

Macrozoobenthos of the rivers of North-Eastern Azerbaijan

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Abstract. Between 2020 and 2023, an in-depth analysis was conducted on the species composition of the macrozoobenthos in the Yalama River, including its tributaries Telchay, Mukhtadyrchay, Velmirchay, and Khuraychay, as well as other significant rivers in northeastern Azerbaijan. During this period, a total of 53 species of benthic organisms, representing 14 different taxonomic groups, were identified across the rivers studied. These findings provide important insights into the biodiversity and ecological health of the region's freshwater ecosystems. Among the various groups recorded, mollusks, dragonflies, crustaceans, and chironomid larvae were particularly prominent, both in terms of species richness and their ecological significance within the aquatic habitats. These groups are crucial for understanding the dynamics of the river systems, as they play key roles in nutrient cycling, sediment stability, and the food web. The diversity of these species also reflects the environmental conditions and the unique characteristics of the rivers in this region, which may be influenced by factors such as water quality, habitat variation, and seasonal changes.

Keywords: macrozoobenthos, freshwater animals, biomass, species composition, Northeastern Azerbaijan.

1 Introduction

Northeastern Azerbaijan has many water bodies (lakes, rivers), and some rivers from this area are called Yalama rivers (Telchay, Khuraychay, Velmirchay, Mukhtadirchay). These rivers were formed from the development of the Samurchay Delta system. Rivers take their water mainly from springs located above Samur. Mukhtadirchay flows directly into the Caspian Sea. The remaining 3 rivers (Telchay, Khuraychay, Velmirchay) are connected to the sea through special pipes. The Yalama rivers are shallow: the maximum depth is about 60-90 cm. Depths exceeding one meter are found in separate pits. The depth of springs is 15-20 cm. River bed conditions are different: their middle sides are silty-sandy; stone-gravel soil is found in the lower parts of the rivers [1, 2].

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Gusarchay, Gudyalchay, Agchay, Karachay, Velvelechay, Shabbranchay, Devechichay, Atachay, Gil-gilchay are the big rivers of the region, which take their beginnings from the northeastern slope of the Greater Caucasus and called side ridge rivers. Shabbranchay and Devechichay flow into the port of Devechi (Aghzibirchala Lake), and other rivers flow into the Caspian Sea. Rivers are in constant activity. Most of them are raging rivers. Due to the economic importance of the water basins of the region, the study of their hydrofauna, macrozoobenthos, which is an important component of it, has important scientific and practical importance. The region's rivers are used to supply water to the population, irrigation works, energy purchases and fishing. Macrobenthic organisms are involved in the formation of biological productivity of water bodies, in the feeding of fish and wetland birds, and in the natural purification of water. At the same time, they show the degree of water pollution with organic substances - indicator organisms. In addition, their various representatives are carriers of parasites or 1st and 2nd intermediate hosts. Some representatives prevent the normal operation of water pipelines and hydro-technical facilities. It should be noted that at the same time, rivers play an important role in maintaining the gene pool of invertebrate fauna.

Without knowing the species composition, number dynamics, biomass, and ecological characteristics of macrobenthic organisms, and without obtaining information about the biological productivity of water bodies, it is impossible to use them effectively in fisheries. Therefore, our main goal in conducting research is to comprehensively study the macrobenthos of water bodies in the Northeastern region and to study its development patterns.

The first hydrobiological research in the Yalama rivers was conducted in 1947 by R.S. Dengina. During the research period, the author discovered the following hydrobionts: annelids [*Eiseniella tetraedra* (Savigny, 1826), *Tubifex* sp., *Peloscoclex velutinus* (Grube, 1879)], insect larvae [*Perla* sp., *Nemura* sp., *Gomphus vulgatissimus* (Linnaeus, 1758), *Calopteryx splendens* (Harris, 1780), *Epallage fatime* (Charpentier, 1840), *Onychogomphus forcipatus* (Linnaeus, 1758), *Rhyacophila* sp., *Hydroptela* sp., *Lype reducta* (Hagen, 1868), *Cheumatopsyche lepida* (Pictet, 1834), *Chematopsyche* sp., *Hydropsyche* sp., *Notonecta lutea* Müller 1776, *Velia rivulorum* Fabricius 1775, *Simulium* sp., *Tabanus* sp., *Macropelopia* sp., *Heptagenia* sp., *Baetis* sp., *Lathelmis* sp., *Helmis* sp.], and molluscs [*Theodoxus fluviatilis* (Linnaeus 1758), *Th. Pallasi* Lindholm 1924]. At the same time, the researcher collected and analyzed materials on amphipods and isopods. Among isopods, *Asellus aquaticus* (Linnaeus 1758) has been recorded, which has second-degree importance in the trophic level of rivers.

Further studies were carried out by A. Kasymov [4] in the water basins of the region. His research included the Samur-Devechi Canal, Samurchay, Gusarchay, Gudyalchay, and Valvalachay. The researcher discovered 3 insect larvae from the Samur-Devechi Canal. He conducted his research along the Canal and did not detect any other groups.

