Journal of Life Sciences & Biomedicine, vol. 4(77), No 2, p. 80-86 (2022)

Assessment of biological monitoring of Okhchuchay and Basitchay and saprobility of algoflora

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Received: November 10, 2022; Received in revised form: November 30, 2022; Accepted: December 5, 2022

In this paper the information about the biological monitoring carried out in Okhchuchay and Basitchay located in the Zangilan region, and algoflora saprophy of these rivers were reflected. As a result of the research, it was determined that species belonging to the oligosaprobic, mesosaprobic and polysaprobic zones are more often observed among the mass samples. The upper reaches of Okhchuchay and Basitchay are considered to be the most polluted zone, where the common species are called polysaprobic species. The aim of the work is a comprehensive study of the ecological condition of river basins subject to high anthropogenic influences, assessment of saprobity and protection of the water body as a unique biosystem.

Keywords: *Okhchuchay, Basitchay, saprob, phytoplankton, algoflora*

INTRODUCTION

Zangilan district - an administrative-territorial unit in the Republic of Azerbaijan, is located in the southeast of the Lesser Caucasus mountain range, on the left bank of the Araz river. Okhchuchay starts from the Kapichik ridge of the Zangezur range, cuts from the west to the east of the ancient Zangezur territory and flows into the Araz river at an absolute height of 300 m in the territory of Azerbaijan. The main part of the river basin is formed in the remaining part of Zangezur in the territory of Armenia (Budagov and Mikayilov, 1996).

Rivers located in the Zangilan region are severely polluted as a result of sewage discharged from factories located in the territory of Armenia. Okhchuchay and Basitchay belong to the affected rivers (Budagov and Mikayilov, 1996). Okhchuchay, which is excessively polluted by the wastes of Gafan and Gajaran mountain-mining industry, actually plays the role of a collector that removes industrial wastes from this region of Armenia. The length of the river is 85 km, 40 km of the river passes through the territory of Armenia, and the last 43 km through the territory of Azerbaijan. The area of the river basin is 1140 km². The water of the river is so poisoned that there is very little diversity of living things. Toxic waste and sewage generated in the copper-molybdenum and ore processing plants operated in that area are discharged directly into the Okhchuchay river without treatment. Life in the river is almost extinct now. There is exactly ecological disaster and terror in the river. As a result of the Okhchuchay flowing into the Araz river, the degree of pollution of the river is increasing day by day.

Basitchay is one of the polluted rivers flowing through the Zangilan region. Starting from the Bartaz plateau, it connects the Kikhovuz, Kukrataz, Sobusu rivers along its course. Being the left tributary of the Araz River, it takes its source from the territory of Armenia. The length of the river covers 44 km, of which 17 km passes through the territory of Azerbaijan. The area of the river basin is 354 km² (156 km² falls on the territory of Azerbaijan). The river is polluted by waste from pig farms in mountain villages of Armenia.

https://doi.org/10.29228/jlsb.1
Available online 30 December 2022

Depending on the degree of river pollution, the study of the species that make up the saprob system of water bodies is of great importance. The saprobity system of water bodies was developed by German researchers Kolkwitz and Marsson in 1908-1909. According to Czechoslovak hydrobiologist Sladeček, saprobity is the biological condition of a water body determined by the density of organic matter and the intensity of its decomposition process. In the saprob system, the following zones, which differ according to the degree of water pollution, are defined: 1. Katarob (k); 2. Xenosaprobe (x); 3. Oligosaprobe (o); 4. α-Mesosaprobe; 5. β-mesosaprobe; 6. Polysaprobe (p); 7. Isosaprobe (i); 8. Metasaprobe (m); 9. Hypersaprobe (h); 10. Ultrasaprobe (u); 11. Antisaprobe (a); 12. Radiosaprobe (r); 13. α-Cryptosaprobe zone (c).

Catarobic and xenosaprobic zones are characterized by very clean water mass.

