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RESEARCH ARTICLE

Pollution Of the Middle Part of Kura by Petro-Phenols and Their Biodegradation by Microorganisms

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ABSTRACT

The largest river in the Caucasus, Kura, originating from the mountainous areas of Eastern Anatolia of Turkey the basin of which is connected with the territory of 5 states (Turkey, Armenia, Georgia, the Islamic Republic of Iran and Azerbaijan) from olden times has been subjected across the whole flow (1500 km) in varying degree to the anthropogenic influences. At the same time, none of the states located in its basin considers Kura as a major and irreplaceable source of drinking water for more than 80% of the population, agriculture and industry, as in Azerbaijan. Therefore, considering the vital importance, Kura and the reservoirs of its basin are systematically studied by us since 1956 and it continues to this day during all the seasons and years. The complex microbiological studies in the middle of Kura and in the cascade of reservoirs created in different years were started in the second half of the 50-ies of the last century. It was detected that an intensive (with increasing year-by-year rate) pollution of Kura begins in its middle part at the territory of Georgia.

KEYWORDS:
pollutants, saprobity, anthropogenic eutrophication, anaerobiosis, allochthonic organic substance, primary phytoplankton production

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INTRODUCTION

Since the 50-ies of the last century, the technological progress has aggravated the preservation of the ecological stability of the hydrosphere, in particular, of the open water sources. The river systems are subjected to the most intense anthropogenic influences. Change of the physical and chemical properties of water and increase the extent of its saprobity in the transboundary river basins now become a cause of disagreement between the regions and states.

It is known that the availability of the optimum amount of water of local origin is important in the ecological well-being of any region or state. Because the local flow is a kind of own natural wealth, since the protection and the rational and targeted use of it does not depend on other countries.

Therefore, the Stockholm-Geneva Convention on the conservation of ecological stability of transboundary water sources was adopted. Unfortunately, the Convention has not yet been ratified by Armenia and Georgia at the territory of which to the extent of polysaprobity the rivers Kura and Araz are polluted which are considered as the irreplaceable sources of fresh water for the life of Azerbaijan[3, 9, 10].

MATERIALS AND METHODS OF STUDY

For this article we used the materials collected in 1964, 1974, 1977, 1983, 1994, 1998, 2006, 2008, 2012, seasonally within 11 towns and cities of Georgia (middle course of Kura) by the bottle bathometer of Yu.I. Sorokin [24-25]. To separate the petro-phenoloxidating bacteria we used the elective media of Voroshilova-Dianova and Kalabina-Rogowskaya [5] and the methods speciied in the laboratory manual of V.I. Romanenko[15-16], S.I. Kuznetsov [8]. The petro-phenol concentration is determined by R. Robinskaya, V. Fediya [14]. The number of E. coli is accounted for endo medium, and the

quantity of the organic matter degradation in water is determined by the method of G.G. Vinberg [26].

RESULTS AND DISCUSSION

First it shall be stressed that the contamination of river water by volume after the municipal wastewater the second place belongs to industrial effluents. And by the degree of harm to aquatic organisms and the long-term elimination of aquatic ecosystems – the first place is occupied by to the second, due to the presence in it, mainly of petro-phenolic products. If the presence of oil and its homologues is associated to their direct intake the sources a the presence of phenols are much more. It was established that in addition to the oil and petroleum products in the water environment the separate groups of hydrocarbon compounds which acting as the independent toxicants which include phenols are distinguished [1, 2]. The experiments also revealed that the toxicity of phenol significantly outruns the crude oil [3].

As stated above, the phenols come to the water during the discharge of a variety of industrial wastewater; they are part of many plant and animal tissues, released during enzymatic fermentation, during the oxidation of oil and petroleum products, etc. [7, 13]. Thus, the presence of oil, petroleum products, including phenols, in the water of Kura and the reservoirs of its basin is observed in various concentrations in all the expeditions (Table 1).

