the Aras River and its tributaries. 79 species of fauna (Odonata-4, Ephemeroptera - 10, Trichoptera - 8, Diptera - 7, Chironomidae - 17, Simulidae - 10) are aquatic insects, and 11 species are mollusks. The remaining groups are represented by 1-3 species (Table 1).

144 species of macrobenthic organisms belonging to 18 systematic groups were identified from the water basins of Nakhchivan AR. Research was conducted in rivers (Nakhchivanchay - 77, East Arpachay - 68, Salasuzchay - 27, Jahrichay - 21, Bichanakchay - 35, Gilanchay - 55, Ordubadchay - 54, Aylischay - 60) (Table 1). According to the intensity of species encountered in the studied water basins, *Dero dorsalis, Ilyocypris getica, Dekerogammarus haemobaphaes, Gammarus lacustris, Costatella acuta, Aplexa hypnorum, Agrion virgo, Coenagrion scitulum, Pellagenia pachen, Palingenia longiscauda, Culex pipienus, Tanytarsus gregarius, Chironomis thummi, leptoconops caucasicus* and other species differ (Aliyev *et al.*, 2021).

124 species of macrobentic organisms were found in the rivers of the north-eastern region of the Greater Caucasus (Gusarchay - 49, Gudyalchay - 44, Agchay - 50, Garachay - 53, Valvalachay - 29, Shabranchay - 28, Davachichay - 34, Atachay - 12, Gilgilchay - 16). Some of the region's rivers connect directly to the Caspian Sea, and some to the port of Devechi (Table 1).

Table 1. Number of species for macrozoobenthos in Azerbaijan rivers by regions

№	Groups	General number of species	Regions									
			Macrozoobenthos of Kura River	Macrozoobenthos of Aras River and its tributaries	Macrozoobenthos of Nakhichevan AR rivers	Macrozoobenthos of North-western rivers of Greater Caucasus	Macrozoobenthos of rivers of North-eastern slope of Greater Caucasus	Macrozoobenthos of rivers of Southern slope of Greater Caucasus	Macrozoobenthos of rivers of North-eastern slope of Lesser Caucasus	Macrozoobenthos of rivers of Garabakh region	Macrozoobenthos of rivers of Lankaran Natural Region	Macrozoobenthos of rivers of Absheron-Gobustan region
1	Hidrozoa	2	2	-	-	-	-	-	-	-	-	-
2	Oligochaeta	22	15	9	12	6	4	3	7	6	5	4
3	Hirudinea	9	3	3	1	4	1	3	6	1	2	2
4	Mollusca	31	17	11	9	8	9	13	15	8	11	4
5	Ostracoda	9	6	4	4	3	3	2	4	2	2	1
6	Mysidacea	3	2	-	2	2	-	1	2	2	1	-
7	İsopoda	1	-	-	-	2	5	-	3	-	-	2
8	Branchiopoda	1	-	2		-	-	-	-	-	-	1
9	Amphipoda	12	5	4	7	5	4	4	7	4	8	3
10	Decapoda	6	3	3	3	3	3	3	3	3	1	2
11	Hydrocarina	11	5	6	7	4	1	2	4	5	2	2
12	Branchiura	2	-	-	1	-	-	-	-	-	-	1
13	Plecoptera	13	-	2	5	6	4	1	14	3	2	2
14	Odonata	36	14	11	12	13	3	6	3	6	14	2
15	Ephemeroptera	32	16	5	10	8	8	10	9	11	8	3
16	Hemiptera	27	8	8	11	14	7	7	5	3	3	10
17	Coleoptera	36	10	5	13	8	19	7	11	6	7	6
18	Trichoptera	45	20	13	12	15	16	17	3	12	15	14
19	Diptera	16	8	7	6	2	2	6	1	3	4	3
20	Chironomidae	54	10	17	9	13	16	10	13	6	20	6
21	Ceratopogonidae	22	8	2	8	4	4	8	11	6	2	2
22	Culicidae	15	13	4	7	6	6	4	7	10	4	5
23	Simulidae	21	15	5	4	7	8	7	11	6	3	9
24	Aranei	1	-	-	-	1	-	-	-	1	-	-
25	Lepidoptera	3	2	-	1	2	1	1	3	-	-	-
	Total	**431**	**172**	**121**	**144**	**136**	**124**	**115**	**142**	**104**	**114**	**84**

Benthic fauna of the north-western region of the Greater Caucasus (Alazanchay, Katekhchay, Kurmukchay, Ayrichay, Kishchay, Silbanchay, Balakanchay) and the southern slope (Turyanchay, Vendamchay, Goychay, Girdimanchay, Damiraparanchay, Bumchay, Agumchay, Bumchay, Agumchay, Bumchay) was identified. 136 species of benthic organisms were found in the rivers of the north-western region and 115 species of benthic organisms in the rivers of the southern slope. The number of species in the rivers of the region varied between 32-64 (Table 1). The formation of hydrofauna is weak due to frequent floods, rivers and flood waters in the studied areas. Due to the intensity of encountering species, Nais communis, Branchiura sowerbyi, Hydrobia longiscata, Ecnomus tenellus, Hydropsyche ornatula, Limnophilus flavicornis, Leptocerus tineiformis, Oecetis furva, Procladius cholreus and other species differ. These areas are mainly dominated by lithophilic species (Aliyev, 2016).