The researcher had identifies 7 species in Samurchay [*Galba truncatula* (Müller, 1774), *Planorbis planorbis* (Linnaeus, 1758), *Coenagrion scitulum* (Rambur, 1842), *Orthetrum albistylum* (Selys, 1848), *Polypedilum convictum* (Walker 1856), *Procladius* sp., *Bezzia* sp.], 6 species in Gusarchay [*Radix auricularia* (Linnaeus, 1758), *G. truncatula*, *Notonecta glauca* Linnaeus, 1758, *Syndiamesa nivosa* Goetghebuer, 1928, *Psectrocladius barbimanus* (Edwards, 1929), *Tendipes plumosus* (Linnaeus, 1958)], 10 species from Gudyalchay [*Gammarus lacustris* Sars, 1863, *Asellus aquaticus* (Linnaeus, 1758), *G. truncatula*, *R. auricularia*, *P. planorbis*, *Pisidium casertanum* (Poli, 1791), *Sympetrum* sp., *N. glauca*, *Limnoporus rufiscutellatus* (Larteille, 1807), *Procladius* sp.], 11 species from Valvalachay (*G. lacustris*, *G. truncatula*, *P. casertanum*, *Coenagrion pulchellum* (Linden, 1825), *Sympetrum* sp., *Nepa cinerea* Linnaeus, 1758, *Ranatra linearis* Linnaeus, 1758, *L. rufiscutellatus*, *Gyrinus* sp., *Anatopynia* sp., *Bezzia* sp.). It should be noted that the number

of benthic organisms in Gusarchay was 870 ind./cm², and in Gudyalchay the number was 360-620 ind./m². The dominant species in this river were amphipods (200 ind./m²), *Planorbis planorbis* (120 ind./m²) and *Procladius* sp. (100 ind./m²). For the first time, *S. nivosa* was recorded for the water basins of the high mountain zone of the Caucasus. The authors noted that *Theodoxus pallasi* Lindholm, 1924 was recorded only in Velmirchay, they live mainly in the stone biotope.

For the first time, research was conducted in the rivers located in the Khinalig area. 28 species of benthic organisms were recorded in Gudyalchay and other rivers connected to it.

2 Methods

Macrozoobenthic materials were collected from different parts, areas, and biotopes of rivers. Materials were collected in the spring, summer, and autumn seasons during 2020-2023. The materials were collected and analyzed based on Jadin's method [3].

Net sieves and scrapers were used to study the composition of the macrozoobenthos species. Samples were collected from the coastal zone of water bodies with these tools. Samples from deep areas were collected with a dredger. The materials collected with these tools were washed like scum, the remaining mass was filled in special containers, fixed with 4% formalin solution, labeled, and prepared for laboratory use. The samples brought to the laboratory were cleaned from the soil, and the organisms were carefully removed with a knife and placed in special containers. Then the organisms were divided into groups and the species composition was investigated. Samples were collected and analyzed from different depths with a Petersen-type dredger (area 0.025 m²) to study the quantity and biomass of organisms living in macrobenthos. The collected samples were brought to the laboratory after initial processing on the spot, and cleaned of soil. A magnifying glass was used for this purpose. The materials collected in this way were divided into groups and species, and their number and biomass were calculated.

Before weighing the organisms, they were dried on filter paper. Organisms were weighed on torsion and large individuals on pharmacy scales. Their masses are expressed in grams.

Various determination books were used to analyze the materials down to species composition. To determine mollusks, Jadin [3], *Odonata* Popova, *Hemiptera* Kirichenko [5], *Oligochaeta* Chekanovskaya, chironomid larvae Pankratova [7, 8] books were used.

2.1 Macrozoobenthos of the Yalama rivers

Telchay. Samples of macrozoobenthos in this river were collected from different parts of the river and different biotopes. During the research period, the water temperature in the river varied between 12.5 and 18.2 °C depending on the seasons. Ph of water was 7.1-7.2, oxygen was 8.1-8.2. The soil of the river is made of clay and in some places, gravelly sand.

The analysis of the materials collected from the river showed that its fauna consists of 20 species included in 10 systematic groups. The maximum number of species was in mollusks (5 species). In other groups, *Odonata* was represented by 3 species, and the remaining groups were represented by only 1-2 species (Table 1). According to the intensity of species occurrence, *Theodoxus danubialis* (C.Pfeiffer, 1828), *Th. transversalis* (C.Pfeiffer, 1828), *Th. fluviatilis* (Linnaeus, 1758), *Agrion virgo* (Linnaeus, 1758), *Coenagrion lindenii* (Leliys, 1840), *Siphonurus linnaeanus* (Eaton, 1871), *Cheumatopsyche lepida* (Pictet, 1834), etc. were distinguished (Table 2). Mollusks, *Odonata* larvae, nymphs, and springflies are mostly found in gravel biotopes. The maximum development of benthic organisms is observed in summer.

The quantitative development of benthic organisms varied depending on the seasons. Thus, the biomass of organisms varied from 0.05 to 0.3 g/m², and the number from 72 to 99 ind./m². Mollusks dominated in the river in terms of number and biomass.

Mukhtadirchay. The river flows through forests and the territory of Mukhtadir village and joins the Caspian Sea. The soil of the river consists of clay, gravel sand, and stone biotopes. Research was carried out in different parts and biotopes of the river. During the observations, the water temperature varied from 12.8 to 19.2 °C, pH from 7.2 to 7.3, and oxygen regime from 8.1 to 8.3.

31 species of organisms included in 12 systematic groups were found in the benthos of the river (Table 1). 4 of the detected species belong to *Trichoptera*, and 4 species to *Diptera*. The remaining groups were represented by 1-3 species. The species with the highest frequency of occurrence are *Dero dorsalis* Ferronniere, 1899, *Costatella acuta* (Drapparnaud, 1805), *Eylais hamata* Koemike, 1897, *C. lindeni*, *C. armatum* (Charpentier, 1840), *Ch. lepida*, *Rhyacophila* sp., *Tabanus* sp., *Helius* sp., *Atherix* sp. and others (Table 2). It should be noted that mollusks, Odonata larvae, mayflies larvae, springflies, and dipterans are found in gravel-stone biotopes. The maximum development of benthic organisms is observed in summer. In the spring and autumn seasons, when the rivers and flood waters flow, the species' occurrence frequency is low.

The quantitative development of benthic organisms in the river varied depending on the seasons. Thus, the biomass of benthic organisms varied from 0.04 to 0.27 g/m², and their number from 76 to 89 ind./m².

Velmirchay. The river flows through residential areas and connects to the Caspian Sea through special pipes. The materials were collected from different parts of the river and different biotopes.

