Advances in Biology & Earth Sciences
Vol.7, No.2, 2022, pp.152-167

THE ENVIRONMENT OF MACROZOOBENTHOS OF KURA-ARAS BASIN RIVERS

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Abstract. The article studied the influence of environmental factors and hydrochemical parameters on macrobenthos of the rivers of Azerbaijan within Kura-Aras basin. An evaluation has been made regarding the role of environmental influences in the formation of macrobenthic organisms. It has been determined that the role of biocenoses in the formation of organisms is great.

Keywords: *macrozoobenthos, river, biocenosis, biotope.*

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Received*: 2 June 2022;* ***Accepted****: 2 August 2022;* ***Published****: 9 August 2022.*

1. Introduction

Rivers are a complex system of continents, a mass of water flowing from source to source under the influence of gravity. Rivers have a different number of branches. The flow velocity is not the same in the upper, middle, lower and estuarine parts of the rivers. Rivers flow through different landscapes, valleys, and plains. Most of the rivers of Azerbaijan flow to Kura and Aras rivers, the two biggest water basins in the country. The flow of river water is different in the mountainous and flat parts and is subject to a large range of variation.

A more widely accepted theory to explain the succession of habitats along a stream is the concept of a river continuum (Vannote *et al*., 1980). In this theory, the river is considered as an integral system interacting with those located in each of its parts. The main factors that determine the structure of river habitats downstream are the shading and turbidity of water, with their increase, the process of photosynthesis is significantly reduced, and consumer habitats use more allochthonous organic matter (Barishev, 2014). These indicators determine the heterotrophy of the system in the upper reaches of the river and flat areas and autotrophy in the middle reaches.

The opposite theory of the functioning of the river ecosystem was presented in the concept of "point dynamics". According to this theory, refugia are located randomly in the river system, and the structure of groups of living organisms in each section of the river is formed randomly (Yanygina, 2014). In practice, as a rule, there is a unity of continuous (continuous) and discrete (separate) features of river ecosystems described in these two concepts.

The composition of macrozoobenthos fauna of watercourses is more influenced by two factors: flow rate and soil stability (Jadin & Gerd, 1961). Running water contains more dissolved oxygen than still water but living things in running water need more oxygen than living things in still or slowly flowing water, so they need more

oxygen to keep themselves flowing. If the current carries them into low stagnant water, they die from lack of oxygen (De Jong *et al*., 2014).

The water flow in the upper reaches of the Kura River is 1.0-1.5 m/s, in its middle sections 0.5-1.0 m/s, and in the lower and estuarine sections 0.5-1.0 m/s. It is known that the qualitative and quantitative development of hydro fauna depends on the speed of the current. The change in river flow has a positive and negative impact on the development of the fauna that has formed over the years.

Due to the high flow velocity in the mountainous part, the formation of macrozoobenthos is slow. Out of benthic organisms, Caddisfly, Amphipods, and some types of mollusks may live in these areas. Among those organisms, Caddisflies build special nests and houses in the lower and upper parts of the stones and live there. Mollusks and leeches also live on and under rocks (Aliyev, 2021a).

Due to the high flow velocity in the upper reaches of the rivers of the Greater Caucasus, the formation of organisms is slow. At the same time, the vegetation of these areas is weak or absent. Since the biotope consists mainly of stones, the species composition of the fauna is very small. Trichoptera and some types of mollusks are more common. In the middle and lower reaches of the rivers, the number of groups of hydrobionts gradually increases as the water flow decreases. At the same time, plants are found in these areas. At the mouth of the rivers, the speed of the current is high. Rivers are divided into 3 places in the direction of their flow: upper, middle, and lower parts (Mammadov, 2012). The rivers of the Greater Caucasus originate from the southern slopes of the mountains of the Greater Caucasus. As an example, for those rivers, we may mention Filizchay, Balakenchay, Kurmukchay, Demiraparanchay, Turyanchay and others. Since the flow velocity (1.0-3.0 m/s) is high at the beginning of the rivers, not all groups of animals can adapt to these areas. Since these areas are rocky and gravel, mainly Caddisfly, Amphipods and mollusks may adapt to such circumstances (Aliyev, 2021b).

Water mites *Eylais hamata, E. degenerata* move freely against the river flow. Since flow velocity of the Kura River is 1-1.5 m/sec.^{2}, large groups of invertebrates cannot resist. Since some of their groups (Oligochaeta, Ostracoda, Diptera, Chironomidae, Heleidae) live in the soil, they cannot be directly affected by water flow. Several groups (Hiruidinea, Mollusca, Trichoptera) lead a clinging lifestyle. Caddisflies build a special nest on stones, substrates and continue their way of life there. Decapods such as *Astacus leptodactulus* live in areas with low river currents (0.5-1 m/s). These organisms can be found throughout the entire water area of the Kura River and reservoirs on it, as the speed of the water flow slows down. In the Lower Kura, due to high flow velocity, crayfish are observed on the coastline, in the lower part of the substrates. *Palaemon elegans, Palaemon adspersus* from Amphipods and Decapods move against the speed of the water flow. They can be found even in the sources of mountain rivers.

In the northeastern part of the Greater Caucasus, the river flow velocity is different. Part of the rivers directly flows into the Caspian Sea, another part - into the bay of Devechy. The flow velocity in the rivers of Gudyalchay, Gusarchay, Agchay, Karachay, Zhagadygchay, Valvelachay ranges from 1-1.6 m/s depending on floods and currents (2014a). In recent years, the Valvalachay water has been directed to the Takhtakorpu reservoir. During high water, organisms in the rivers are not observed. Since the water of the rivers is muddy and has a very high speed, it washes them and carries them to the mouth. However, organisms attached to substrates may remain in the

soil (Palatov, 2015). We noted that the adaptation of organisms in running water occurs in 2 directions. Direction 1 - geophiles adapt differently to water flow. In the 2nd direction, they morphologically and physiologically adapt to the rise and fall of oxygen. This situation is typical for running water.