The oligosaprobic zone is considered a completely clean zone of water bodies. Water is usually saturated with oxygen. According to the chemical indicators of water, it differs little from catarobic and xenosaprobic basins, but traces of human activity are found. Thus, the amount of saprophytic organisms is high in this type of basins (zones). Phytoplankton is dominated by diatom algae. This zone is characterized by species diversity of algae. However, their number and biomass are small. From diatom algae - *Cyclotella comta* (Ehr.) Kuetz., *Diatoma vilgare* Bory., *Fragilaria bicapitata* A. Mayer., *Neidium productum* (W. Sm.) Cl., *Cymbella affinis* Kuetz., from green algae - *Ulotrix aequalis* Kuetz., *Closterium navicula* (Breb). Liitkom., *Hyalotheca dissilins* (Smith.) Breb. is characteristic of this zone (Alimjanova, 1991).

In the mesosaprobic zone, the degree of water pollution is relatively small, proteins are completely dissolved, hydrogen sulfide and carbon dioxide are in small amounts. The mesosaprobe zone, in turn, is divided into α and β -Mesosaprobe zones. β-Mesosaprobic zone has water contaminated with high amount of organic matter. Complete mineralization of organic matter occurs in this zone. The fauna of the mesosaprobic zone is characterized by high species diversity (Barinova et.al., 2006). The main groups of organisms in this zone are various algae. The α-Mesosaprobic zone is considered to be a zone where chemical processes are intense and highly polluted with organic substances. A number of blue-green algae are found here. α - Mesosaprobic zone is usually polluted with waste water. Organic compounds are dissolved under aerobic conditions, mainly by bacteria. Species attributed to α-Mesosapropic algae are: *Oscillatoria chalybea* (Mert.) Gom., *Phormidium uncinatum* (Ag.) Gom., blue-green algae, *Cyclotella meneghiniana* Kuetz., *Stephanodiscus hantzschii* Grun., *Synedra tabulata* (Ag.) Kuetz diatoms, *Enteromorpha intestinalis* (L.) Link is a species of green algae (Alimjanova, 2008). The β -Mesosaprobic zone contains many species of algae, but their number and biomass are much lower than in the α-Mesosaprobic zone. Blue-green algae are not found in this zone. From diatom algae – *Melosira varians* Ag., *Cyclotella kuetzingiana* Thw., *Fragilaria construens var.binodis* (Ehr.) Grun., *Navicula cincta* (Ehr.) Kuetz., *Gyrosigma acuminatum* (Kuetz). Raben., *Cymbella aspera* (Ehr.)., *C. cistula* (Hemp.) Grun., *C. prostrate* (Berk.)., *Gomphonema constrictum* Ehr., *Nitzschia communis* Rabenh., *Surirella angustata* Kuetz.; (Zabelina, Kisleyov, 1951) from eugenic algae *Trachelomonas oblanga* Lemm., *Phacus parvulus* Klebs.; from green algae - *Scendesmus bijugatus* (Turp.) Kuetz., *Ulotrix tenerrima* Kuetz., *Cladophora glomerata* (L.) Kuetz., *C. fracta* Kuetz., *Closterium parvulum* Naeg. species are found (Yuldasheva, 2018).

The polysaprobic zone has water contaminated with excessive organic and mineral matter. As a result of anaerobic decomposition of organic substances in this zone, a large amount of various substances and gases (ammonia gas, hydrogen sulfide, sometimes methane gas, etc.) accumulate in the water. Algal species found in this area are very few and their biomass is very high (Canter et al., 1951).

The isosaprobic zone is generally characterized by having highly organically contaminated water. An example of isosaprobity is fresh domestic water (waste).

The metasaprobic zone is characterized by stronger contamination with organic matter. In addition, toxic substances are also found in the waters of this zone. These substances enter through waste water.

The hypersaprobic zone is characterized by having water saturated with highly organic substances. In this zone, the decomposition of organic matter takes place under anaerobic conditions, and the water is mainly polluted by industrial waste.

The ultrasaprobic zone is known as the "dead" zone. There are no active living organisms here. However, algae spores are found in this zone.

The antisaprobic zone is found in industrial waste. This zone is considered a dead zone.

The radiosaprobe zone is contaminated with dangerous radioactive substances.

These substances accumulate in body of living beings and are transferred to other organisms through the food chain (Sladechek, 1973).