During the research period, water temperature in the river was 12.3-18.4 °C, pH 7.1-7.2, oxygen regime 8.1-8.3. The analysis of materials collected from rivers shows that its fauna consists of 30 species of organisms included in 11 systematic groups (Table 1). According to the number of species, mollusks (4 species), *Trichoptera* (5 species), *Odonata* (3), *Ephemeroptera* (3 species), *Diptera* (3), and chironomid larvae (3 species) are distinguished. According to the intensity of occurrence of the mentioned species, *Lymnaea auricularia*, *Costatella acuta*, *Theodoxus transversalis*, *Coenagrion mercuriale*, *Siphonurus lacustris*, *Baetis tricolor*, *Hydropsyche ornatula*, *Helus* sp., *Atherix* sp. etc. species dominate (Table 2). It should be noted that some groups (mollusks, *Diptera* larvae, *Trichoptera*, *Odonata* larvae) are more common in stone biotopes. The maximum development of organisms is observed in summer. The quantitative development of benthic organisms varied depending on the seasons. Thus, the biomass of organisms was 0.1-0.29 g/m², and the number was 78-120 ind./m², depending on the season. The maximum growth in biomass is observed in mollusks.

Khuraychay. This river flows through the residential area and connects to the Caspian Sea through special pipes. It was collected from different parts and biotopes of the river during the research period. During the observations, the water temperature was 12.2 - 19.1 °C, pH 7.1 - 7.2, oxygen regime 8.1 - 8.2. 41 species of benthic organisms included in 14 systematic groups were found in the fauna of the river (Table 1). According to the number of species, mollusks (6 species), *Odonata* (5 species), and *Ephemeroptera* (5 species) prevailed. The remaining groups are represented by 1-4 species. It should be noted that according to the intensity of species occurrence, *Lymnaea auricularia*, *Costatella acuta*, *Theodoxus danubialis*, *Th. transversalis*, *Agrion virgo*, *Coenagrion lindeni*, *Siphonurus linnaeanus*, *Cloen dipterum*, *Ephemerella ignita*, *Hydropsyche ornatula*, etc. species differ (Table 2). Most of the detected species are found in gravel and stone biotopes. The maximum development of organisms is observed in summer. In the spring and autumn seasons, the development of organisms is poor, as flood waters flow in the river. The quantitative

development of benthic organisms varied depending on the seasons. Thus, the biomass of organisms varied from 0.10 to 0.30 g/m², and the number from 52 to 109 ind./m². In terms of biomass, decapods and mollusks dominated.

Gusarchay is formed by the confluence of the Shahnabad and Yatikhdere rivers flowing from the north-eastern slope of the Greater Caucasus. The Yatakhdere river is considered the main river. The source of the river is 3780 m above the Bazarduzu mountain. Gusarchay flows directly into the Caspian Sea (26 m). 92 km above the mouth it is called the Shakhnabad River, until the Shatsi River flows out, and below it is called the Gusar River. Gusarchay flows through the territory of Gusar, Guba, and Khudat. Its length is 113 km, the basin area is 694 km², the average density of the river network is 0.71 km/km². According to the water regime, it is lush in the spring and summer seasons. The energy potential of the river is great. Gusar, Khuray, Anikh, and Guzun hydropower plants operated on the river. It is widely used in irrigation. The basis of the river bed is stone, stone-gravel, sand-silt, etc. forming biotopes and replacing each other [26]. The amount of dissolved oxygen in water is 8.7 - 9.1 mg/l. Vegetation is poorly developed. During the research, the water temperature varied between 12.2 and 22.2 °C depending on the seasons. The pH of the water was 7.1 - 7.4. During the research, the benthos of Gusarchay consisted of 44 species from 13 systematic groups. The maximum number of species was observed in mollusks (7 species). In other groups, the larvae of *Odonata* and *Ephemeroptera* (6 species each), *Coleoptera* (4 species) were recorded. The remaining groups were represented by 1-3 species (Table 1).

Table 1. The number of species of the macrozoobenthos of the rivers of Northeastern Azerbaijan by groups (2020 - 2023).

Rivers Groups	Telchay	Muxtadurchay	Velmirchay	Khuraychay	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelechay	Shabbranchay	Devechichay	Gil-gilchay	Atachay
Oligochaeta	1	2	2	1	4	3	2	3	2	-	3	-	-
Hirudinea	-	-	-	1	2	1	2	1	-	2	1	-	-
Mollusca	5	3	4	6	7	8	8	7	5	4	5	2	4
Decapoda	1	1	-	1	1	1	1	1	-	-	-	-	-
Mysidacea	-	-	-	1	1	1	-	1	-	-	-	-	-
Hydracarina	-	2	1	2	2	1	2	2	-	2	2	-	-
Odonata	2	3	3	5	6	2	6	6	6	4	5	3	-
Ephemeroptera	1	2	3	5	6	5	5	8	4	3	4	2	4
Hemiptera	2	3	2	4	3	4	5	6	3	5	6	1	3
Trichoptera	2	4	5	4	3	4	5	6	5	6	3	4	2
Coleoptera	-	3	2	3	4	6	4	5	2	2	2	-	-
Diptera	3	4	3	2	3	2	3	2	4	-	1	-	-
Chironomidae	2	3	3	4	2	3	3	4	-	-	-	-	2
Ceratopogonidae	1	1	2	2	-	1	2	1	-	-	-	-	1
Total:	20	31	30	41	44	42	48	53	29	28	32	12	16

Table 2. Species composition of macrozoobenthos of rivers of Northeastern Azerbaijan (2020 - 2023).