The water flow in the Aras River ranges from 0.5-1.8 m/sec. River water is favorable for the normal development of organisms. The hydromorphology of the river is varied. In some sections the river flows narrowly, while in other sections the water area is very wide. A certain part of the biotope of the rivers consists of stones and pebbles. Pollution prevents the normal development of organisms in the river. Okchuchay, the left tributary of the Aras River, is heavily polluted on the territory of Armenia. Its negative impact is directly observed in the fauna of the Kura and Aras rivers (Bayramov, 2019).

In areas where pollution is not observed, the growth of organisms is recorded. On the other hand, the Debid River flows into the Central Kura through Armenia. Various groups of insects (Odonata, Ephemeroptera, Hemiptera, Coleoptera, Trichoptera, Diptera) are found in places with low flow rates (1.9-1.8 m/s). Amphipods (*Pontogammarus robustoides, Dikerogammarus haemobaphes, Gammarus lacustres* and other species) are sensitive to the high flow velocity. Decapods such as *Astacus leptodactylus* intensively develop in the coastal zones of rivers, in areas with a low flow rate (0.5-1.0 m/s). Decapods *Palaemon adspersus, P. elegans* are observed in the speed range of 1.5-2.5 m/s. Caddisflies have made special nests in the upper and lower parts of the stones and live in them. Annelids (Oligochaeta), Diptera are found in clay biotopes (Aliyev, 2014b).

The Central Kura River and its right tributaries have different flow rates. The flow velocity is 1.5-2 m/s on the Central Kura, 1-1.5 m/s on its tributaries. The intensive development of mollusks occurs in the Central Kura. The speed of the current in the rivers Tovuzchay and Shamkirchay is 0.5-1.5 m/sec. Insects flourish in these rivers (Odonata, Ephemeroptera, Hemiptera, Coleoptera, Diptera). In those rivers, Annelids, chironomid larvae, and wood lice live in the soil. Leeches and Caddisflies live on the top and bottom of rocks. In the Zayam and Agstafa rivers of the region, the flow rate varies between 1-1.5 m/sec. Some types of crayfish (*Gammarus balcanicus, G. alaroidus, G. matienus, Pontogammarus robustoides*, etc.) floating in the studied rivers are intensively developing. Among molluscs, the most common species are *Lymnaea aurcularia, L. stagnalis, Planorbis planorbis, Aplexa hypnorum* (Aliyev, 2014b).

2. Association of macrobenthic organisms with water transparency

Transparency plays an important role in the life of macrobenthic organisms. Bottom organisms are formed in biotopes and biocenoses depending on transparency. Various groups of organisms live in the formed biocenoses, their species composition, quantitative development and ecology are studied. The transparency of river water is highly dependent on floods and floods. Strong flood waters wash away coastal zones and muddy rivers. Biotopes and biocenoses that have been formed for months and years are disintegrating. As a result of floods and floods, the mouths of the rivers are filled, preventing the normal flow of water. The amount of suspended matter in river water reduces its transparency. On the other hand, an increase in phytozooplankton in rivers affects transparency. In the spring and summer seasons, river water transparency

changes due to the intensive development of phytoplankton and precipitation (Barishev, 2015).

Among the rivers located in the northwestern part of the Greater Caucasus, floods periodically occur on the rivers Filizchay, Balakenchay, Kurmukchay, Katehchay, Kishchay, Shinchay, Silbanchay. In the summer months, the transparency of these rivers is -0. Especially in Shinchai, during the flood, large areas are flooded, the coast and adjacent territories are eroded. Transparency in this river is mainly observed in the summer months (0.10-15 cm). Among the organisms found in rivers, some species of mollusks and Shinchai mollusks differ in the intensity of occurrence. The density of individuals is 3-5 per 1 m^2.

Alazan (Ganikh) originates in the mountains of the Greater Caucasus and forms the border between Georgia and Azerbaijan. At the same time, from the left side, the rivers Katehchay, Balakenchay, Filizchay, Eyrichay flow into it, originating from the Greater Caucasus, on the territory of Azerbaijan. Turbidity of the river is 500-1000 g/m^3. Turbidity is relatively low in Shilbanchay of the said region (100-250 g/m^3) (Aliyev, 2020).

Most of the rivers of the Shirvan zone originate from the southern slopes of the Greater Caucasus (Aliev, 2013). Floods and torents are observed on the rivers of the region. Turbidity is high. Therefore, water transparency is very poor. It should be noted that river transparency is good mainly in February, March, April, August, and September. Depending on the water level, transparency is 10-30 cm, sometimes to the bottom (Mamedov, 2012, Aliyev, 2013).

The water level in the Turyanchay and Goychay rivers of the region is high in all seasons of the year. Annelids (Oligochaeta), crabs, aquatic insects, species of Diptera are found in these rivers. The number of individuals range between 10-15 ind./m^2, and the biomass ranges from 0.02-0.10 g/m^2 (Aliyev, 2016). Turbidity during torrents and floods is 250-600 g/m^3. In other rivers such as Ahokchay, Vandamchay, Girdimanchay, Demyaparanchay, Aksuchay the water level is high in winter when it rains. In winter, transparency is visible to the bottom. The transparency of water leads to the rich development of organisms in biocenoses and biotopes. Because organisms and their gene pool are preserved in rivers. During floods, turbidity ranges from 200 to 500 g/m^3, at other times from 50 to 200 g/m^3. In the rivers, the number is 60-120 individuals, biomass is 0.20-0.36 g/m^2.