The cryptosaprobic zone is characterized by unfavorable physical conditions. In this zone - the environment (water) has excessively high or low-temperature conditions (Aghamaliyev, 2010).

MATERIALS AND METHODS

Material: Algological samples for the study were taken from the Zangilan district, located in the southeast of the Lesser Caucasus mountain range. These studies cover the months of May, July, and October 2022. In May, research was carried out only in Okhchuchay, and in July and October, both in Okhchuchay and Basitchay. Six sampling points were predetermined and samples were collected from those points. The samples were taken from Burunlu village on the upper stream of Okhchuchay, Tagly village on the middle stream, Jahangirbarli village on the downstream, Baharli village on the lower stream of Basitchay, Ordekli village on the middle stream of Basitchay, Rezere reserve on the upper stream of Basitchay. The biological analyzes were carried out on the samples taken from all 6places. In total, 13 samples were collected and 15 species were determined.

Methodology: A plankton glass and a plankton net were used to collect samples in the studied rivers, then phytoplanktons were collected by passing the water through a filter made of gas material No. 25 and No. 77, stored in hermetic glass containers, then the materials were labeled and the GPS coordinates of the collection sites were taken (Aghamaliyev, 2010; Schwoerbel, 2013). In addition to collecting the material, the water temperature is measured with a laboratory mercury thermometer, and the active reaction of the environment (pH) is measured with a universal indicator device. The process of collecting, recording and preparing the material that was taken for the study was carried out according to the generally accepted methodology (Gollerbach and Polyanskiy, 1951). For the further and detailed study of the materials, 40% formalin was added. For working in an electron microscope, the method described by G.Hasle and G.Fryxell (1970), which relatively preserves the thin structure of the upper crust, was used. The map-scheme of the research area was prepared with ArcGIS 10.7 version (Fig.1).

Electron microscopic examination (SEM) of diatoms was performed using a scanning electron microscope. A JSM-35 SEM produced by the Japanese company JEOL was used. The study of blue-green and green algae was carried out using a Nikon E 100 optical microscope. When specifying the names of algae species, the latest nomenclature was referred to using the "Algae Base" "California Academy" and "Alga Terra" websites [www.algaebase.org; www.algaterra.org; www.calacademy.org].

RESULTS AND DISCUSSION

Algal flora was studied in Okhchuchay and Basitchay rivers, which were affected by anthropogenic influence. Due to the loss of species inhabiting, the tendency of species diversity of leading flora groups to decrease, and the development of saprobic species in the waters subject to increasing pollution was simultaneously revealed. Plankton and macrophytobenthos were studied in these rivers. It has been shown that changes in the species diversity of algae occurred with the change in the mode of discharge of sewage into the rivers. The data obtained in Okhchuchay and Basitchay rivers are considered a good indicator for monitoring. The analysis of species composition of algae in the monitoring carried out in the rivers located in the Zangilan

region showed that these algae have adapted to the high degree of pollution of water bodies.

14 species have been identified in these rivers. 8 species from the *Bacillariophyta* division- *Navicula cryptotenella* Lange-Bertw., *Frustulia vulgaris* (Thwaites) De Toni., *Synedra ulna* (Nitzsch) Ehrenberg., *Pinnularia viridis* (Nitz.) Ehrenb., *Cymbella amphicephala* Näegeli ex Kützing., *Nitzschia linearis* W.Smith., *Caloneis silicula* (Ehrenberg) Cleve., are species of *Navicula schoenfeldii* Hustedt (Jafarova, Mukhtarova 2018) 3 species from the *Charophyta* division - *Spirogyra crassa* (Kützing) Kützing., *Spirogyra porticalis* (O.F. Müller) Dumortier., *Spirogyra condensata* (Vaucher) Dumortier., 1 specie from the *Chlorophyta* division - *Cladophora glomerata* (Linnaeus) Kützing.. 2 species from the *Cyanoprokaryota* division - *Oscillatoria margaritifera* Kütz ex Gomont., *Oscillatoria limosa* Agardh ex Gomont - were identified. These species were photographed using SEM and light microscope (Figure 2).

