The primary crop of phytoplankton and total organic matter destruction in Varvara reservoir, one of the main reservoirs of Azerbaijan

Abstract

The role of phytoplankton in regulating the flow of physico-chemical processes in ecosystems, including hydrobionts, which is involved in the formation of biological products, the circulation of substances in the life of reservoirs, the creation of their energy source, is very large. Fhytoplankton ecosystems are very sensitive to abiotic factors and anthropogenic influences to many physical, chemical and biological factors present in the environment. Therefore, phytoplankton is considered the basis of trophic relationships in the hydroecosystem.

Keywords: anaerobiosis, saprophytes, coliform bacteria, saprobicity, biogenic elements.

Introduction

For the first time in Azerbaijan, microbiological, sanitary-hydrobiological and environmental studies have been conducted and completed in 10 main reservoirs of Azerbaijan in a planned manner.As a result of comprehensive monitoring studies, tropical types, the level of saprobity, physico-chemical characteristics and the current ecological state of waters were determined.

A joint study was carried out on the amount of the degraded substrate and the primary product of phytoplankton, which was considered the main balance of organic substances in reservoirs.

For the first time, systematic biological, ecological, and microbiological studies were conducted in reservoirs under different climatic conditions that differed from different ecosystems, in a comparative order. Biological fruitfulness, the level of self-purification of water, anthropogenic eutrophication and its ecological essence were studied for the first time. It was found out that reservoirs built on the Kura and Araza rivers are sharply polluted by Armenia and Georgia, and as a result, a large mass of organic substances of allochthonous origin and various pollutants accumulate in these reservoirs, due to which anthropogenic eutrophication occurs in the basins, the water becomes polysaprophic and autoeutrophic. Studies have proved that due to pollution over the years in reservoirs on the upper reaches of the Araz and Kura Rivers, stabilization and formation in the gas, salt, microbiological regime, physico-chemical parameters of water do not occur, oxygen consumption in the silt increases over the years, hypoxia and anaerobiosis occur. It is proved that in reservoirs that receive water enriched with biogenic elements and organic substances, phytoplankton develops to flowering levels and water is enriched with easily digested organic substances, metabolic and bacteiroplankton products, turns into unusable, acquires dangerous quality, On the basis of comparative studies, alternative reservoirs and reservoirs useful for use in everyday life have been identified regions. Active strains of splitting phenols and petroleum carbohydrogens from polyutants sharply negatively infusing on hydrobionts were obtained in the studied reservoirs.

Materials and methods

In 2012-2017, studies and observations were carried out in 10 main reservoirs created in different years and in different regions of Azerbaijan. These reservoirs are: Mingechaur reservoir, Shamkir reservoir, Yenikend reservoir, Varvarinsky reservoir, Akstafachay reservoir, Shamkirchay reservoir, Arpachay reservoir, Nakhichevan reservoir, Ekakhan reservoir, Ashygbayramlin reservoir. Sampling stations in each reservoir were selected in such a way as to cover all biotopes (drawings on maps are shown). The general development of hydrobionts, the formation of water mass, the ratio of the course of the circulation of substances with biotic-abiotic factors, the restoration of biological productivity, the state of self-purification in the hydroecosystem, the negative impact of anthropogenic factors on the physico-chemical, sanitary-hydrobiological, ecological state of water and all other problems are comprehensively, scientifically investigated by the seasons of the whole year, together with external factors.

Microbiological, hydrobiological and hydrochemical analyses of water and soil sludge were carried out with different instruments: samples related to microbiological studies - on sterile glassware, with a Yu.I.Sorokin bathometer, water for hydrobiological–hydrochemical analysis - were taken with a Knudsen bathometer, from the intended depth. Samples of silt-soil, depending on the depth of the reservoir, were obtained either with GOIN-a tubular devices. In all cases, a microbiological emulsion was prepared for sowing from the top layer of soil into different nutrient media. For this purpose, silt-soil was used in natural humidity with antimicrobial water with a different ratio – 1:1000, 1:10 000. In all seasons, microbiological studies of water samples were carried out no later than 1.5-2 hours. Sometimes thermos bags were used to keep the water temperature stable. The transparency of the water was measured by a white Secchi board, and the temperature was measured by a deep mercury thermometer.