The southern slope of the Greater Caucasus is rich in rivers. The rivers of the region, which are characteristic of mountainous features, are fast flowing, rich in oxygen, low-temperature water, etc. has features. Rivers are of great economic importance and are widely used in water supply, irrigation, energy production and fisheries development. The hydrofauna of the southern slope rivers and its important component, macrozoobenthos, have not yet been studied. During the research, 106 species of organisms belonging to 15 systematic groups were found from Akhokchay, Agsuchay, Bumchay, Damiraparanchay, Girdimanchay, Goychay, Vendamchay, Turyanchay rivers of the region.

Relevant researches were carried out in the rivers of Dashkasan-Gadabay region located in the north-eastern part of the Lesser Caucasus. 142 species of macrobenthic organisms were identified in the rivers of this region (Table 1).

114 species of organisms (Astarachay - 56, Lankaranchay - 64, Girdenichay - 48, Veravulchay - 42, Boladichay - 54, Gumbashichay - 68, Vilashchay - 56) live in the rivers of the southern region. Most of the species recorded in the rivers are phytophilous and lithophilic species.

84 species of benthic organisms were found in Absheron-Gobustan (Jeyrankechmez, Pirsaatchay, Sumgayitchay) rivers. Of the registered species, 42 live in the Pirsaatchay, 35 in the Sumgayitchay and 14 in the Jeyrankechmez River. Lithophilic species predominate in the rivers due to the predominance of rocky habitats.

104 species of macrobenthic organisms were recorded from the Tartarchay, Khachinchay, Gargarchay, Kurekchay rivers located in the Karabakh volcanic plateau of the Lesser Caucasus. Of the identified organisms, 86 species were identified in the Tartarchay, 94 species in the Khachinchay, 74 species in the Gargarchay, 80 species in the Kurakchay, and 66 species in the Injachay. The basis of river fauna is chironomid larvae, Trichoptera larvae, Ephemeroptera larvae, and mollusks. The studied rivers have good conditions for the development of benthic organisms.

There are many rivers in the western part of the republic. They form the right and left tributaries of the Kura River. Some rivers (Agstafachay, Tovuzchay) are transboundary rivers. Hydrobionts growing in these rivers play an important role in the formation of biological productivity of reservoirs on the Kura River. Transboundary rivers are polluted by neighboring countries. Their negative impact affects the development of fauna.

In modern times, the use of bio-indicator macrobenthic species is preferred to determine the level of organic contamination in reservoirs. These species are multicellular bottom invertebrates that live in the bed of aquatic ecosystems, on and inside the soil. They are more durable and long lasting than other hydrobionts. Other aquatic organisms, such as antelopes, ciliated infusors, zooplankton and fish, are also used for saprobiological analysis.

It should be mentioned that according to the standards of the recent EU Water Framework Directive (2000/60 EC), the quality of water should be determined by biodiversity. Depending on the degree of pollution, new ecological conditions formed in any area of aquifers or in the ecosystem as a whole can be favorable for the development of certain species and destructive for others. The main criteria for assessing the response of a macrobenthic community to organic pollution are the number, biomass, intensity of encounter, their saprobial coefficient and indicator load of bottom-dwelling species. The attitude of all hydrobionts, including macrobenthic organisms, to the degree of water pollution in water bodies and its oxygen regime is not the same. Thus, most organisms in rivers and reservoirs have adapted to living in clean and oxygen-rich water. The degree of saprobility of the studied water bodies (according to Makrushin, 1974, Sladecek, 1974 classifications) was studied. It was determined that 85-88% of the organisms registered in rivers, 75-80% in reservoirs and 45-60% in lakes are oligosaprobic organisms. Polysaprobic organisms are 2-4% in rivers, 4-6% in reservoirs and 10-15% in lakes.

4. Role of macrozoobenthos in ecosystem

It is known that reservoirs are artificial catchments created by humans based on rivers or lakes. They are often built on rivers. For this purpose, the area where the river flows are studied, a suitable place is selected there, and a huge dam is built on the riverbed in a direction perpendicular to the bed. Depending on the purpose and direction of the reservoir, the design of the dam is selected. Small reservoirs for irrigation are mostly built on small rivers. At present, small reservoirs are used not only for irrigation, but also in fisheries. Some reservoirs are built for energy purposes. One of the distinguishing features of my reservoirs from natural reservoirs is that their water level is unstable. Fluctuations in the level of reservoirs depend on several factors. This includes the operating mode of the turbines, the volume of incoming water, the volume of water allocated for crops, etc. Decreases in reservoirs occur most often in the first months of spring and summer. Because more water is needed to supply the fields with water during these months. It is known that the spring months are the most intensive breeding period for animals. Most of the freshwater fish spawn currently, in the coastal shallows. It is very easy to understand the consequences of a drop in the water level in the reservoir at the end of spring and the beginning of summer.