Algae species are found in oligosaprobe, mesosaprobe, and polysaprobe zones. *Spirogyra condensata* (Vaucher) Dumortier. from the upper stream of Okhchuchay, *Synedra ulna* (Nitzsch) Ehrenberg. from the middle stream, *Navicula cryptotenella* Lange-Bertw., *Frustulia vulgaris* (Thwaites) De Toni., *Spirogyra crassa* (Kützing) Kützing., *Oscillatoria limosa* Agardh ex Gomont., from the lower stream *Caloneis silicula* (Ehrenberg) Cleve., Kützing species are identified. The upper stream of Okhchuchay is considered to be the most polluted place, this part starting from the territory of Armenia is a polysaprobic zone, its middle stream is a mesosaprobic upper stream, and it is considered an oligosaprobic zone.

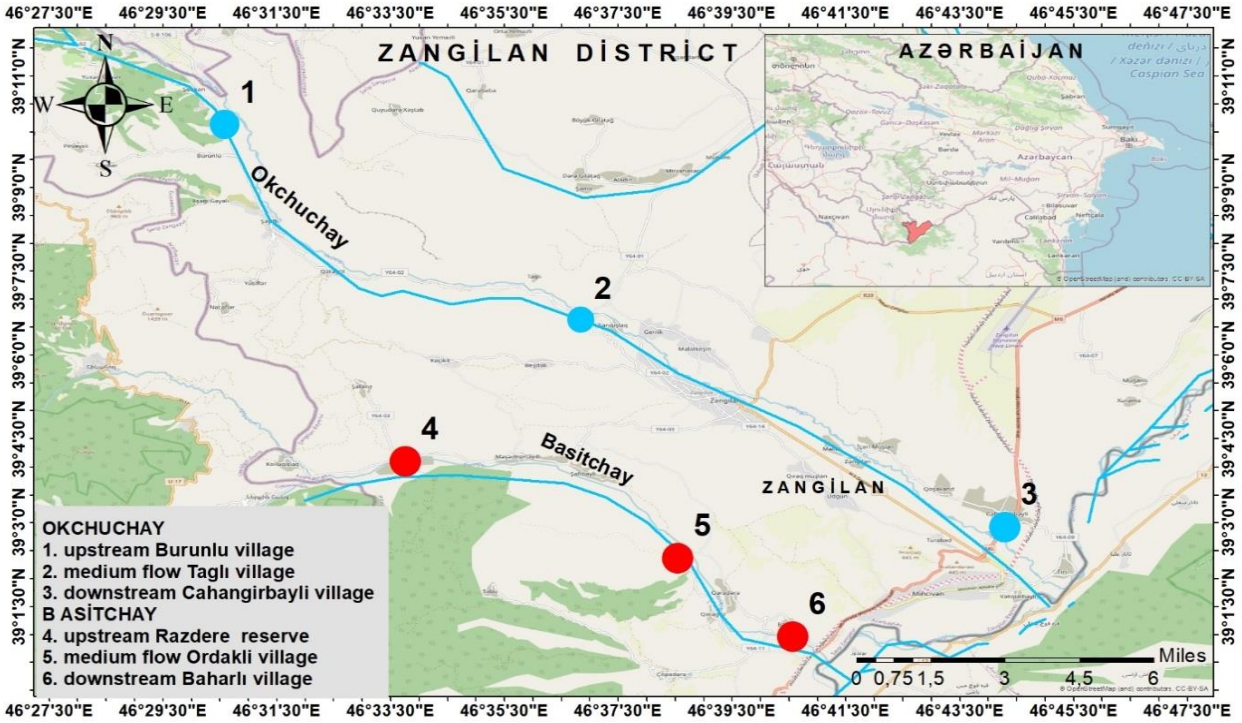

Fig. 1. Topographic map of the Zangilan district with the designation of rivers

Table. Environmental pH, temperature and dates of collection

Rivers	**16.05-20.05.2022**		**18.07-20.07. 2022**		**26.10-28.10.2022**	
	pH	temperature (ºC)	pH	temperature (ºC)	pH	temperature (ºC)
Okhchuchay						
upper stream Burunlu village	7.2	8.0	7.9	21	7.95	16.0
middle stream Tagli village	7.3	15.0	8	19	7.8	16.2

lower stream Cahangirbayli village	7.9	15.0	8.24	23	7.76	18.6
Basitchay						
upper stream Razdere reserve	-	-	-	-	8.32	15.0
middle stream Ordakli village	-			-	7.93	16.8
lower stream Baharli village	-	-	8.22	25	7.89	18.5