Groups \ Rivers	Telchay	Muxtadurchay	Velmirchay	Khuraychay	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelechay	Shabbranchay	Devechichay	Gil-gilchay	Atachay
Oligochaeta													
Stylaria lacustris (Linnaeus, 1758)	+	-	-	-	+	-	-	+	-	-	+	-	-
Ophidonais serpentina (Müller, 1774)	-	+	+	-	+	-	-	+	-	-	+	-	-
Dero dorsalis Ferronnière, 1899	-	+	-	-	+	-	+	-	+	-	+	-	-
D.obtusa d'Udekem, 1855	-	-	+	-	-	+	-	+	+	-	-	-	-
Nais variabilis Piquet, 1906	-	-	-	-	+	+	-	-	-	-	-	-	-
Pristina bilobata Bretscher, 1903	-	-	-	+	-	+	+	-	-	-	-	-	-
Hirudinea													
Piscicola geometra (Linnaeus, 1761)	-	-	-	+	+	+	+	+	-	+	+	-	-
P.fasciatus Kollar, 1842	-	-	-	-	+	-	+	-	-	+	-	-	-
Mollusca													
Lymnaea auricularia (Linnaeus, 1758)	+	-	+	+	+	+	+	-	+	-	+	-	-
Costatella acuta (Draparnaud, 1805)	-	+	+	+	+	+	+	+	+	+	+	-	-
Theodoxus danubialis (C.Pfeiffer, 1828)	+	-	+	+	+	+	+	+	+	+	+	-	-
Th.transversalis (C.Pfeiffer, 1828)	+	-	+	+	+	+	+	+	+	+	-	-	+
Th.fluviatilis (Linnaeus, 1758)	+	-	-	+	+	+	+	+	+	+	+	-	+
Anisus spirorbis (Linnaeus, 1758)	-	+	-	+	-	+	+	+	+	-	+	-	+
Gyraulus ehrenbergi (H.Beck, 1837)	-	-	-	-	+	+	+	+	-	-	-	+	+
Valvata pulchella S.Studer, 1789	+	+	-	-	+	+	+	+	-	-	-	+	-

Continuation of table 2.

Groups \ Rivers	Telchay	Muxtadurchay	Velmirchay	Khuraychay	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelchay	Shabbranchay	Devechichay	Gil-gilchay	Atachay
Decapoda													
Astacus leptodactylus Eschscholtz, 1828	+	+	-	+	+	+	+	+	-	-	-	-	-
Mysidacea													
Paramysis lacustris (Czerniavsky, 1882)	-	-	-	+	+	+	-	+	-	-	-	-	-
Hydracarina													
Eylais hamata Koenike, 1897	-	+	-	+	+	-	+	+	-	+	+	+	-
E.degenerata Koenike, 1897	-	+	+	+	+	+	+	+	-	+	+	+	-
Odonata													
Agrion virgo (Linnaeus, 1758)	+	-	+	+	+	-	+	+	+	-	-	-	-
Coenagrion lindeni (Selys, 1840)	+	+	-	+	+	-	+	+	+	+	+	-	-
C.mercuriale (Charpentier, 1840)	-	-	+	+	+	-	+	+	+	+	+	-	-
C.armatum (Charpentier, 1840)	-	+	-	+	+	+	+	+	+	+	+	+	-
C.puella (Linnaeus, 1758)	-	-	-	+	+	+	+	+	+	+	+	+	-
C.scitulum (Rambur, 1842)	-	+	+	-	+	-	+	+	+	-	+	+	-
Ephemeroptera													
Siphonurus linnaeanus (Eaton, 1871)	+	+	-	+	-	+	+	+	-	+	-	-	+
S.lacustris Eaton, 1870	-	-	+	+	+	+	+	+	-	+	-	-	+
Cloe diptera (Linnaeus, 1761)	-	+	-	+	+	-	+	+	-	+	-	-	+
Centropitulum luteolum Müller, 1776	-	-	-	+	+	-	-	+	+	-	+	-	+
Baetis tricolor Tshernova, 1928	-	-	+	+	+	+	-	+	+	-	+	-	-

Continuation of table 2.

Groups	Rivers												
	Telchay	Muxtadirchay	Velmirchay	Khuraychay	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelechay	Shabbranchay	Devechichay	Gil-gilchay	Atachay
<i>Ephemerella ignita</i> Poda, 1761	-	-	+	+	+	-	-	+	+	-	+	-	-
<i>Ephemera vulgata</i> Linnaeus, 1758	-	-	-	-	+	+	+	+	+	-	+	+	-
<i>Paraleptophlebia submarginata</i> (Stephens, 1835)	-	-	-	-	-	+	+	+	-	-	-	+	-
Hemiptera													
<i>Notonecta lutea</i> Müller, 1776	+	+	-	-	+	+	+	+	-	+	-	-	+
<i>Velia revulorum</i> (Fabricius, 1775)	-	+	-	-	+	-	-	+	-	+	-	-	+
<i>Sigara falleni</i> (Fieber, 1848)	-	+	-	-	-	+	+	+	+	+	+	-	+
<i>Corixa punctata</i> (Illiger, 1807)	-	-	-	+	-	+	-	-	+	-	+	-	-
<i>Nepa cinerea</i> Linnaeus, 1758	+	-	-	+	-	+	+	+	+	-	+	-	-
<i>Aphelocheirus breviceps</i> Horvath, 1895	-	-	+	+	+	-	+	-	-	-	+	+	-
<i>Hydrometra stagnorum</i> (Linnaeus, 1758)	-	-	+	+	-	-	+	+	-	+	+	-	-
<i>Gerris costai</i> (Herrich-Schaeffer, 1850)	-	-	-	-	-	-	+	+	-	+	+	-	-
Trichoptera													
<i>Lype reducta</i> Hagen, 1868	-	-	+	-	-	-	+	+	-	+	+	+	-
<i>Cheumatopsyche lepida</i> (Pictet, 1834)	+	+	+	+	+	+	+	+	+	+	-	+	-
<i>Rhyacophila</i> sp.	-	+	-	+	-	+	-	+	+	+	-	+	-
<i>Hydroptila</i> sp.	+	+	+	-	+	+	+	+	+	+	-	-	+
<i>Polycentropus flavomaculatus</i> (Pictet, 1834)	-	-	+	+	-	-	+	+	+	+	-	+	+
<i>Hydropsyche ornata</i> McLachlan, 1878	-	+	+	+	+	+	+	+	+	+	+	-	-

Continuation of table 2.