The speed of the flow of rivers in normal times is 5-6 m/s, during floods and torrents it is higher. The rivers of northeastern region of the Greater Caucasus have better transparency. The water is very clean. Flow rate 1.0-2.0 m/s. The rivers are inhabited mainly by crayfish and aquatic insects. Their number was 30-94 ind./m^2, and their biomass was 0.26-0.54 g/m^2.

The turbidity of the rivers Gudyalchay and Gusarchay is high - 500-2000 g/m^3. Transparency appears during the winter months. The water level in Agchay, Karachay and Chagauzchay is high in all seasons of the year. Turbidity is recorded at a relatively low level (100-300 g/m^3).

Phytoplankton is also highly developed in the rivers. Transparency 0.10-0.30. Among benthic organisms, Annelids, leeches, crabs, water mites and aquatic insects are found frequently. Their number is 45-82 individuals/m^2, and the biomass ranges from 0.16-0.66 g/m^2 (Aliyev, 2012). Turbidity is observed during floods and torrents.

In Atachay, the water level is low in all seasons of the year. During rains and floods the turbidity is very high (200-800 g/m^3). Other rivers of the region are Pirsaat,

Sumgaitchay, Jeyrankechmez. In some periods, there is no water in the Jeyrankechmez River. During rains and floods, there is a lot of water, turbidity increases. The rest of the time the transparency is maximum. In Pirsaatchay, floods are mainly observed during rains and floods. Turbidity in the river ranges from 500-800 g/m^3. Transparency 0.0-40 cm in winter, early summer, and autumn. Bottom organisms in the river are poorly developed. The biotope is based on rocks. Characteristic species develop mainly in the stone biotope.

The high-water period of Sumgaitchay falls on rains and floods. The turbidity of the river during this period is 400-700 g/m^3. During these periods, transparency is not observed. Periodically, the transparency changes from 0.10 to 0.45 μm. Benthic organisms include pinworms, leeches, crustaceans, water mites and aquatic insects. Their number is 35-94 individuals/m^2, biomass is 0.28-0.48 g/m^2.

The southern region of the republic has a dense river network. Among these rivers, the rivers Astarachay, Lenkoranchay, Girdenichay, Veravulchay directly flow into the Caspian Sea. Other rivers (Boladi, Gumbashi and Vilashchay) flow into the Lesser Kyzylagach Bay. Lankaranchay is rich in water. Transparency here is 0.20-0.60 depending on the season. During floods and torrents, turbidity ranges from 150 to 400 g/m3. Transparency is high in Astarachay (0.20-0.40 m).

Aquatic plants and phytoplankton grow well in the rivers of the region. The average degree of turbidity in the river was 17 g/m^3, the maximum was 2400 g/m^3. Transparency (0.0-0.35 m) is available in Boladichay, Gumbashichay, Girdenichay, Veravulchay. The flow of water in the rivers varies between 1.0-2.5 m/s. The water level in the reservoir varies depending on the season. Turbidity increases during rains and floods (300-700 g/m^3) (Palatov, 2016).

The transparency of the rivers of the Nakhchivan AR varies depending on rain flood waters and seasons. The main phase of the water regime of the Eastern Arpachay is the spring flood. According to the feeding conditions, the river belongs to the type of snow-rain fed rivers, and 80-85% of the runoff volume from the total turbidity falls on the surface, i.e. snow and rain water. During high water, the transparency of the water is "0" (Bayramov, 2016). The degree of turbidity in the upper reaches reaches 100-150 g/m^3, in the lower reaches 500-1000 g/m^3. The degree of mineralization in the upper reaches of the water is high. (30-160 mg / l), and in the lower reaches more than 250 mg / l. The water of the river is dominated by hydrocarbonate-calcium. The average annual turbidity of Nakhchivanchay is 620 g/m3. Up to 55.0% of unfinished deliveries are postponed to April. Water transparency is 0.0-0.5 cm at the end of summer, 0.20-0.54 cm in winter and early summer. The mineralization of the river in the high-water period is 110-260 mg/l, and in the low-water regime - 220-450 mg/l, hydrocarbon content - 30-45% eq (Aliyev *et al*., 2021c).

The Kura River is a river with a fast regime. The average annual flow of water in the river varies with the flow. In winter and early summer, the transparency of the river reaches 0.5-1 m. High transparency is observed in the section from the Yenikend reservoir to the upper dam of the Mingachevir reservoir. Depending on the seasons, transparency in the lower reaches of the Kura and in the reservoirs of the ridge also changes dramatically. During the summer months, intensive development of phytoplankton is observed in coastal zones. With the commissioning of cascade reservoirs, the flow of the tributary to the Kura River has changed significantly. The degree of turbidity in the middle part of the bay was 3400 g/m^3, and in the lower part - 9100 g/m^3. The lowest degree of turbidity is 55 g/m^3.

The water of the Aras River fluctuates along the course depending on floods and floods, seasons. The transparency of water largely depends on them. In January, February, March, April, September, the transparency of the water in the river is 0.20-0.60 m, and during floods and floods "0". During the summer months there is an intensive development of phytoplankton. Turbidity ranges from 100-1200 g/m^3.

3. Response of macrobenthic organisms to water temperature

The temperature factor plays an important role in the life of macrobenthic organisms. The water temperature of rivers depends on local conditions, water flow, depth, and air temperature. Rivers are less affected by air temperature than stagnant waters and lakes. The water temperature in the studied rivers varied from 0.0º to 20.5ºC. The temperature range was 0-5°C in the mountainous areas, 3-8°C in the foothills and 20-29.5°C in the lowland rivers. The nature of the temperature regime lies in its daily and annual variability. Compared to the plain, the temperature in the mountainous and foothill zones approaches "0". It should be noted that, according to the temperature factor, macrobenthic organisms are divided into the following groups:

1. Eurythermic organisms - temperature range 0-29ºC.
2. Mesothermic organisms - temperature range 0-20 ºC.
3. Stenothermic organisms (troglobionts) - in the range of low temperatures (8-12ºC)
4. Oligothermic organisms - species with a temperature range of 0-8 ºC and living in groundwater (Shapovalov, 2020).