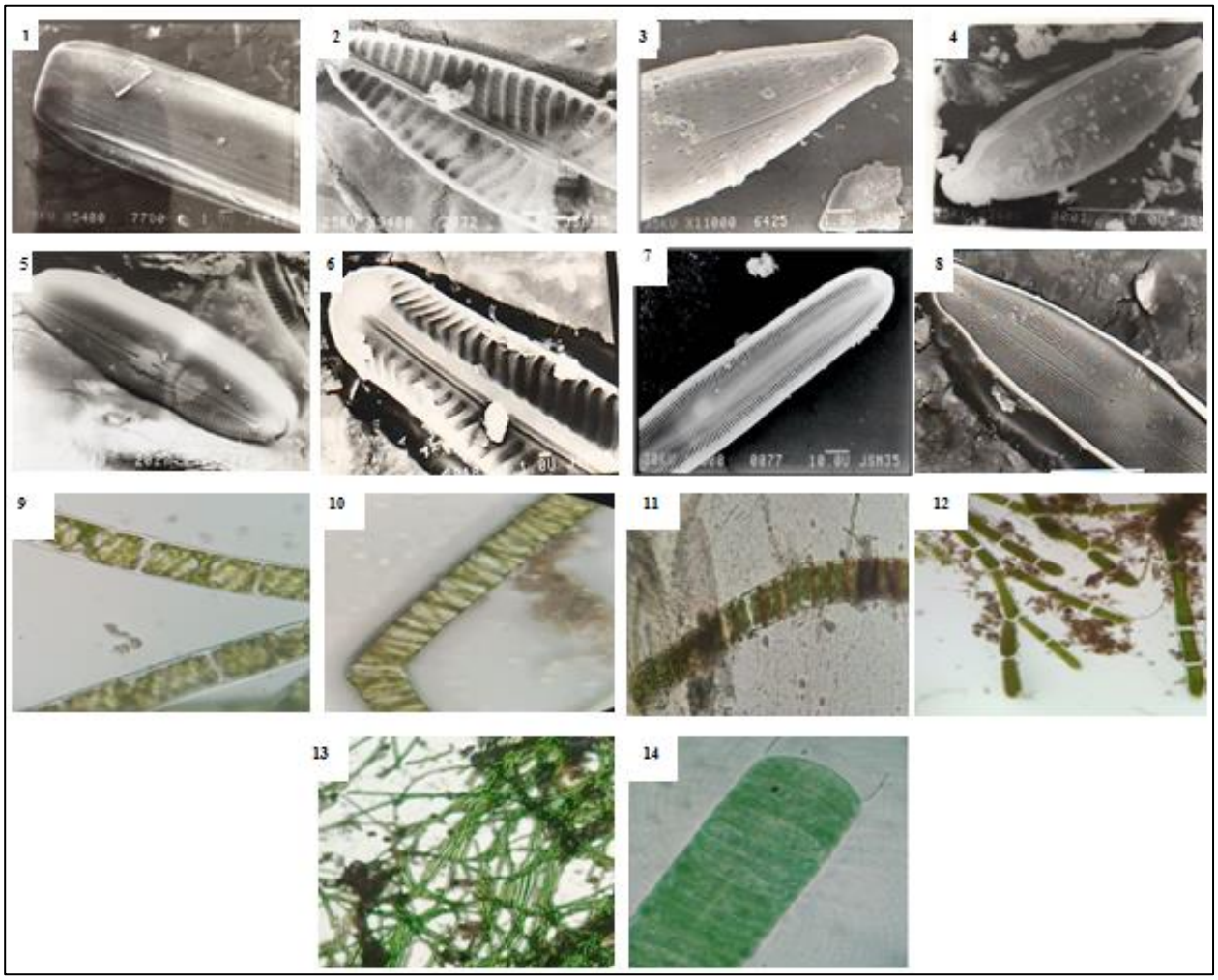

Fig. 2. View of species under the scan electron microscope (SEM) and light microscope:
1. *Nitzschia linearis* W.Smith., 2. *Navicula schoenfeldii* Hustedt., 3. *Navicula cryptotenella* Lange-Bertw.,
4. *Cymbella amphicephala* Näegeli ex Kützing., 5. *Caloneis silicula* (Ehrenberg) Cleve., 6. *Frustulia vulgaris* (Thwaites) De Toni., 7. *Pinnularia viridis* (Nitz.) Ehrenb., 8. *Synedra ulna* (Nitzsch) Ehrenberg., 9. *Spirogyra porticalis* (O.F.Müller) Dumortier., 10. *Spirogyra condensata* (Vaucher) Dumortier., 11. *Spirogyra crassa* (Kützing) Kützing., 12. *Cladophora glomerata* (Linnaeus) Kützing., 13. *Oscillatoria limosa* Agardh ex Gomont.,
14. *Oscillatoria margaritifera* Kütz ex Gomont

Spirogyra condensata (Vaucher) Dumortier. from the upper stream of Basitchay, *Navicula schoenfeldii* Hustedt. from the middle stream, *Cymbella amphicephala* Näegeli ex Kützing., *Oscillatoria margaritifera* Kütz ex Gomont., *Spirogyra porticalis* (O.F.Müller) Dumortier., *Cladophora glomerata* (Linnaeus) Kützing., and from the lower stream *Nitzschia linearis* W.Smith., *Pinnularia viridis* (Nitz.) Ehrenb. types were determined. The upper stream of Basitchay

is considered to be the most polluted area, this is the polysaprobic zone, the middle stream is considered to be mesosaprobic, and the lower stream is considered to be oligosaprobic.

As a result, it was determined that in May, the species diversity and quantity of algae decreased compared to other months. Also, after the liberation of the Zangilan region, a noticeable increase in the diversity and number dynamics of algoflora is observed. During the study of the samples, the pH and temperature indicators of the environment and the dates of the collection were recorded (Table).