Groups	Rivers	Teichay	Muxtadirchay	Velmirchay	Khuraychay	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelechay	Shabbranchay	Devechichay	Gil-gilchay	Atachay
	Coleoptera													
Aulonogyrus concinnus (Klug, 1834)	-	-	-	+	+	+	-	+	-	+	-	-	-	-
Helophorus aquaticus (Linnaeus, 1758)	-	+	-	+	-	+	+	-	+	+	-	-	-	-
Hydrochus elongatus (Schaller, 1783)	-	+	-	+	+	+	+	+	+	-	+	-	-	-
Hydrous piceus (Linnaeus, 1758)	-	+	-	-	+	+	+	+	-	-	-	-	-	-
Hydrobius fuscipes (Linnaeus, 1758)	-	-	+	-	+	+	-	+	-	-	+	-	-	-
Noterus crassicornis (Müller, 1776)	-	-	+	-	-	+	+	+	-	-	-	-	-	-
Diptera														
Tabanus sp.	+	+	-	-	+	-	+	-	+	-	-	-	-	-
Tabanus autumnalis Linnaeus, 1761	+	+	+	+	+	+	+	+	+	-	-	-	-	-
Helus sp.	+	+	+	+	+	+	+	-	+	-	+	-	-	-
Atherix sp.	-	+	+	-	-	-	-	+	+	-	-	-	-	-
Chironomidae														
Stempelina bausei (Kieffer, 1911)	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Micropsectra praecox (Wiedemann, 1818)	-	+	+	-	-	-	-	+	-	-	-	-	-	-
Cryptochironomus defectus (Kieffer, 1913)	+	+	+	-	-	-	+	-	+	-	-	-	-	-
Chironomus thummi (Kieffer, 1911)	+	+	-	-	-	+	-	+	-	-	-	-	-	-
Polypedilum convictum (Walker, 1856)	-	-	-	-	+	-	-	-	+	-	-	-	-	-

Continuation of table 2.

Groups \ Rivers	Telchay	Muxtadirchay	Velmirchay	Khuraychay	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelechay	Shabbranchay	Devechichay	Gil-gilchay	Atachay
Pentapedilum exectum Kieffer, 1916	-	-	-	-	-	+	-	-	+	-	-	-	-
Microtendipes chloris (Meigen, 1818)	-	-	-	-	-	-	+	-	-	-	-	-	-
Brilla pallida Chernovsky, 1949	-	-	+	-	-	+	-	+	-	-	-	-	-
Cricotopus silvestris Fabricius, 1794	-	-	-	-	-	-	-	-	+	-	-	-	-
Procladius choreus (Meigen, 1804)	-	-	-	-	+	-	-	+	-	-	-	-	-
Ceratopodonidae													
Culicoides sp.	-	+	+	+	-	-	+	-	-	-	-	-	-
Bezzia sp.	+	-	+	+	-	+	+	+	-	-	-	-	+
Total:	20	31	30	41	42	44	48	53	29	28	32	12	16

Among the detected species are *Th. danubialis*, *Th.transveralis*, *Agrion virgo*, *Hydroptila* sp., etc. species differ in intensity of occurrence (Table 2). The biomass of benthic organisms in the river was 0.86 g/m², and the number was 303 ind./m². In terms of number and biomass, mollusks dominated (93 ind./m²; 0.27 g/m²). The biomass of other groups varied from 0.02 to 0.26 g/m², and the number varied from 2 to 75 ind./m². *Th.danubialis* species differs from mollusks in terms of its biomass (Table 3).

Gudyalchay begins at an altitude of 3000 m, 1 km south of Ifan mountain on the southern slope of the Greater Caucasus. The upper stream is called Khinalykhchay until it flows into Ashchay. Below Guba, the river divides into 2 branches; the right tributary is called Gudyalchay, and the left tributary is called Kymilchay, and they join again in the downstream. Gudyalchay joins the Caspian Sea near the village of Nizovaya. The length of the river is 108 km, the area of its basin is 799 km². This river has the largest annual flow volume among the rivers flowing from the northeastern slope of the Greater Caucasus [1].

The water temperature varied between 14.2 and 20.6 °C during the research period depending on the seasons. The pH of the water was 7.2 - 7.4, O₂ was 8.8 - 9.4 mg/l. The basis of the soil of the river is stone, stone-gravel, gravel-sand, sand-silt, etc. They form biotopes and replace each other. 42 species of benthic organisms included in 14 systematic groups were found in the river. 8 species of the detected organisms belong to mollusks, 6 species to *Coleoptera*, and 5 species to *Diptera*. The remaining groups were represented by 1-4 species (Table 1). *Theodoxus danubialis*, *Th.fluviatilis*, *Lype reducta*, *Hydropsyche ornatula*, *Cloen dipterum*, *Ephemerella ignita*, *Vilia rivulorum*, *Nepa cinerea*, *Aphelochirus brevicops*, *Polycentropus flavomaculatus*, *Aulonogurus concinnus*, *Helophorus aquaticus*, *Tabanus* sp. etc. species can be shown (Table 2). Depending on the frequency of occurrence of species in this area, the species that enter the mollusks and *Ephemeroptera* differ. The biomass of benthic organisms was 0.06-0.28 g/m², and the number was 15-90 ind./m² (Table 3).