Hydropower plants (HPPs) built on the Kura River are of great importance for the country. They provide the country with energy. However, HPPs cause some damage to hydrobionts that accumulate in rivers and reservoirs. It is known that the gene pool of hydro-fauna is preserved in rivers and reservoirs. It is widely used in obtaining energy from reservoirs, water supply of the population, irrigation of agriculture, development of fisheries, tourism, recreation, sports water games. The construction of hydropower dams prevents the migration of a few hydrobionts. Hydrobionts lose their breeding grounds. An example of a transient fish in this direction. During their reproduction, these fish move from the Caspian Sea to the source of the rivers, placing their eggs in suitable places at the source of the rivers. However, the Bahramtapa hydro junction built on the Aras River and the Varvara HPP dams commissioned in 1956 on the Kura River do not allow fish to reach the river source. Temporary fish spawn at the bottom of the dams. On the other hand, when the turbines of HPPs operate, the thermal regime of the water changes, the temperature rises, and to some extent, pollution occurs, because of which some hydrobionts are destroyed. To improve water supply, it is necessary not only to reduce water use and use it sparingly, but also to conduct research to increase water resources. However, in this way it is possible to provide all sectors of the population and the economy with the required amount and quality of water in accordance with international standards, and at the same time to achieve a stable environmental situation in rivers, lakes, and reservoirs. The quality of water in reservoirs depends on the degree of pollution of the rivers flowing into it, the sanitary and hygienic condition of their beds. Studies have shown that water quality deteriorates sharply as a consequent of anthropogenic eutrophication (food fractions) of reservoirs created against the background of intensive river pollution. In the past, small water bodies were subject to anthropogenic eutrophication, but now "water pollution" occurs in large reservoirs, especially in reservoirs built on cascading rivers.

Primitive organisms include many infusors and whipworms that feed by filtration and precipitated organic matter. Thanks to the movement of special lashes and lashes, they create a special stream of water towards the mouth, which transports the substances to the cytostome (cell mouth) and from there to the cytoplasm.

It should be noted that all representatives of sponges and pogonophorae’s feed only on sedimentary organic matter. This provides almost complete biological treatment of water.

The processes of water filtration and purification are more pronounced in snails. Thus, due to the vibrating movement of the lashes in the epithelium of the snail's mantle cavity, water passes from the inlet siphon to the mantle cavity, and then is discharged through the outlet ducts and the outlet siphon. As a result of this process, substances suspended in water settle on the gallbladder and parts of the body, and thus water is released from those substances. The precipitated food material is directed to the oral cavity through the lashes on the epithelium: non-nutrient particles are collected with the help of mucus and released into the water in the form of pseudofecali. The filtration of water by living beings in this way leads to the purification of toxins and pathogenic microorganisms and the clarification of water.

As for cancers, experiments have shown that they are more actively involved in water purification. For example, it has been established that a crab can purify 0.8 liters of water containing 5.5-9.0 mg of Sangachal oil per liter per day. As a result, these cancers, which are in a thin biological layer of 1 m^2, filter up to 125 liters of water per day and clean the aquatic environment from harmful substances.

The biological cover is a complex biocenosis, and the micro- and macro-organisms that live there are of different types and have a high biomass. From microscopic organisms living in the biological cover, mainly to whips, infuzors, bacteria, plankton algae, etc. happens to come across. In the biological cover, as well as in the aquifer, these organisms play an important role as a biofilter in the purification of water from harmful substances. Organisms specific to the biological cover (crustaceans, snails, etc.) form a very large biomass in almost all water bodies: on underwater objects in the seas and oceans, in submarines, in the underwater parts of ships. Organisms with such a large biomass play a "sanitary" role in filtering water, cleaning it of harmful wastes and substances, feeding on pathogenic microorganisms and preventing water pollution. It should be noted that all single and multicellular organisms living in the biological cover alternate in the biological cover cenosis (bacteria-algae-primitive-multicellular organisms), repeatedly filtering the water around them, and the water is repeatedly purified. In this biocenosis, the process that many organisms cannot perform is completed by other groups. Therefore, living things in the biological cover play a very important role in water purification.

Pollution of water sources with household waste leads to many dangerous diseases. This is because household waste is rich in microorganisms that cause terrible diseases such as cholera and typhoid.

As a result of the deposition of toxins and other substances in the soil by aquatic organisms, the transparency of water increases in both freshwater and seas. Snails, crustaceans, ascites, skinworms, various insect larvae, primates and other animals are more closely involved in this process. Thus, it should be noted that the biological treatment of all water bodies from various organic and inorganic pollutants can be achieved through the protection of flora and fauna of these water bodies.

During the study period, monitoring was carried out on permanent biological stations in Shamkirchay and Alijanchay. The results obtained are detailed in the tables and graphs below.