Table 1: The amount of oil and phenol (mg / l) in the water of the middle part of Kura within Georgia during the different periods of the study (in average, in summer)

Water sampling points	1964		1974		1984		1998	
	oil	phenol	oil	phenol	oil	phenol	oil	phenol
Akhalkalaki	0,4	0,01	0,05	0,03	0,6	0,04	1,3	0,05
Borjomi	1,4	0,025	1,6	0,06	2,1	0,08	3,6	0,09
Khashuri	2,3	0,03	3,4	0,08	4,4	0,08	5,2	0,09
Gori	2,6	0,04	3,8	0,09	5,7	0,09	6,3	0,09
Mtskheti	4,6	0,06	6,3	0,08	7,4	0,09	9,8	0,09
Tbilisi	6,3	0,07	10,3	0,09	13,3	0,09	14,2	0,09
Rustavi	7,8	0,08	11,2	0,09	14,2	0,09	16,3	0,09

As it can be seen from Table 1, increase of the concentration of the oil and phenols in the water of the middle part of Kura occurs both by years and with the flow. It also shows that the increase of the amount of oil, in average, by 2-3 times overruns the increase of the concentration of phenols. Therefore, we can assume that for 34 years (1964-1998) in the middle of the Kura the pollution of oil increased. It should be emphasized that during this period the degree of domestic pollution has increased dramatically, and the number of saprophytic and coliform bacteria increased by more than 700 and 180 times, respectively [17-23]. Along with mentioned above, the presence of oil and phenols with the tendency of subsequent increase in the number of petro-phenoloxidating bacteria the sharp increase was not observed (Table 2).

Against the background of an increase in saprophytic-ammonifiers for 35 years by the hundreds of times which indicate the excessively of intensive enrichment of water with municipal allochthonic organic substances the increase of petro-phenoloxidating matters is very low. This does not mean that the water is not contaminated by these pollutants. The fact is that some researchers experimentally proved that in the presence of the sufficient concentration of the readily available organic matter in water which include the allochthonic organic substances of municipal household origin the micro-organisms prefer the latter [8, 13, 16]. It is also found that at low temperatures of water the oil and its products are subjected to the very weak mineralization [8; 13].

Table 2: The number of oil and phenol decomposing bacteria (thousand / ml) during the different periods of the study (in average, in summer)

Points of observation	1964		1974		1984		1998	
	PO1	PD2	PO	PD	PO	PD	PO	PD
Akhalkalaki	1,0	0,03	1,0	0,03	1,2	0,04	1,4	0,05
Borjomi	0,1	0,03	1,3	0,03	2,4	0,05	3,3	0,06
Khashuri	0,1	0,04	2,1	0,04	3,2	0,05	4,6	0,01
Gori	0,4	0,045	1,0	0,06	5,0	1,0	10,0	1,0
Mtskheti	10	0,60	10	0,08	10	1,0	10,0	1,0
Tbilisi	10	0,08	100	0,09	100	10	100	1,0
Rustavi	10	0,10	100	0,09	100	10	100	1,0

Note: PO1 –petro-oxidating;
PD2 – phenol-decomposing.

The positive effect of ambient temperature, concentration of energetic material, oxygen, nutrients and other factors on the biochemical activity of microbiota was proved by many experiments[6, 12]. At the same time in the water of the middle course of Kura the enrichment of habitat of the bacterial plankton by various substances of allochthonic nature and human origin and the abiotic factors are different. For example, t°C, O2, pH differs by the areas (Table 3).

Table 3: The indicators of temperature and oxygen (mg / l) and pH in the water of the middle part of Kura (in average, in summer)

Points of observation	1964			1974			1984			1998		
	t°C	O2	pH	t°C	O2	pH	t°C	O2	pH	t°C	O2	pH
Akhalkalaki	12	10,0	7.7	13	9.3	7,7	12	9,1	7,7	8,0	7,3	7,6
Borjomi	14	9,6	7,2	13	9,0	7,8	13	8,4	7,6	14	7,0	7,5
Khashuri	17	9,0	7,9	16	8,7	7,7	16	7,0	7,5	17	6,8	7,6
Gori	20	8,4	7,8	19	8,0	7,8	19	7,3	7,3	18	6,3	7,4
Mtskheti	23	7,0	7,6	21	6,4	6,4	22	5,4	6,0	23	5,2	5,8
Tbilisi	24	6,3	6,3	22	6,0	6,3	22	6,0	6,1	24	4,4	5,4
Rustavi	24	6,6	6,6	23	6,3	6,4	23	6,2	6,2	24	5,6	6,3