Aghchay takes its source from the northeastern slope of the Greater Caucasus at an altitude of 1780 m from Yarmyaylag mountain, is formed by the confluence of several springs, and flows into the Caspian Sea. Its length is 68 km, the area of its basin is 299 km². One main left tributary is Gusarchay, 8 km long [1]. The soil of the river consists of gravel-stones in the upper parts, gravel-sand, and clay-sand in the parts connecting to the sea. During the research period, the water temperature is 14-22.5 °C, the oxygen regime is 8.1-8.4 mg/l, pH is 7.1-7.2.

48 species of organisms included in 13 systematic groups were recorded in the benthos of the river (Table 1). 8 species of organisms affect molluscs (*Lymnaea auricularia*, *Costatella acuta*, *Theodoxus danubialis*, *Th. transversalis*, *Th. fluviatilis*, *Anisus spirorbis*, *Gyraulus ehrenbergi*, *Valvata pulchella*), 6 species affect Odonata (*Coenagrion lendei*, *C. mercuriale*, *C. armatum*, *C. puella*, *C. scitulum*, *Ischnura elegans*) was related. Other groups were represented by 1-5 types (Table 2). *Oligochaeta*, *Hirudinea*, *Chironomidae*, and *Hemiptera* are observed mainly in the lower parts of the river. The water of the river flows slowly in this area. Other groups of mollusks, *Odonata*, Ephemeroptera, *Trichoptera* are found in stony-pebble biotopes in the upper parts of the river. Those groups are more adapted to this biotope because the water velocity is faster in the upper reaches of the river. *Theodoxus danubialis*, *Th. transversalis*, *Th. fluviatilis*, *Coenagrion lindenii*, *Lype reducta*, and *Hydropsyche ornatula* differ according to the intensity of occurrence of the species. The biomass of benthic organisms in the river was 0.82 g/m², and the number was 232 ind./m². The biomass of benthic organisms in groups varied from 0.04 to 0.218 g/m², and their number was from 8 to 58 ind./m². The maximum biomass and number of mollusks (58 ind./m²; 0.18 g/m²), and the minimum development (8 ind./m²; 0.04 g/m²) are observed in *Ephemeroptera* (Table 3). The quantitative development of organisms in the rivers varied according to seasons. So, the maximum development occurs in the summer season. Growth is slow in spring and autumn. Because there are rains in these seasons, rivers and floodwaters flow.

Garachay originates from the confluence of springs that originate from the northeastern slope of the Greater Caucasus, Gojadarabashi, and Babadag mountains. Its source is at an altitude of 2900 m, and its outlet is at the place where it flows into the Caspian Sea. Its length is 78 km. This river is a torrential river, the average perennial duration is up to 140 days. It should be noted that in the rivers flowing from the northeastern slope of the Greater Caucasus, due to the geological regime of the basin, the chemical composition of the water is dominated by calcium cations, and the total amount of ions is up to 446 g/l in the peak period, and 407 mg/l in the intermediate period. The quality of the water is great. River water is widely used for irrigation [1]. The soil of the river is mainly stone, stone-gravel, gravel-sand, sandy-silt, etc., biotopes replace each other. During the research period, the water temperature varied between 13.2 - 21.4 °C, pH 7.2 - 7.4, and the oxygen regime 8.4 - 8.6 mg/l, depending on the seasons.

53 species included in 14 systematic groups were found in the river (Table 2). Of the detected organisms, 7 species belong to molluscs (*Lymnaea auricularia*, *Theodoxus danubialis*, *Th. transversalis*, *Th. fluviatilis*, *Anisus spirorbis*, *Gyraulus ehrenbergi*, *Valvata pulchella*), 8 species to Ephemeropteras (*Siphonurus linnaeanus*, *S. lacustris*, *Cloen dipterum*, *Centroptilum luteolum*, *Baetis tricolor*, *Ephemerella ignita*, *Ephemera vulgata*, *Paraleptohlebia submarginata*). The remaining groups were represented by 1-6 species. Since most of the soil of the river is gravel-stone, mollusks (7 species), *Ephemeroptera* larvae (8 species), *Odonata* (7 species), *Hemiptera* and *Trichoptera* (each with 6 species) dominated here (Table 2). Since silt-sand, gravel-sand biotope prevails in the lower parts of the river, *Oligochaeta* and chironomid larvae are more common here. *Theodoxus danubialis*, *Th. transversalis*, *Sympetrum danae*, *Siphonurus lacustris*, *Cloen dipterum*, *Baetis tricolor*, *Notonecta lutea*, *Corixa punctata*, *Lype reducta*, *Polycentropus flavomaculatus*, *Hydropsyche ornatula*, etc. are dominate.

Table 3. Number dynamics and biomass of macrozoobenthos of rivers of Northeastern Azerbaijan (ind. g/m²) (2020 - 2023).