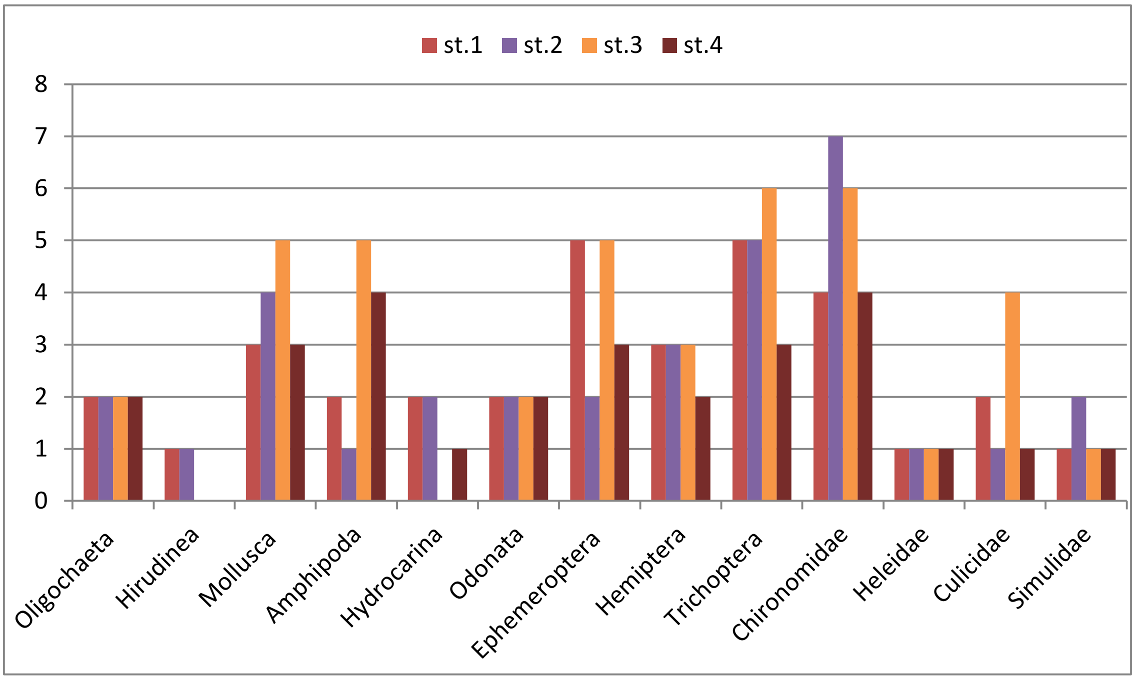

Figure 1. The number of macrobenthos species for groups in Shamkir River (January 2019-March 2020)

During the observations 91 species of macrobenthic organisms were recorded for Shamkirchay River, which were included into 13 systematic groups. During the survey, mainly Mayfly and Caddis fly larvae were distinguished due to their encountering intensity, i.e. they dominated. The percentage ratio of the species identified is presented in Figure 1. As it is clear from the figure, aquatic insects dominated in the studied points.

Biomass of organisms in studied areas was 0,48-1,53 g/m^2, and the number was 132-366 ind./m^2. Species composition of groups included into macrozoobenthos was provided in Figure 2.

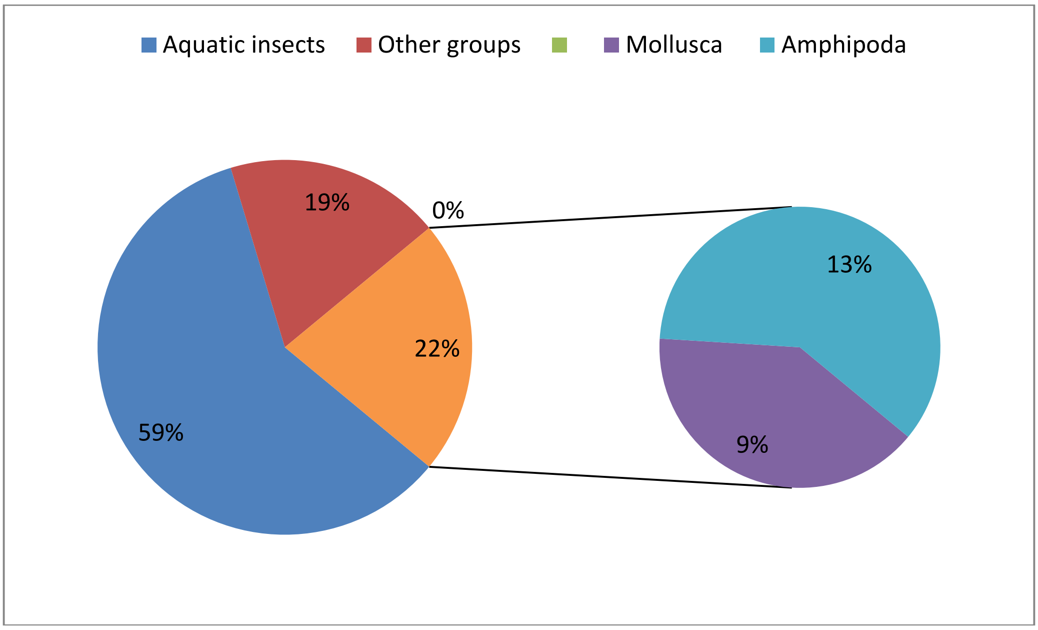

Figure 2. Percentage ratio of species composition of macrozoobenthos in Shamkir River