We prepared a preparation using 3% formalin in 1 liter of water without sediment to determine the dominant species of phytoplankton growing in reservoirs at the "flowering" level. The main biogenic elements, some heavy metal salts in water, and other pollutants were determined by the Pflintes THM Digital apparatus, and oxygen in water was determined by the Milvaquke MWGOO device. The primary product of phytoplankton formed as a result of photosynthesis was calculated by the radioactive carbon isotope (C14) based on the modification of Yu.I.Sorokin. To do this, 3 samples taken from the same place at the same time and with the same instruments were determined: 1) Determination of the amount of the primary product synthesized by phytoplankton in the upper layer during the day; 2) Distribution of solar radiation by depth (light layer); 3) Used to determine the distribution of phytoplankton in depth. After the end of the trial period, all three samples are filtered and dried through filter No. 5 and counted on a Geiger counter. It is, according to the results of such experiments, it is possible to determine the amount of primary product per 1m2 in reservoirs. The main condition is the calculation of the amount of degraded organic matter in the reservoir to determine the balance and direction of biological productivity of the species by trophic type in the studied reservoirs. To do this, we used the method of G.G.Vinberg [2] . In both cases, strict care was taken to ensure that the temperature of the samples intended to determine the amount of the primary product and the amount of destructible organic substances destroyed corresponded to the temperature of the water in the pool during the 24–hour exposure. To obtain a representative sample of the results obtained, the analyses were repeated three times in all variants. Microbiological analyses, plantings, were carried out according to the methodology of V.I.Romanenko [8] , S.I.Kuznetsov [8] and A.G.Rodina [6] . The number of microbes in water and silty soil was calculated by passing through 10 ml of water-ground suspension through membrane filters No. 2-3. The number of saprophytic bacteria was calculated after 10-12 days by introducing into the medium with fish-peptone agar according to the method of S.N.Vinogradsky [8] . The number of spore-forming forms was calculated by thermal method, respectively 80 ° C. The development of bacteria belonging to the physiological group in the elective nutrient medium and the numerical composition were evaluated after 30 days. The production of bacteria that destroy phenols and petroleum hydrocarbons was carried out according to the Voroshilov-Dianov method. The determination of the destruction of organic substances in the silt in the reservoirs of Azerbaijan was carried out according to the method of V.I. Romanenko.

In order to comprehensively determine the role of the common microbiota in such phenomena as restoration of ecosystem stability, self-purification processes in reservoirs, microscopic migrants of micromycetes have been comprehensively studied.

In Azerbaijan, the temperature drop occurs in water areas with a depth of more than 13-15 meters. Therefore, water samples were taken from 0,5; 10; 15; 20; 30; 40 m layers [13,14,16] . The volume of microbiological, hydrobiological, hydrochemical changes, stations and points allocated for the resumption of observations in the reservoirs where the research is conducted is given in Table 1.

Table 1: observations in the reservoirs

Types of research	Observation post	Test – example –	Analysis
Water transparency	180	–	180
Water temperature	176	–	350
The amount of oxygen in the water	370	190	180
Biodestruction of common organic substances	196	360	730
The primary product of phytoplankton	210	420	680
The amount of microbiota in the water	130	160	320
The amount of microbiota in the silt-soil	52	180	160
The number of saprophytic bacteria in the water	580	265	1370
The number of saprophytic bacteria in the silt-soil	66	66	130
The number of coliform bacteria in the water	180	180	310
The number of bacteria of the physiological group in the water-silt soil	66	66	580
Total	2296	1897	5310

Thus, it can be seen that over the years of research, 1897 water or soil samples were collected at 2296 stations, for which 5310 analyses were carried out.
All the results obtained were processed statistically [12,13,14,16,18].