This classification is typical for all macrobenthic organisms according to their ecological and physiological parameters. Temperature factors play an important role in the life of organisms: on the one hand, they play an important role in metabolism, and on the other hand, they are of exceptional importance in the process of reproduction. Hydrobionts carry out the vegetative process with the participation of temperature. Reproduction of mollusks, Amphipods, aquatic insects occurs on the basis of high temperatures.

In Balakenchay, Katekhchay and Silbanchay, located on the southern slope of the Greater Caucasus, the temperature varies depending on the season. The temperature range in the mountainous part is very variable. In winter it approaches 0º-2ºC. In summer it is observed within 10º-12ºC. In the upper reaches of the river, mainly creophilic organisms are found. Mollusks, Amphipods and Decapods predominate in these areas. It should be noted that these organisms belong to the eurythermal group. In the lower reaches of the rivers Balakenchay, Filizchay, Ktechchay, Silbanchay, Ayrichay, aquatic insects intensively develop. Aquatic insects vary in intensity of appearance, mostly starting in spring. Among aquatic insects, the development of dragonfly larvae, Diptera larvae, semi-invertebrates, beetles, stoneflies, Diptera, chironomid larvae, and chelids is accelerated (Salmanov, 2018). The temperature range for reproduction of these organisms is 15-29ºC.

The development of organisms in the main rivers of the Shirvan zone located on the southern slopes of the Greater Caucasus (Turyanchay, Demiraparanchay, Akhochay, Vandamchay, Goychay, Akhsuchay) varies depending on temperature. Out of the amphipods, *Pontogammarus robustoides* is found in the upper part of the river, and in the foothills the number of organisms increases. As in other rivers, the temperature range in the rivers of this region ranges from 9-20ºC. The temperature range in the

lower parts of the rivers is 15-26ºC. There is a high temperature range during the spring and summer seasons. During these seasons, there is an intensive development of crustaceans, aquatic insects, and water mites. Annelids, chironomid larvae and heleids dominate in autumn and winter. In autumn, the second development period for chironomid larvae (2-10ºC) begins. During those seasons, *Chironomus plumosus*, *Chyptochironomus delectus*, *Polypedilum nubeculosum*, *Microtendipes chloris* from chironomid larvae, *Limbriculus terrestis*, *Eiseneella tetraedra* from Annelids, and other species are presented. The species differ in the intensity of occurrence.

Gudialchay, Agchay, Karachay, Valvelalachay, Dzhagachigchay, Shabranchay, Devechichay, Atachay, Gil-gilchay, located in the north-east of Azerbaijan, originate from the north-eastern slope of the Greater Caucasus. The temperature changes along the flow of these rivers. In the sources of these rivers, the temperature at the beginning of summer is 0-2°C, in the lower parts 20-26°C. Creophilic organisms are observed in the upper reaches of the rivers. Mostly crustaceans and mollusks predominate. These organisms adapt to different temperature ranges. In spring and summer, species typical of rivers flourish.

The rivers of the Karabakh zone (Tarterchay, Gargarchay, Khachinchay, Inchechay) originate from the Karabakh volcanic plateau. Most of its course flows through the plain. Temperatures are lower in the mountains. All species found in the river are marked downstream. All detected species (leeches, crustaceans, water mites, aquatic insects) belong to eurythermal forms. During the winter months, the temperature range in the flat parts of the rivers ranges from 0-5ºC. At a temperature of 15ºC in the lower part of the rivers, leeches, Dragonfly larvae, Mayfly, beetles, true bugs, Caddisfly larvae, dipterans can be found on the substrates. Beginning in spring, these organisms multiply intensively. In spring, when the temperature reaches 20ºC, the reproduction of macrobenthic organisms begins. Reproduction of aquatic insects ends in August. However, the second time chironomid larvae are born in November.

4. The response of macrobenthic organisms to Ph

All reservoirs contain, to varying degrees, several salts, acids and alkalis in dissolved form. When these substances are dissolved in water, some of them, as well as water molecules, dissociate, i.e., decompose into ions with positive (cations) and negative (anions) charges. Neutral, that is, neither acidic nor alkaline water contains the same amount of hydrogen (H+) and hydroxyl (OH) ions.

$$K_{H_2O} = [H^+] \cdot [OH^-]$$

It has been established that the coefficient of water stability K = 10-14. This means that 1 liter of water at 25ºC contains 10-14 ions. So -107·107=10-14, this value in most cases depends on the temperature. If the concentrations of H+ and OH- ions in the medium are equal, that is, 1 liter of water contains 10-7 ions, then the medium is neutral. If the concentration of ions increases from 7 and decreases, the medium becomes acidic or alkaline, respectively. In an acidic environment, hydrogen ions (H+) predominate, in an alkaline environment, hydroxide ions (OH-) predominate. In general, the activity of the medium is characterized by the concentration of hydrogen ions and is designated Ph. So, Ph is the opposite sign of the logarithm of the concentration of

hydrogen ions. In such cases Ph=7 in neutral water, Ph<7 in acidic water and Ph>7 in alkaline water.

In spring and summer, phytoplankton actively develops in the Lankaranchay, Boladi, Gumbashi, Vilash, Devachichay and Shabranchay rivers of the southern region. The amount of Ph in these rivers ranges from 7.5-9.5. Ph = 7.1-7.7 in the tributaries of the Kura and Aras rivers, in the northwestern rivers of the Greater Caucasus. The ratio of hydrobionts to Ph is different. The Ph interval is inhabited by a group of organisms: chironomid larvae, Annelids, heleids, *Plariorbis planobis*, *Tubifex tubifex*. Ph should be 2-9 for these organisms.