During the observations, 80 species of macrobenthic organisms were recorded for Alijanchay River, which were included into 12 systematic groups. Found organisms include annular worms (4 species), leeches (3 species), crustaceans (11 species), mollusks (8 species), odonata larvae (9 species), Mayfly larvae (11 species), Caddisfly (14 species), Chironomidae larvae (6 species), Simulidaes (4 species), Culicidaes (5 species), Heleidaes (4 species). As it is known, 67 % of the recorded species fall to the portion of aquatic insects (Odonata, Ephemeroptera, Hemiptera**,** Trichoptera, Chironomidae, Culicidae, Simulidae, Heleidae) (Figure 3).

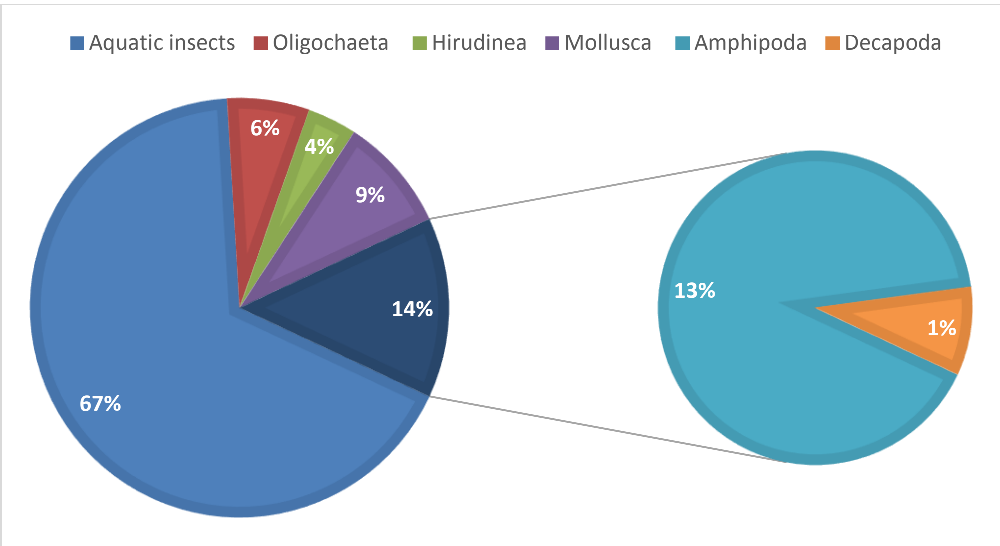

Figure 3. The percentage ratio of macrozoobenthos species composition for Alijanchay River

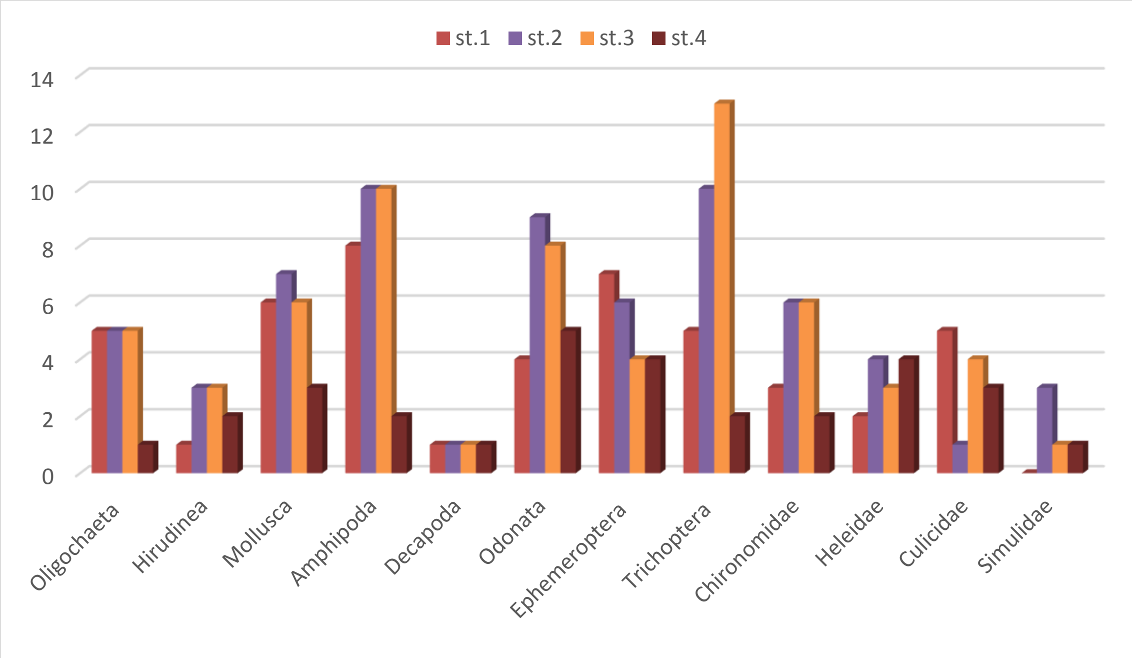

Figure 4. The ratio of macrozoobenthos specimen composition for Alijanchay River for the groups (January 2019-March 2020)