Results and discussion

In the Varvarinsky reservoir, the destruction process proceeds relatively "calmly, a decrease is observed only in the winter months, although in other seasons environmental factors are different, the destruction of organic substances is at a high level (Table 2).

Table 2 Seasonal changes in the destruction of organic matter in the water of the Varvarinsky reservoir in 2015

Region	**Winter**	**Spring**	**summer**	**Autumn**
Upper	0,30 ± 0,01	0,70 ± 0,02	1,60 ± 0,07	0,90 ± 0,04
Average	0,60 ± 0,02	1,20 ± 0,04	2,10 ± 0,09	2,00 ± 0,08
Lower	1,10 ± 0,04	2,80 ± 0,12	3,70 ± 0,16	2,40 ± 0,11
Left Bank	1,40 ± 0,06	3,20 ± 0,14	4,80 ± 0,18	3,40 ± 0,14
On average	0,85	2,00	3,00	2,20

The table 2 shows that in the spring, summer and autumn seasons, the destruction of organic substances in the water of the Varvarinsky reservoir continues almost at the same level, even when the water temperature changes. In addition, as well as in terms of phytoplankton productivity, destructive indicators are not the same in the areas-sections – of the Varvarinsky reservoir. The table shows that the seasonal index of destruction in the upper and middle sections-districts – of the Varvarinsky reservoir is 2-3 times less than in the middle and left-bank districts. Interestingly, if the massive development of phyto-bacterioplankton in reservoirs created in the upper reaches is associated with allochthonous substances brought by rivers, then anthropogenic eutrophication occurs in the Varvarinsky reservoir with wastewater discharged from the city of Mingechaur and neighboring settlements. The intensification of destructive processes by seasons shows that the enrichment of reservoir water with organic substances of allochthonous origin continues continuously. It is noteworthy that over the past 33 years, an increase in the composition of organic matter has been observed in the Varvarinsky reservoir [12,13]. Comparative indicators are presented in Table 3

Table 3: Change in the destruction of organic matter in the water of the Varvarinsky reservoir by year

Indicator	**Winter**		**Spring**		**Summer**		**Autumn**	
	1982	2015	1982	2015	1982	2015	1982	2015
Average daily product with/l	0,42	0,85	0,90	2,00	1,46	3,00	1,70	2,20
G S/m2	3,80	76,0	82,0	180,0	134,0	270,0	156,0	198,0
On the entire territory of the reservoir thousand tons / s	809	1637	1755	3852	2874	5778	3346	4237

The table shows that in 1982 878 tons were destroyed in the Varvarinsky reservoir, and in 2015 15504 tons of organic matter. During this period, 6720 tons of additional organic matter (or 1.7 times more) were mineralized in the Varvarinsky reservoir.

The bottom sediments of the Varvarinsky reservoir vary dramatically depending on the area. So the sediments in the actively flowing part of the water in the channel on the right bank consist of sand. Firstly, due to the fact that there are very few terrigenous particles in the water, as well as due to the rapid flow, sedimentation-subsidence - does not occur and silt-ground sediments are not formed as on the left bank. Thus, the indicators of destruction of organic substances in the upper and middle regions of the Varvarinsky reservoir are 2.5-3 times less than the results obtained in the lower and left-bank water areas (Table 4.).