5. The ratio of macrozoobenthos to biocenosis

Biocenosis is a historically established continuous and interconnected form of life of various organisms, adapted to coexist in the same habitat. The development of biocenoses that form in rivers occurs gradually and takes a long period. Therefore, the study of the structure of biocenoses that form in rivers is of great theoretical and practical importance. In this way, the biological productivity of rivers can be determined. The first hypothesis about the formation and evolution of biocenoses on Earth was expressed by V. I. Jadin. He noted the formation in these rivers of 5 main biotopes (stone, sandy, silty, vegetable, clay) and their corresponding biocenoses. According to V. I. Jadin (1940), the following biocenoses are formed in the rivers: litoreophilic; psammoreophil; peloreophil; Argylloreophil; Phytoreophilic.

In the direction of the flow of the rivers of the southern slope of the Greater Caucasus, biocenoses replace each other. Clay-stone biotope dominates in the upper parts. The sandy biotope is more common in river mouths. As a result of the gradual weakening of the water flow in the mouth parts of the rivers, the process of settling of a part of the suspended particles in the water to the bottom of the water begins. The process of sedimentation of suspended particles dissolved in water to the bottom of the water occurs because of a decrease in the water flow rate to 0.3-0.4 m/s. As a result, a silt biotope is formed in the lower reaches of the rivers. The biotope is characterized by an abundance of food. In the biocenosis, a complex is formed, a grouping of organisms that are not so demanding on oxygen. Hydrogen sulfide (H2S) gas is rarely present in the biocenosis of peloreophiles. Under such conditions, there is either no oxygen, or very little of it. It is characteristic that the species composition of organisms is very weak. For example, Tubifex tubifex pinworms produce a large biomass. The estuaries of the studied rivers are dominated by species belonging to the genera Limnodrilus and Chironomus (Aliyev, 2021b).

Since the rivers of the southern region belong to the tropical zone, the development of organisms depending on temperature occurs in different ways. In the mountainous parts of Astarachay and Lankaranchay, the temperature ranges from 0° to 12°C. Cryophilic forms inhabit mainly these areas. The temperature range in the lower parts of the rivers is 4-28ºC. All groups of invertebrates include pinworms, leeches, crustaceans, water mites, dragonfly larvae, diurnal larvae, springtails, hard and semi-invertebrates, dipterans, and other groups differ in intensity of occurrence. Especially intensively aquatic insects develop in spring and summer.

The temperature in the Kura River varies depending on the direction of the flow. Although the Kura River originates in the mountainous part, it flows through the plain

in the territory of Azerbaijan. Characteristic species are found in rocky biotopes downstream of the river.

The study of the influence of the habitat - the change of biotopes in rivers on the change in the species composition, quantitative indicators and ecological belonging of bottom organisms makes it possible to establish patterns of the spatial distribution of fauna in the ecosystem. Our goal was to determine the relationship between the taxonomic and ecological structure of the main rheophilic meanings of zoobenthos that form in the rivers of the region and the types of biotopes.

Zoobenthos samples were taken from various soils and biotopes of rivers and their large tributaries. The material was processed by methods and means generally accepted in hydrobiological studies. The frequency of occurrence (P=m/n»100%) was used to calculate the degree of dominance of the species that make up the macrozoobenthos of the rivers. Here: m is the total number of samples in which the species was found, n is the total number of samples covering the biocenosis.

The region's rivers flow in relatively stable channels of various sizes, usually composed of smooth stones and gravel. In the upper reaches of the rim, formed by moss species (Fontinalis hypnoides, etc.) on large stones, in the middle and lower reaches - in accumulations of fringed algae, grass, hazal, in coastal areas, common reed, lacustrine reed., there are narrow-leaved and broad-leaved weeds, sedges, hornworts and other sandy, sandy-silty and silty areas covered with aquatic plants.

Research materials showed that in the upper and middle reaches typical lithorheophilic and oxyphilic larval (nymph) species belonging to the groups Ephemeroptera (22 species), Plecoptera (10 species) and Trichoptera (40 species) were more common. rivers and account for 55-75% of the total number of macrobenthic invertebrates collected. During a long evolutionary process, they have acquired a number of devices that allow them to effectively use the fast flow of water (1-2 m / s) and live in safety. The relative stability of the species composition in the same biocenoses on the rivers was determined. According to the frequency of occurrence in these watercourses, the species composition of organisms belonging to secondary and random groups differs.

In the upper and middle altitudinal zones of the rivers, the core of the benthic fauna is made up of Mayfly, Caddisfly, Stonefly and Sandfly larvae (of the Simulidae family) and other benthic organisms (*Glossiphonia, Helobdella, Gammarus, Hydrachna, Nepa, Ilybius*, some chironomids - *Polypedilum, Tanytarsus, Rheotanytarsus, Eukiefferiella, Orthocladius*, etc.) are actively involved in the formation of lithorheophilic biocenoses with rich species diversity. The families *Glossosomatidae* (56%) and *Heptageniidae* (68%) usually dominate. *Agapetus Jiscipes* is a characteristic type of spring watercress, which is clearly visible under a transparent layer of water in the upper reaches of the Kukuchay, Shahbuzchay and Arafsachay rivers. Dominant-resistant species of lithophilic zoocenosis were considered species belonging to more than twenty genera.

The subfamilies Lymnaeidae (21%) and Chironomidae (48%) dominate in small areas covered with aquatic vegetation and covered with sandy, silty-sandy, silty-sandy, silty, plant detritus in calm streams of the lower reaches of Arpachay, Nakhchivanchay and Gilanchay. Such biotopes are inhabited by groups of Hirudinea and Ostracoda, Naididae, Tubificidae, Ephemeridae, Dytiscidae, Dryopidae, Ceratopogonidae, Tipulidae, Tabanidae, and other species of the family are characterized by a high frequency of occurrence (Bayramov, 2016).