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Oxçuçay və Bəsitçayın bioloji monitorinqinin qiymətləndirilməsi və alqofloranın saprobluğu

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Məqalədə Zəngilan rayonunda yerləşən Oxçuçay və Bəsitçayla bağlı aparılan bioloji monitorinqlər və alqofloranın saprobluğu haqqında məlumatlar öz əksini tapmışdır. Tədqiqat nəticəsində müəyyən olunmuşdur ki, kütləvi nümunələr arasında oliqosaprob,mezosaprob və polisaprob zonaya aid növlər daha çox müşahidə edilir.Oxçuçay və Bəsitçayın yuxarı axını ən çox çirklənmiş zona hesab olunur, burada yayılmış növlər polisaprob növlər adlanır. İşin məqsədi yüksək antropogen təsirlərə məruz qalan çay hövzələrinin ekoloji vəziyyətinin hərtərəfli öyrənilməsi saprobluğun qiymətləndirilməsi və su obyektinin unikal biosistem kimi qorunmasıdır.

***Açar sözlər**: Oxçuçay, Bəsitçay, saprob, fitoplanktonun, alqoflora*

Оценка биологического мониторинга и сапробности альгофлоры Охчучая и Беситчая

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В статье даны сведения о проведении мониторингов рек Охчучая и Баситчая, расположенных в Зангиланском районе, а также о сапробности альгофлоры этих рек. В результате выявлено, что среди исследованных образцов проб олигосапробные, мезосапробные и полисапробные виды встречаются довольно часто. Вследствие сильного загрязнения верхних течений Охчучая и Баситчая, распространенные здесь виды являются полисапробными. Цель работы - всестороннее экологическое изучение состояния бассейна рек, подвергшихся антропогенному воздействию, оценка сапробности и охрана водных объектов, как уникальных биосистем.

Ключевые слова: *Охчучай, Баситчай, сапробность, фитопланктон, альгофлора.*