Natural water basins purify themselves, without outside intervention. This feature is realized due to the living organisms that inhabit in those basins. Naturally clean water is generated directly because of its inhabitants, and water stands under the circumstances where people can use it. The phenomenon of self-purification or biological purification consists of very comprehensive physical-chemical processes complex, and it results with sedimentation of suspended mixtures in the water and the process, where the substances dissolved in water are exposed to chemical changes. Biological processes are implemented by vital activities of aquatic organisms. The importance of biological processes is particularly great in the basins which are polluted with organic substances (pollutants). Almost all groups of aquatic organisms are involved in the recycling of organic pollutants. First, organisms that are fed with on dissolved organic matter are of great importance. As a result of self-purification processes, there are gradual changes in the physicochemical regime of water bodies and their wildlife. Changes that have taken place are determined by the saprobity system.

The saprobity system was first proposed by German researcher Kolkwitz-Marsson in years 1908-1909. Later, Czechoslovakian hydrobiologyst V. Sladechek developed biological scheme of water basins. According to V. Sladechek, saprobity is a biological condition of water bodies determined by the concentration of organic substances of water basins and the intensity of its decomposition process. Several saprobic zones (xenosaprob -x, oligosaprob, α-β- mesosaprob and polisaprob) have been identified in the saprobity system, which differ in the level of their contamination.

We have identified the saprobity zones of found macrozoobenthos in the river studied by us.

91 macrobenthic organisms were recorded in Shamkirchay River (Figure 5).

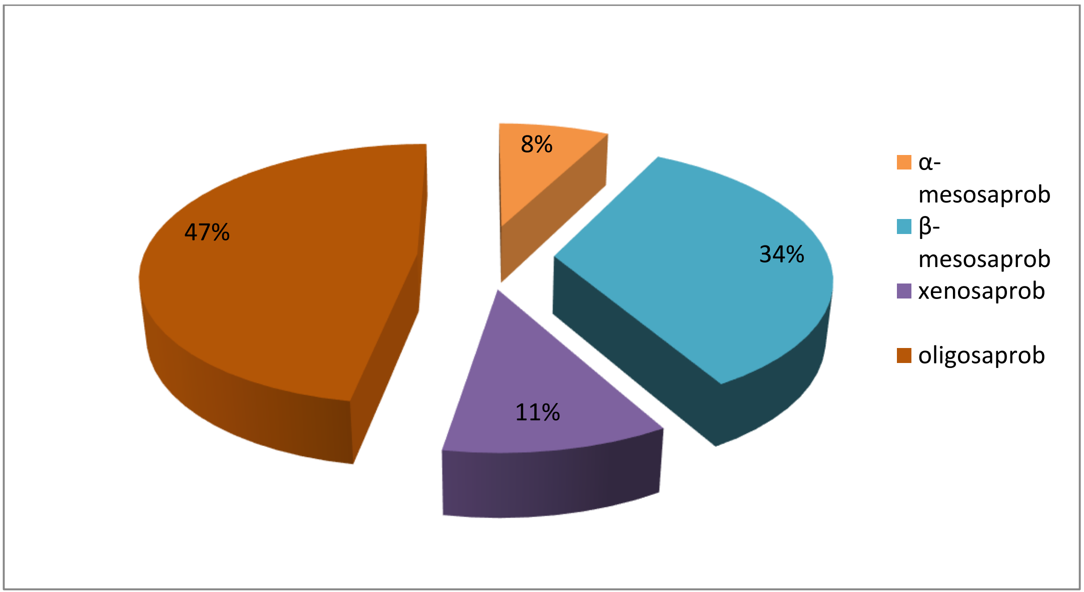

Figure 5. Saprobity ratio of organisms in Shamkirchay River

Out of found organisms, 7 (7,7%) are α- mesosaprob, 31 species (34,07 %) are β-mesosaprob, 10 species (11%) are x-xenosaprob, and 43 species (47,3%) are oligosaprob organisms.

In Alijanchay River, 80 species of organisms were identified (Figure 6)