The macrobenthic fauna of psammoreophilic biocenoses of rivers is quite simple in terms of species composition and other indicators. Some species of the classes Ostracoda, Pisidium, Gammarus, Ephemera, Ophiogomphus, Crypthochironomus, Polypedilum, and others are permanent elements of the sandy biotope. The importance of biocenosis in the biogeological life of rivers is small.

Due to the physical and geographical features of the region, the peloreophilic biocenosis in the rivers has small areas and is scattered in the lower reaches. Silt biocenoses are distinguished by a variety of types and quantitative indicators; there are species of the families Tubificidae, Sphaeriidae, Hydrachnidae, Baetidae, Caenidae, Corduilidae, Chironomidae, Ceratopogonidae and individuals of other systematic groups (Aliyev *et al*., 2021c). Calculations showed that the proportion of pinworm populations in the biocenosis in the benthic topium was low (3-5%).

The presence of plants in the waters leads to the creation of a completely new, favorable habitat for benthic fauna. Vegetation serves as a shelter and substrate for organisms, providing them with food and oxygen. Specimens of *Stylaria, Nais, Eiseniella, Glossiphonia, Herpobdella, Limnaea, Planorbis, Gammarus*, water mites (Hydrachnidae), insects and their larvae - Odonata, Ephemeroptera, Trichoptera, Coleoptera, Diptera, larvae - *Endochironomus, Cricotopus, Psectrocladius, Orthocladius, Ablabesmyia species, Diamesa, Microtendipes, Stictochironomus, Micropsectra, Polypedilum, Chironomus, Eusimulium, Odagmia, Tabanus, Psychoda* and other genera are characterized by a high frequency of occurrence in phytophilic biocenoses. The biocenosis is quite rich in quantity and quality of chironomid larvae.

6. Ratio of macrozoobentic organisms to water depth

The depth of hydro-biologically studied rivers in the republic is not the same. The depth depends on the speed of the current and the level of the water.

The depth of the rivers located in the northwest of the Greater Caucasus fluctuates mainly in the range of 0.0-0.5 m. The depth increases slightly during heavy rains and floods. The Shin and Kish rivers of the region are more prone to floods and floods. During observations, the number of organisms in Shilbanchay, Katekhchay, Talachay up to a depth of 0.5 m is high in spring and summer. It should be noted that Shilbanchay has favorable conditions for the development of benthic organisms. Aquatic insects, water mites and bivalve mollusks intensively develop in this river. The number of aquatic insects in Silbanchay is 35-40 individuals/m^2 per 1m^2. The number of mollusks is 20-25 individuals, bivalves 35-40 individuals, leeches 10-15 individuals, crabs range from 30-35 individuals. In autumn, the water level in the river rises slightly. During this period, Annelids and chironomid larvae predominate. The soils of the Katekhchay and Talachay rivers are mainly composed of pebbles. Leeches, Mayflies and Caddisflies predominate in these rivers. The number of Mayfly larvae in the river ranges from 22-28, and the number of Caddisfly larvae ranges from 30-31 individuals. During the summer season, the water in the rivers decreases. Sometimes the maximum depth is 10-15 cm. The depth of rivers can vary between 0.5-1 m. In these rivers, macrozoobenthos is mainly concentrated in areas up to 0.5 m. Intensive development of organisms occurs in spring and summer. The soil of the rivers is changeable along the course of the river. It is known that organisms are formed according to the nature of each soil. In the stone biotope of the rivers, the population is 26-34 individuals, in the clay biotope 45-52 individuals. The clay biotope is dominated by Annelids, chironomid larvae, and heleids.

From Annelids (*Stylaria lacustris*-30, *Aulodrilus piqueti*-28, *Branchiura sowerbyi*-32, *Eiseniella tetraedra*-42 specimens), chironomid larvae (*Stempelina bausei*-32 specimens, *Eifeldia pagana*-40, *Pentapedilium exectum*-54 specimens, *Microtendipes chlores* -30, *Psectrocladius psilopterus*-36) differ in intensity of occurrence. Most of the found species are observed in coastal zones (depth 20-30 cm). This situation is mainly recorded in the spring and summer seasons. Annelids and chironomid larvae are found in these rivers in the autumn-winter period. In the spring-summer period, aquatic insects (Dragonfly larvae, Mayfly larvae, Caddisflies, true bugs, Hemiptera) are intensively observed.

The depth of the Alazan River sometimes reaches 2.5 m. The soil of the river is based on lithophilic biocenoses. Macrobenthic organisms inhabit the coastal zones of the river. In deep zones, the intensity of the appearance of organisms decreases. The number of *Dikerogammarus haemobaphes* individuals from crabs swimming in deep-water zones varies from 23 to 30 per 1 m^2 of area, the species *Pontogammarus robustoides* intensively develops in biotopes with silt and sand in coastal zones. The number of individuals found in these biotopes is 25-28 individuals per 1 m^2. In the spring-summer period in coastal zones (depth 0.0-30 cm), aquatic insects, water mites and mollusks intensively develop. In the coastal zone, the number of mollusks ranges from 18-24, water mites 5-10, dragonfly larvae 28-34, daylilies 36-40, beetles 22-27, springtails 40-48, chironomid larvae 52-56 ind./m^2. In areas up to 0.5 m deep, leeches, mollusks, Mayfly larvae and Caddisflies are often observed on substrates, and in clay biocenoses - Annelids, ostracods, and chironomid larvae. Most of the rivers of northeastern Azerbaijan are full of water. Depending on the season, its depth ranges from 0.5-1.5 m or more. There are many rivers in the Nabran region. Among them, the depth of Mukhtadyrchay is more than 0.5 m. The distribution of macrobenthic organisms in Mukhtadyrchay varies in depth. Most organisms (e.g. Dragonfly larvae, Mayfly larvae, Caddisflies, true bugs) develop intensively. In deep areas, mollusks, leeches, Caddisflies and Decapods are often observed on stones. The number of insects in coastal zones fluctuated within 64-84 individuals/m^2.