Table 4 Destruction in silt-soil in Varvarinsky reservoir (2015 mg/m2)

Region	Property or-ground	Seasons			
		Winter	Spring	Summer	Autumn
Upper	dark-colored sand	96,0 ± 4,2	110,0 ± 5,2	130,0 ± 5,8	120,0 ± 4,8
Average	weak and left sand	115,0 ± 5,4	133,0 ± 6,4	150,0 ± 6,6	140,0 ± 6,3
Lower	dark brown or	200,0 ± 8,6	410,0 ± 18,4	570,0 ± 25,6	490,0 ± 22,5
Left Bank	or-a mixture with detritus-vegetable residue	310,0 ± 12,4	520,0 ± 22,6	680,0 ± 31,8	630,0 ± 24,6
On average		188,0	298	375	337

Naturally, these deposits of the Varvarinsky reservoir have different indicators of destruction depending on the mechanical – granulometric composition. Because numerous studies have proved that destructive processes occur more intensively in soft, loose mud-soil. Interestingly, over the past 33 years, the amount of degradable organic substances in the silt, as well as in water, has increased.

So, if in 1982 2,431 tons of organic substances were mineralized in the bottom sediments of the Varvarinsky reservoir[20], then in 2015 this figure was 4,490 tons. Depending on the nature of silty-ground deposits in the Varvarinsky reservoir, the intensity of destruction of organic matter sharply differs.

From the figures given in Table 4, it can be seen that the average annual amount of degraded organic matter in the upper and middle parts of the reservoir was 4.5 times less than the amount of organic matter that was mineralized in the middle and lower parts of the reservoir reservoir. In other words, only 24% of the organic matter mineralized in the silt of the basin was assimilated in the water area of its right bank.

According to the results of the performed studies by seasons, the calculation of the total amount of organic substances mineralized in the silt of the Varvarinsky reservoir is presented in Table 5.

Table 5 Calculation of the degraded organic matter during the year in the silt of the Varvarinsky reservoir

Indicator	Winter	Spring	Summer	Autumn
Average daily destruction mg S/m2	90,0	110,0	169,0	130,0
All bottom sediments of the reservoir on the site, with/thin	810,0	990,0	1520,0	1770,0

Note: in just a year – 5090 tons

Thus, it can be seen that 5,090 tons of organic matter are absorbed by the microbiota of the bottom sediments of the Varvarinsky reservoir during the year. The destruction of organic substances in the bottom sediments of the reservoir is equivalent to 30 percent of the primary product synthesized by phytoplankton in the basin of the Varvarinsky reservoir.

Discusion

Interestingly, in 1982, the amount of mineralized organic matter in the left-soil of the Varvarinsky reservoir, according to A.Manafova, was 2,431 tons. Thus, it was revealed that over the last period the total mass of the degraded organic matter in the silt in the reservoir was more than 2000 tons. It should be noted that the degraded organic substances in the silt-soil in the Mingechaur and Varvarinsky reservoirs account for 30 percent of the primary product, which indicates an intensive process of self-purification and organic substances in the environment are easily digestible substrates. In addition, the shorter the column of water on the muddy ground, the less complex organic matter in the bottom sediments in composition.

Our research has calculated for the first time the balance of organic substances in both the Mingechaur reservoir and the Varvarinsky reservoir (Table 6).

Table 6 **The balance of organic matter in Varvarinsky reservoir (2015)**

Sources of income	thousand tons/year	%	Expenditure	thousand tons/s	%
Allochthonous organic substances	**2,00 ± 0,1**	**14,0**	**Destruction in water**	**15,5 ± 0,7**	**77,5**
Primary source product	**14,4 ± 0,5**	**86,0**	**Destruction in silt-soil**	**4,5 ± 0,2**	**22,5**
Total	**16,4**	**100**	**in total**	**20,0**	**100**

Conclusion

From the figures given in Table 6, it can be seen that 16.4 thousand tons of organic matter are created in the Varvarinsky reservoir during the year, and 20,000 tons of organic matter are mineralized. If we divide the organic substances formed and consumed both in water and on the left-ground, the area of the reservoir per square meter is 673 and 218 g/s, respectively. Of course, these indicators are 1.5-2 times higher than those obtained from eutrophied other reservoirs, such as on the Volga, on the Dnieper. Therefore, we can admit with absolute certainty that the Mingechaur and Varvarinsky reservoirs are reservoirs of the eutrophic type!

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