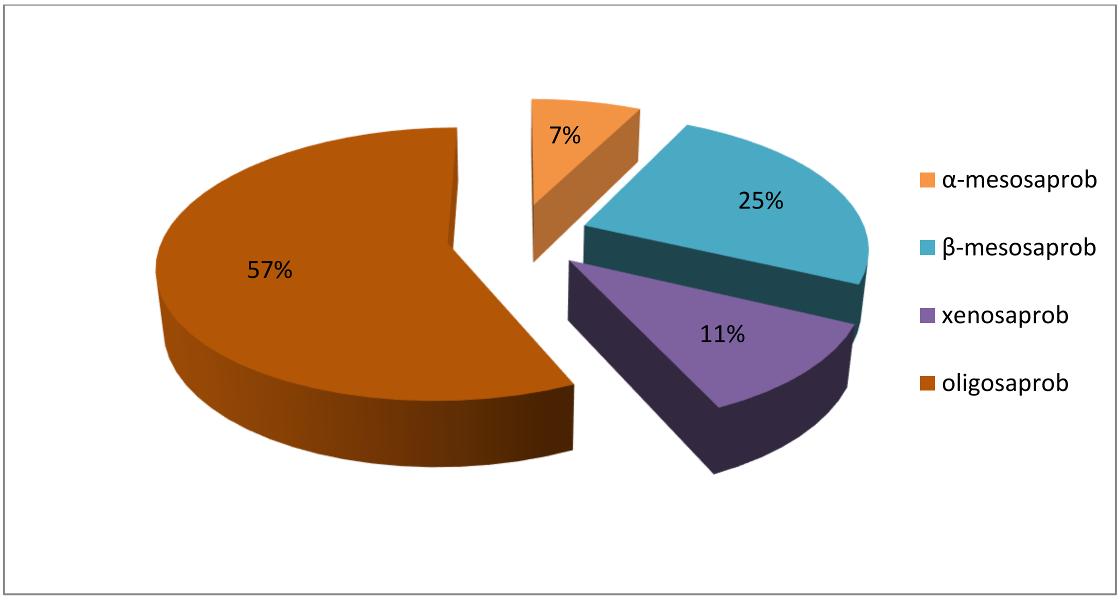

Figure 6. Saprobity ratio of organisms in Alijanchay River

Out of found organisms, 6 (7,4%) are α- mesosaprob, 20 species (25 %) are β-mesosaprob, 9 species (11%) are x-xenosaprob, and 46 species (57%) are oligosaprob organisms.

Biotic Index Value in Shamkirchay Basin was calculated according to Woodiviss (1964). The index of organisms at the stations of Shamkirchay Basin varied between 7-8 in May-August. The obtained results indicate that river water is “clean”. During the observation conducted in Alijanchay for the same period, biotic index varied between 6-7. This value indicates that river water was slightly contaminated (moderately contaminated water) (Table 2).

Table 2. Biotic Index Value for biological stations in Shamkirchay and Alijanchay water basins (Woodiviss, 1964)

Biological stations	Shamkirchay			Alijanchay		
	2019 may	2019 july	2019 august	2019 may	2019 july	2019 august
St.1	8	8	8	7	7	7
St.2	8	8	8	7	7	7
St.3	8	7	7	7	6	6
St.4	8	7	7	7	6	6

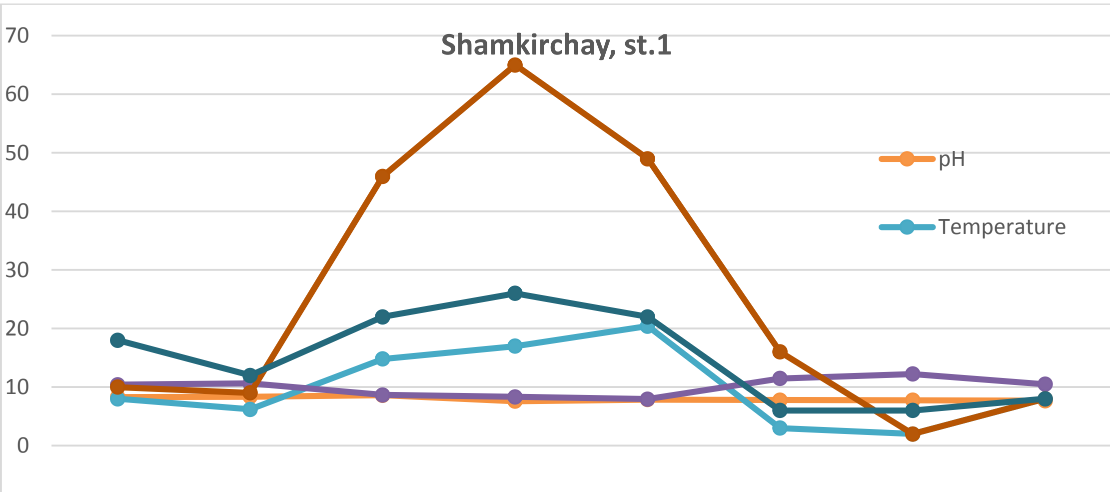

Figure 7. Dependence of macrozoobenthos and the plants on physical-chemical parameters of water