Other rivers of the region, Gudyalchay, Gusarchay, Agchay, Karachay, Chagauchay, Shabranchay, vary in depth depending on the season. In the spring-summer period of the year in the coastal zones (depth 0.5 m) there is a dense population of macrobenthic organisms. In this area, leeches, mollusks, Dragonfly larvae, Mayfly and stoneflies are often found on stones, and aquatic insects (Dragonfly larvae, Mayflies) and mollusks are often found among plants. The lower part of Devechichay and Shabranchay is covered with hard and soft aquatic plants. Phytophilic species predominate in these places. The number of phytophilous species in Shabranchay was 275-82 ind./m^2, and in Devachichai 92-104 ind./m^2. In the lower reaches of both rivers, aquatic insects predominated. *Lestes sponsa* (10 individuals), *Sympucna fusca* (15 individuals), *Coenagrion consinnum* (24 individuals), *Ecnomus tenellus* (18 individuals), *Limnophilus flavicornis* (17 individuals), *Notonecta lutea* (10 individuals), *Hydrometra staghorum* (21 individuals)), *Laccophilus hyalinus* (22 specimens), *Cybister tripunctatus* (12 specimens), *Heptagenia sulferea* (25 specimens), *Ordella macrura* (19 specimens), *Cloeon dipterum* (23 specimens) were found. In Shabranchay, the number of Annelids was 22-26 individuals, and the number of chironomid larvae was 30-32 individuals, and in Devachichay, the number of chironomid larvae was 46-54 individuals, and the number of Annelids was 37-42 individuals. All observed species

are found at depths up to 0.5 m. Mollusks and aquatic insects live mainly among soft aquatic plants.

The water level of the Kura River and the Agstafachay, Hasansuchay, Tovuzchay, Zayamchay, Shamkirchay rivers, which form its left branches, varies depending on the season. The water level of these rivers varies between 0.0-1.0 m. In these rivers, lithophilic biocenosis and argelophilic biocenosis replace each other. Phytophilic biocenoses and silt-sand biocenoses are observed in some sections of the rivers. Macrobenthic organisms are more concentrated in the coastal zones of the river. Annelids and chironomid larvae dominate in the clayey biocenosis (depth 0.0-0.25 cm). Mollusks, Dragonfly and Mayfly larvae and Caddisflies live on large stones. The number of aquatic insects was 68-72 ind./m^2 in Tovuzchay, 42-50 ind./m^2 in Zayamchay, 62-72 ind./m^2 in Agstafachay, 15-20 ind./m^2 in Shamkirchay, and 72-76 ind./m^2 in Khasansuchay. Leeches and mollusks are often observed on stones and plants of the coastal zone. Crabs are found at all depths; Amphipods predominate among crabs. Decapods are also encountered in these areas.

Among the rivers of the southern region, the depths of Astarachay and Lenkoranchay exceed 1.5 m. Stones and clay cover the bottom of the rivers. During observations, the distribution of macrobenthic organisms at a depth of 0.0-0.25 m is recorded. In Lenkoranchay, the depth in autumn and winter reaches 1.5 m. The main part of the organisms is concentrated in the coastal zone (up to 0.5 m). Biocenoses of the coastal zone are diverse. At the same time there are large stones. Leeches, mollusks, Mayfly and Caddisfly larvae develop on the stones. Water mites and crabs are found at different depths of water. The number of water mites is 30-35 individuals/1 m^2. Annelids and chironomid larvae develop intensively in clay zones. The number of chironomid larvae is 260-68 individuals/1 m^2, and the number of Annelids is 38-42 individuals. Similar situations are observed on other rivers of the region. The maximum water depth in the rivers Gumbashy, Boladi, Vilash, Girdeni and Veravul is 1.0-1.20 m. Soft and rough plants thrive in these rivers. Consequently, phytophilic species predominate in these rivers. Mostly aquatic insects predominate.

Out of aquatic insects, the number of Dragonflies was 45-50 individuals/m_2, Mayflies – 20-25 individuals/m_2, Coleoptera - 65-70 individuals/m_2, and Caddisfly - 10-18 individuals/m_2.

The water level in the Aras River varies depending on the season. At the same time, different biotopes replace each other in the direction of the current. In autumn and winter, in early spring, the depth is 1-1.5 m. The rest of the time, the maximum depth does not reach 0.5. 5-10 km below the Bahramtepe dam, the bottom of the river is composed of alluvium. Sandy biotopes occupy the area up to the source. In areas with a depth of 0.0-0.35 m, Amphipods predominate. Crabs and shrimps can be found in this river. The rocky areas are dominated by Mayflies and Caddisflies. *Ecnomus tenellus, Limnophilus flavicornis, Oecetis furva from spring beetles, Ordella macrura, Leptocerus tineiformis* and other species differ in intensity of occurrence. Leeches, mollusks, and Caddisfly intensively develop on the stones. 68.2% of the organisms found in the Aras River were recorded at a depth of up to 0.5 m.

The depth of the Kura River often changes depending on the water level. The average depth of the river is 4-6 m depending on the season. The depth of reservoirs built on the river ranges from 20 to 70 m. Most organisms live at a depth of up to 0.5 m. In the clay biotope of the coastal zone, Annelids and chironomid larvae predominate. The number of Annelids is is 48-50 individuals/m^2, chironomid larvae - 72-72

individuals/ m^2. Caddisflies build nests on stones located in deep areas. At different depths of the river, shrimp, Amphipods and water mites differ in the intensity of the encountering. The number of Amphipods was 30-36 individuals/m^2 of area, shrimps - 20-24 individuals. The Lower Kura is dominated by sandy biotopes.