Based on the indicators of Table 3, it can be assumed that the elimination of the various components of the multi-profile pollutant in the water of the middle part of Kura at the territory of Georgia within Akhalkalaki to the border with Azerbaijan is very weak and the self-purification processes of the ecosystem cannot recover their stability. There are a lot of facts that Kura and its numerous branches are very dirty. Also, it is well established that Kura originating from mountain ranges in its upper reaches at the territory of Turkey is environmentally stable. All the environmental disasters of Kura begin in its middle part at the territory of Georgia [4] and in the same polysaprobic condition it flows at the territory of Azerbaijan. For comparison, it may be recalled that if in the upper part the total number of flora varies from 1.2-2 million / ml, in the middle (Georgia) and bottom (Azerbaijan) parts it is 24 and 19 million / ml, respectively. For a more clear idea of the ecological state of Kura by parts, the results of comparison are provided in Table 4.

Table 4: Comparison of the number of saprophytic and coliform bacteria (thousand / ml) in the water of Kura within Turkey, Georgia and Azerbaijan

Country	Points	Saprophytic	Coliform	Author
Turkey (2008)	Shankaya	6	0,09	M. Salmanov A. Ozaran [22]
	Gele	5	0,09	
	Ardakhan	6	0,07	
	Average	6	0,08	
Georgia (2004)	Borjomi	176	4,2	A. Mansurov M. Salmanov [11]
	Gori	336	4,8	
	Mtskheti	380	28,3	
	Tbilisi	448	49,0	
	Rustavi	420	63,0	
	Average	352	30,0	
Azerbaijan (2006)	Evlakh	380	23,0	A. Ansarova [2]
	Sabirabad	276	26,0	
	Shirvan	387	27,0	
	Salyan	316	30,0	
	Average	310	24,0	

As can be seen from Table 4, the saprophytic and coliform bacteria in the water of Kura at the territory of Georgia are superior to those in the upper reaches of it by 54 and 370 times, respectively. Moreover, the results of many years of repeated studies have shown that only a communal household as well as the technical and industrial pollution of the Kura water in its middle reaches increases from year to year (Table. 5).

Table 5: Change in the number of saprophytic and coliform bacteria (thousand / ml) in the water of the middle part of Kura by years (summer)

Point	Saprophytic bacteria					Coliform bacteria				
	1964	1976	1984	1994	2003	1964	1976	1984	1994	2003
Borjomi	13,2	52	124	176	210	0,06	0,13	0,9	1,04	2,10
Akhaldaba	14,8	34	81	110	120	0,09	1,04	1,6	2,1	2,4
Gori	48	78	210	336	370	0,08	0,16	1,0	1,8	2,0
Mtskheti	90	240	260	300	340	3,0	8,0	18,0	24,0	28,0
Tbilisi	103	166	210	410	460	11,0	13,2	24,5	30,0	37,0
Rustavi	120	187	330	363	410	9,7	26,0	34,0	39,6	41,0
Khramchay (bridge)	41	100	210	310	340	5,0	7,8	16,3	21,4	30,0

CONCLUSION

The results of the first microbiological studies 60 years ago showed that Kura is heavily polluted within the cities of Gori, Mtskheti, Tbilisi, Rustavi, Gardobani, at the territory of Georgia. During the expired period, the domestic pollution of water has become irreversible, starting with the section of Akhalkalaki (Turkey border) to the confluence of Aragvi, then the industrial wastewater are added and the concentration of petro-phenols in them increases year after year. It was established that since 1976 the Medium Kura within Georgia became polysaprobic.

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