Groups	Rivers								
	Yalama rivers	Gusarchay	Gudyalchay	Aghchay	Garachay	Velvelechay	Shabbranchay	Atachay	Devechichay
Oligochaeta	$\frac{18}{0.06}$	$\frac{15}{0.06}$	$\frac{22}{0.08}$	$\frac{20}{0.08}$	-	$\frac{10}{0.02}$	-	-	$\frac{20}{0.08}$
Hirudinea	-	-	-	-	-	-	-	-	-
Mollusca	$\frac{75}{0.24}$	$\frac{90}{0.28}$	$\frac{110}{0.36}$	$\frac{58}{0.18}$	$\frac{56}{0.20}$	$\frac{26}{0.12}$	$\frac{40}{0.16}$	$\frac{24}{0.08}$	$\frac{62}{0.18}$
Decapoda	-	-	-	-	-	-	-	-	-
Mysidacea	-	-	-	-	$\frac{6}{0.02}$	-	$\frac{8}{0.03}$	-	-
Hydrocarina	-	-	-	-	$\frac{10}{0.02}$	-	-	-	-
Odonata	$\frac{20}{0.08}$	$\frac{32}{0.09}$	$\frac{10}{0.03}$	$\frac{16}{0.06}$	$\frac{22}{0.09}$	-	-	-	$\frac{18}{0.05}$
Ephemeroptera	$\frac{20}{0.09}$	$\frac{48}{0.10}$	$\frac{46}{0.14}$	$\frac{8}{0.04}$	-	$\frac{32}{0.12}$	$\frac{24}{0.10}$	$\frac{18}{0.06}$	$\frac{38}{0.12}$
Hemiptera	$\frac{12}{0.08}$	-	-	$\frac{30}{0.12}$	$\frac{18}{0.10}$	-	-	-	-
Trichoptera	$\frac{58}{0.18}$	$\frac{76}{0.24}$	$\frac{48}{0.12}$	$\frac{44}{0.18}$	$\frac{46}{0.18}$	$\frac{62}{0.19}$	$\frac{39}{0.10}$	$\frac{32}{0.09}$	$\frac{40}{0.11}$
Coleoptera	-	-	$\frac{12}{0.06}$	-	-	-	$\frac{14}{0.04}$	$\frac{10}{0.03}$	-
Diptera	$\frac{24}{0.09}$	$\frac{32}{0.10}$	$\frac{22}{0.06}$	$\frac{34}{0.12}$	$\frac{38}{0.12}$	$\frac{34}{0.12}$	$\frac{22}{0.08}$	$\frac{20}{0.08}$	$\frac{22}{0.04}$
Chironomidae	$\frac{10}{0.02}$	-	-	$\frac{22}{0.04}$	$\frac{26}{0.08}$	-	$\frac{15}{0.07}$	-	-
Total:	$\frac{237}{0.84}$	$\frac{293}{0.87}$	$\frac{270}{0.77}$	$\frac{232}{0.82}$	$\frac{222}{0.81}$	$\frac{164}{0.57}$	$\frac{162}{0.58}$	$\frac{104}{0.34}$	$\frac{200}{0.58}$

The biomass of benthic organisms in the river was 0.81 g/m², and the number was 222 ind./m². Due to its quantitative development, mollusks prevail (56 ind./m²; 0.20 g/m²). The biomass of benthic organisms varied from 0.02 to 0.20 g/m², and the number varied from 6 to 56 ind./m². Minimal development is observed in myzids (6 ind./m²; 0.02 g/m²) (Table 3).

Valvalachay originates from the north-eastern slope of the Greater Caucasus and is formed by the confluence of Babachay and Cemichay. Its source is in Babadag at an altitude of 2920 m. The length of the river is 98 km, it flows through the territory of Gonaqkend, Guba, Devechi, and Khachmaz. Below the Khachmaz railway, the river divides into 2 branches (right – Valvalachay, left – Chamlar), which flow freely into the Caspian Sea. The degree of mineralization ranges from 450 to 550 mg/l. Water resources of the river are widely

used in irrigation [1]. The grave-sand biotope is dominant in the river. During the research period, the water temperature varied from 13.7 to 21.4 °C, oxygen regime from 8.3 to 8.5 mg/l, and pH from 7.3 to 7.4.

29 species of benthic organisms included in 8 systematic groups were recorded from the river (Table 1). Among the discovered organisms, 5 species belong to mollusks, 6 species to *Odonata*, and 5 species to *Trichoptera*. The remaining groups are represented by 2-4 species (Table 1). *Theodoxus danubialis*, *Th.transversalis*, *Th.fluviatilis*, *Agrion virgo*, *Coenagrion lindeni*, *E.puella*, *Lype reducta*, *Hydropsyche ornatula*, *Cheumatopsyche lepida* are distinguished according to the intensity of species occurrence (Table 2).

The biomass of benthic organisms in the river was 0.57 g/m², and the number was 164 ind./m². The biomass of benthic organisms by groups was 0.02-0.19 g/m², and the number was 10-62 ind./m². The maximum development was recorded in the *Trichoptera* (62 ind./m², 0.19 g/m²) (Table 3).

Shabbranchay is formed by the confluence of springs flowing from the eastern slope of Klit mountain, the side ridge of the northern-eastern slope of the Greater Caucasus. One of them is considered the main source and is 1680 m high. This river flows 4 km north-east of the village of Sarvan in the port of Devechi (into Agzibirchala lake). The length of the river is 53 km, the area of its basin is 203 km². Its water is hydrocarbonate-calcium and the degree of mineralization exceeds 500 mg/l [1]. The soil of the river is mainly stone-gravel, gravel-sand, sand-silt, etc. biotopes replace each other. During the research period, the water temperature varied between 13.4 - 21.2 °C, pH 7.2 - 7.4, the oxygen regime 8.1 - 8.4, depending on the seasons.

28 species of benthic organisms included in 8 systematic groups were recorded from the river (Table 1). Of the detected organisms, 4 species belong to mollusks (*Theodoxus danubialis*, *Th.transversalis*, *Th.fluviatilis*, *Valvata pulchella*), 6 species to *Trichoptera* (*Lype reducta*, *Cheumatopsyche lepida*, *Rhyacophile* sp., *Hydroptila* sp., *Polycentropus flavomaculatus*, *Hydropsyche ornatula*), 5 species to *Hemiptera*. (*Notonecta lutea*, *Velia rivulorum*, *Sigara falleni*, *Corixa punctata*, *Nepa cinerea*). The remaining groups are represented by 2-4 species (Table 2). According to the frequency of occurrence of species, *Th.danubialis*, *Th.transversalis*, *Lype reducta*, *Cheumatopsyche lepida*, *Hydropsyche ornatula*, etc. are dominated. At the mouth of the river, more aquatic insects are found.

Biomass of benthic organisms in the river ranges from 0.03 to 0.16 g/m², and their number varies from 8 to 40 ind./m². The average annual biomass in the river was 0.58 g/m², and the number was 162 ind./m². The maximum development of organisms is observed in mollusks (40 ind./m²; 0.16 g/m²) (Table 3).