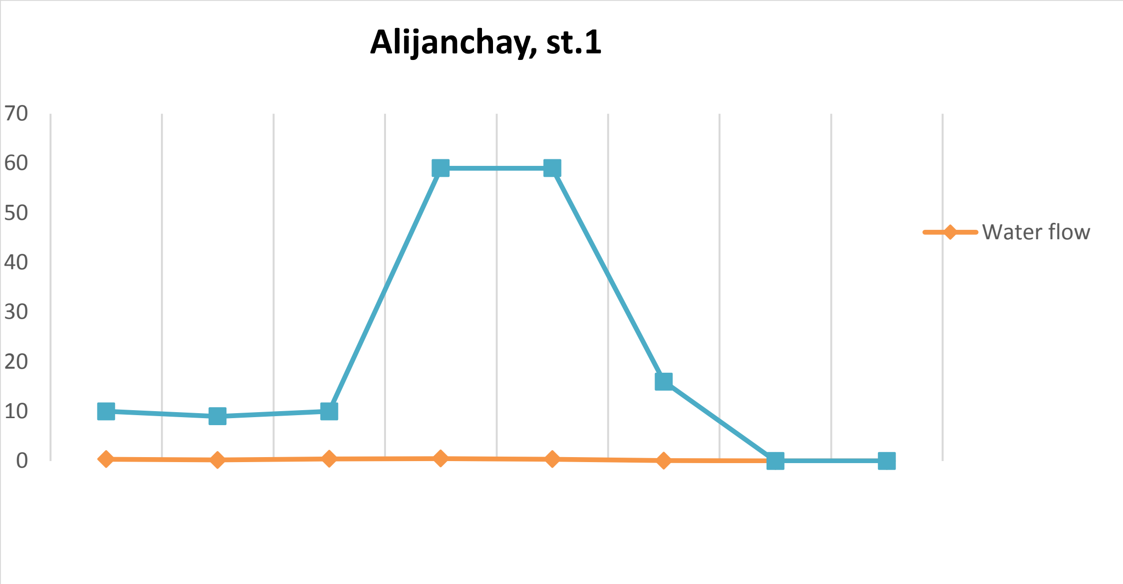

Figure 8. Dependence of macrozoobenthos on water flow (discharge) at biological station 1 in Alijanchay River

During the studies, certain water samples were taken from the 4 stations and sent to the Central Laboratory of the Ministry of Ecology and Natural Resources. Based on the results, the average indicators for physical-chemical elements in water are as follows (Table 1).

Table 3. Physical-chemical parameters of water in Shamkirchay River during January 2019 - March 2020 period

	Average	min	max
Dissolved Oxygen, mg/L	10,2	8,39	12,4
TDS, mg/L	150	108	197
Turbidity, NTU	8,35	3,5	19,4
pH	8,02	7,29	8,64
Conductivity, µs/cm	301	201,5	394
Temperature, C	14,3	2	27,2
Ammonia (NH4+), mg/L	<0,02	<0,02	<0,02
Fluoride (F^-), mg/L	0,15	0,11	0,18
Chloride (Cl^-), mg/L	4,03	<3	7
Nitrite (NO_2^-), mg/L	0,04	<0,03	0,12
Bromide (Br^-), mg/L	<0,05	<0,05	<0,05
Nitrate (NO_3^-), mg/L	6,5	4,2	9,2
Sulphate ($SO4^{2-}$), mg/L	32,9	5,3	56
Phosphate (PO_4^{3-}), mg/L	0,57	<0,04	1,78
COD, mg/L	28	<5	212
BOD5, mg/L	3	1	3
TSS, mg/L	7,48	<2	21

With the help of the experts involved in UNDP-GEF Kura 2 Project, the initial assessment was conducted to determine the status of benthic community (Imanov, 2019). The obtained result from chemical analysis enables us to summarize that there are normal conditions in the river for the development of organisms (Table 3).

Table 4. The status of benthic community in Shamkirchay River

Benthic Community state assessment - Shamkirchay River	
January 2019	Poor
March 2019	Good
May 2019	Moderate
July 2019	Good
August 2019	Good
November 2020	Moderate
January 2020	Poor
March 2020	Good

Table 5. Physical-chemical parameters of water in Alijanchay River during January 2019 - March 2020 period

	Average	min	max
Dissolved Oxygen, mg/L	9	8,50	11,07
TDS, mg/L	165	114	195
Turbidity, NTU	143	1,97	990
pH	8,20	7,60	8,49
Conductivity, µs/cm	323	228	386
Temperature, C	19,3	8	28,6
Ammonia (NH4+), mg/L	<0,02	<0,02	<0,02
Fluoride (F^-), mg/L	0,13	0,09	0,15
Chloride (Cl^-), mg/L	4,29	<3	7,1
Nitrite (NO_2^-), mg/L	<0,03	<0,03	<0,03
Bromide (Br^-), mg/L	<0,05	<0,05	<0,05
Nitrate (NO_3^-), mg/L	2	0,9	3,1
Sulphate ($SO4^{2-}$), mg/L	51,25	30	72,5
Phosphate (PO_4^{3-}), mg/L	0,44	<0,04	<0,5
COD, mg/L	20	<5	48,3
BOD5, mg/L	4	2	19,8
TSS, mg/L	99	<2	710

With the help of the experts involved in UNDP-GEF Kura 2 Project, the initial assessment was conducted to determine the status of benthic community. The obtained result from chemical analysis enables us to summarize that there are normal conditions in the river for the development of organisms (Table 6).

Table 6. The status of benthic community in Aliyanchay River

Benthic Community state assessment – Alijanchay River	
January 2019	Poor
March 2019	Good
May 2019	Moderate
July 2019	Good
August 2019	Good
November 2020	Moderate
January 2020	Poor
March 2020	Good

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