The depth of the rivers of the Absheron-Gobustan region (Pirsaat, Jeyrankechmez, Sumgaitchay) is very small. The depth of the Jeyrankechmez River is 0.0-0.30 m throughout the year. Mostly aquatic insects live here. On the Pirsaat River during high water it is 0.5-1.10 m. The rest of the time the depth varies between 0.10-0.45 m. 0.20-1.30 m. Aquatic insects, Dragonfly larvae, Mayflies, Hemiptera, and true bugs are intensively encountered (Aliyev *et al*., 2012).

7. The ratio of macrozobenthic organisms to oxygen (O_2)

The chemical composition of water depends on the source of biogenic elements (salt content) and the regime (gases dissolved in water) of the rivers.

Before characterizing the O_2 regime of the rivers of Azerbaijan, analyzing the O_2 regime of some rivers of other republics, oxygen is used for respiration and oxidation-destruction processes in water bodies. Oxygen is reasonably available in all rivers during the summer months.

The distribution of oxygen in the water column is very interesting. Compared to lakes, where the distribution of oxygen depends on temperature changes, one can observe the equality of oxygen in the entire column of river water - from the surface to the bottom, and the change in the amount of oxygen towards the coast.

It should be noted that the amount of oxygen in the Alazan, Kura and Aras rivers decreases from the water surface to the bottom and from one bank to another. Since the contact of air and water in mountain and lowland rivers is different, the biological factor of saturation with oxygen and water is completely different. Green organisms (aquatic plants, algae) are the main biological factors affecting the water saturation of mountain and lowland rivers, and phytoplankton play a key role in this process in full-flowing lowland rivers. In fact, in mountain rivers and on rocks in a stream, the conditions are favorable for the growth of algae - it has the right substrate and the right depth so that light can penetrate to the bottom of the water. However, in mountain rivers, where the bottom is covered with sandy or clay deposits, or in some of its sections, the turbidity of water with substances in the most critical time of the year leads to the absence of conditions for the development of phytobenthos. and the amount of dissolved oxygen in water reaches especially high values.

For the growth of algae and higher vegetation in the Kura River, the presence of relatively small littoral areas (which is necessary for water bison) and littoral areas with a stable bottom is important. Interestingly, even epiphytes do not grow well in lowland rivers with complex turbidity, which is often found here on the leaves and roots of large plants.

The enrichment of Kura water with oxygen in autumn and early winter coincides with the abundant development of diatom phytoplankton. In winter, under conditions of very weak phytoplankton, little oxygen flows. They divide oxygen depletion factors into physicochemical and biological ones. In practice, it is very difficult to separate these factors. The phenomenon of oxygen absorption from water, as a phenomenon of a purely physicochemical nature, for example, the oxidation of organic substances entering water or transported from iron compounds to oxide compounds, proceeds with

the participation of microbes. In general, without trying to draw a sharp line between physicochemical and biological factors, we will give a short list of the causes of oxygen starvation. This is the feeding of rivers with groundwater, weak oxygen, the acquisition of easily oxidized inorganic substances (for example, black iron), industrial and domestic wastewater entering the rivers, swamp waters, irrigation waters rich in organic matter, washing out of soil particles, mixing from the bottom of bottom sediments, waste, allowing them to be dumped into water, aquatic organisms, decomposition of dead plants and animals, respiration of aquatic organisms.

When less oxygen enters and leaves the river at the moment, it cannot be said that the problem is that the phenomenon of oxygen depletion is greater. Therefore, biological oxygen saturation practically does not occur since the ice cover on the river is separated from atmospheric oxygen, and the factors of biological oxygen saturation are low water temperature and insufficient illumination (Mährlein *et al.,* 2016).

The amount of oxygen in rivers largely depends on the vital activity of hydrobionts. In turn, oxygen dissolved in water is a powerful factor regulating the fauna of rivers.

Due to the high oxygen regime, diurnal larvae and spring worms from aquatic insects actively develop in most of the studied rivers. The oxygen regime in Shamkirchay is 102-108%, in Alijanchay 104-111, in Khalkhalchay 104-106, in Zayamchay 112-114, in Agstafachay 109-111, etc. varies between Therefore, insect larvae, crustaceans and mollusks from macrobenthic organisms develop well in these rivers.

River rheophilic larvae get along well in well-aerated water, but under natural conditions, larvae that form openwork forms from sand and gravel lose the ability to build in water and build shapeless dwellings. Apparently, the flow is important to best position the building material.

According to the examples given there, we add that the larvae of the fly *Baetis rhodani* absorbs oxygen 3-4 times faster than the larvae of the pond fly *Cloeon dipterum*. We remind you that marine animals that have migrated to freshwater consume more oxygen than their freshwater counterparts. The inhabitants of the Caspian Sea - *Pontogammarus sarsi, Dikerogammarus haemobaphes, Metamysis* strauchi - can live in the rivers of the Volga basin and come to the floodplain only under conditions of a good oxygen regime, die in the river when the near-bottom oxygen deficiency occurs in summer and at the beginning of wintering.

8. Conclusion

Thus, the main ecological factors affecting the development of macrozoobenthos in the main river basins of Azerbaijan were studied in detail. It has been found that some species of benthic invertebrates, especially Mayflies and Caddisflies live in water bodies that are more oxygen-rich.

Factors such as water transparency, temperature, depth, oxygen content, pH each play a unique role in the formation and development of macrozoobenthos, and this dependence is explained in detail in the article.

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