Gilchay takes its source from a height of 1980 m in the north-east of Gulum-Dostu (27131 m) mountain on the north-eastern slope of the Greater Caucasus and flows into the Caspian Sea. The length of the river is 72 km, the area of its basin is 800 km². Sodium sulfate dominates the chemical composition of water. The degree of mineralization reaches 920 mg/l. Its water is mainly used for irrigation [1].

12 species of benthic organisms included in 5 systematic groups were recorded from the river. Among the detected organisms, 2 species belong to mollusks (*Lymnaea auricularia*, *Costatella acuta*), 3 species to *Odonata* (*Coenagrion lindeni*, *C. armatum*, *Ischnura elegans*), 2 species to *Ephemeroptera* (*Cloen dipterum*, *Baetis tricolor*), 1 specie to *Hemiptera* (*Nepa cinerea*), and 4 species belong to the *Trichoptera* (*Lype reducta*, *Cheumatopsyche lepida*, *Polycentropus flavomaculatus*, *Hydropsyche ornatula*) (Table 2). Most of the discovered organisms are mollusks observed in gravel-stone biotope.

Devechichay originates from the confluence of the Zahlinchay and Piribadil rivers, which flow from the Ketandan range, which is the main part of the side range of the Greater Caucasus. The length of the river is 45 km, the area of its basin is 239 km². Devechichay flows through the territory of Devechi district and flows into Devechi port. The soil of the

river is composed of stones, pebbles, pebbles, sand, and silt-sand in the areas near the mouth of the river. The water temperature during the research period is 11.6 - 18.4 °C. The pH changed from 7.1 to 7.2, oxygen regime from 8.1 to 8.4 mg/l.

During the observations, 32 benthic organisms included in 10 systematic groups were found in the river (Table 1). 6 species belong to Hemiptera (*Velia rivulorum*, *Corixa punctata*, *Nepa cinerea*, *Hydrometra stagnorum*, *Gerris costai*), 5 species to mollusks (*Lymnaea auricularia*, *Costatella acuta*, *Theodoxus danubialis*, *Th. transversalis*, *Th. fluviatilis*), 5 species to Odonata (*Agrion virgo*, *Coenagrion lindeni*, *C.mercuriale*, *C.puella*, *C.scitulum*). Other groups were represented by 1-4 species. *Th.danubialis*, *Th.transversalis*, *Coenagrion lindeni*, *C.mercuriale*, *Nepa cineria*, *Velia rivulorum* differ according to the intensity of occurrence of the species (Table 2).

The average annual biomass of benthic organisms was 0.58 g/m², and the number was 200 ind./m². The number of organisms in groups varied from 18 to 62 ind./m², and their biomass varied from 0.04 to 0.18 g/m². Maximum development is observed in mollusks (62 ind./m²; 0.18 g/m²) (Table 3). It should be noted that the water of the river is clean in its upper reaches, belongs to the type of hydrocarbonate-calcium water and the degree of mineralization varies from 435 to 640 mg/l. Downstream, the water of the river is very dirty due to sewage.

Atachay starts from the north-eastern slope of the Greater Caucasus and originates from the confluence of Muntyanka River and Vardakhchay (Aghchay). The length of the river is 45 km, the area of its basin is 347 km². Its water is sulfate-sodium and the degree of mineralization is 900-1300 mg/l. The soil of the river consists mainly of pebble stones.

During the observations, 16 species of organisms included in 6 systematic groups were found in the river. Of the organisms, 4 species are mollusks (*Costatella acuta*, *Anisus spirorbis*, *Gyraulis ehrenbergi*, *Valvata pulchella*), 4 species are Ephemeroptera (*Cloen dipterum*, *Centroptilum luteolum*, *Baetis tricolor*, *Ephemerella vulgata*), 3 species are Hemiptera (*Velia rivulorum*, *Sigara falleni*, *Corixa punctata*), 2 species belong to the Trichoptera (*Lype reducta*, *Hydropsyche ornatula*), and 1 species belongs to the heliids (*Bezzia* sp.). *Costatella acuta*, *Anisus spirorbis*, *Baetis tricolor*, *Velia rivulorum* are dominant according to the intensity of species occurrence (Table 1).

The quantitative development of benthic organisms varied. So, the average annual number was 104 ind./m², and the biomass was 0.34 g/m². According to the number dynamics, mollusks were 24 ind./m², and according to their biomass, molluscs were 0.08 g/m². Biomass of benthic organisms by groups varied from 0.03 to 0.09 g/m², and their number from 10 to 32 ind./m² (Table 2). The maximum development of organisms in the river is observed in the summer season, and the minimum development is observed in the spring and autumn seasons.

3 Conclusion

Fifty-three species of benthic organisms, belonging to 14 taxonomic groups, were recorded from the rivers of northeastern Azerbaijan. The number of species varied across the rivers, ranging from 12 to 53 species. In the Yalama River system, the species count fluctuated between 20 and 41 species.

The quantitative distribution of macrobenthic organisms in the water bodies also showed variation. The average annual biomass of benthic organisms in the Yalama rivers was 0.84 g/m², with an average density of 237 individuals per m². In other rivers, the biomass ranged from 0.34 to 0.87 g/m², and the number of individuals ranged from 104 to 293 per m².

The number of species per group in the rivers ranged from 1 to 12, with the Yalama rivers hosting between 1 and 5 species per group, while other rivers had between 2 and 8 species per group. The majority of species identified were aquatic insects, including representatives

from the orders Hydrocarina, Odonata, Ephemeroptera, Hemiptera, Trichoptera, Coleoptera, and Diptera.

Previous studies reported 24 species of benthic organisms in the Yalama rivers, but in our research, we recorded 35 species, including those in the Velmirchay. However, some species previously recorded were not encountered in subsequent surveys

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