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BIOECOLOGICAL ANALYSIS OF URBAN WATER SAMPLES FROM THE TURA RIVER

SUMMARY. This article is devoted to the research of physiological and behavioral reactions of Paramecium caudatum. In our experiment ciliates acted as indicators of toxic complexes in water samples which were taken from different parts of the Tura River with various types and degrees of anthropogenic pressure. Parts of the river selected for analysis were located both in the urban and rural areas of Tyumen. Abnormal reactions of ciliates were used for the analysis of areas of the river under study. Over the course of the analysis, the most toxic and the safest sections of the river were identified. After further analysis of chemical elements, assumptions were made concerning the impact of individual chemical elements as well as their complexes on the reaction of ciliates. It was also revealed that behavioral and physiological reactions of ciliates were dependent not only upon chemical, but also upon biological factors.

KEY WORDS. Test-object, toxicity, Paramecium caudatum, the Tura River.

In terms of vastness of space and sharply differentiated population density, abundance of natural resources and contrasts in the standard of living, diversity of cultural traditions and complexity of political institutions, the Tyumen Region is reminiscent of Russia as a whole. As regards population, the Tyumen Region occupies the 11th place, representing 2.3% of population in Russia [1]. Tyumen city is supplied with water from several intakes: Metelevsky, Golovnoy, and Velizhansky. Only the last of these three uses underground water sources; the other two obtain water from the Tura River. The quality of water taken from the river can be ranked as dirty and extremely dirty [2-7].

Therefore, it is clear that monitoring of water bodies is extremely important and necessary not only from the environmental and hygienic, but also from the economic viewpoint.

The part of the Tura river-bed under study was subdivided into strategic representative sectors. As a result, the total segment chosen for analysis is the most interesting in terms of biomonitoring, as it presents overlapping types of microrelief and experiences different degrees of pressure at each sector (see Fig. 1).

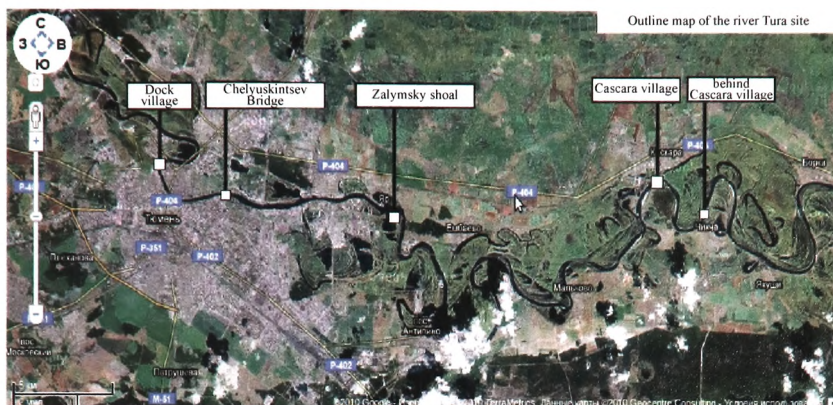


Figure 1. Location of sampling points of water

Sampling water points were established in the Dock village, the Chelyuskintsev Bridge, the Zalymy shoa, the Cascara village, and after the Cascara village.

Ciliates *Paramecium caudatum* acted as indicators of toxic complexes in water samples.

Water analysis was conducted in the laboratory of Tyumen State University on the basis of the number and locomotor activity of ciliates [8].

Having conducted the above mentioned analysis, we obtained the following results.

The quickest and easiest way to determine the presence of toxic agents in water is by means of bioassay with the employment of ciliates. In this study it was found that the number of cells in the river water is many times greater than in settled water, which indicates a large amount of organic matter and bacteria.

Table 1

Test functions of *Paramecium caudatum* in samples from the Tura River

Object	Number of ciliates, in pcs		Locomotor activity, %	
	The 1 st day	The 9 th day	The 1 st day	The 9 th day
Check measurement *	11,7±0,56	11,9±0,61	27,3±2,42	33,0±2,40
The Doc village	26,1±2,52*	22,1±2,21*	13,0±1,15*	13,6±1,42*
The Chelyuskintsev Bridge	43,8±3,97*	29,6±2,91*	13,3±1,35*	8,6±0,98*
The Zalymy shoa	38,7±3,23*	19,4±1,64*	18,6±1,56*	5,7±0,38*
The Kaskara village	31,7±3,25*	34,2±3,54*	29,4±2,73	21,5±0,97
3 km after the Kaskara village	30,7±3,39*	28,1±2,67*	25,3±2,28	33,8±3,21

The legend: * — the statistically significant difference in comparison with the check measurement is $\alpha = 0,95$;

Eating bacteria, ciliates multiplied in large numbers within a short period of time, but after a few days their numbers reduced by half in the area of the Zalymsky shoal, which can be explained by the effect of high concentrations of toxic substances. A sharp decline in the number of ciliates was registered in the area of the Chelyuskintsev Bridge, i.e. in the area prior to the Zalymsky shoal. The number of ciliates indicates that the river contains a high concentration of organic matter and microorganisms; moreover, in the area of the Chelyuskintsev Bridge and the Zalymsky shoal there is a high concentration of toxic complexes.

In order to clarify and elaborate on the toxic effects traced in the areas of the Tura River under study we shall analyze the physical activity of ciliates. A natural feature of ciliates is life in motion, i.e. when a ciliate stops moving, its death can be registered. There was a sharp decrease in the degree of motion of ciliates in the water within the area of the Chelyuskintsev Bridge and the Zalymsky shoal, which confirms the increased concentration of toxicants in these sections of the river or their more aggressive nature.

Natural peculiarities of the Zalymsky shoal, and high amplitude of the change of parameters of test objects in the area under study specifies that at a given location the river accumulates toxic substance, whereas the subsequent downstream areas contain water with lower toxicity or lack thereof.

Adequacy of estimation of test systems is possible only with the help of chemical analysis of water samples. Since wastewater is a complex entity having multi-componential chemical composition, it is necessary to consider its combined effect. The latter manifests itself in the form of synergy, antagonism and additive action [9].

Synergy is clearly manifested in the combinations of heavy metals, ammonia and copper, phenol and polychlorpropylene, copper and synthetic surfactants. Consequently, even a mixture of subtoxic concentrations of these substances can be fatal. [10] Consideration of the results of chemical analysis allows us to predict areas of the strongest toxic effect due to a large amount of active ingredients.

Water samples from different parts of the Tura River were tested for the following chemical parameters: pH, Fe^{2+} , NH_4^+ , surfactants, NO_2^- , NO_3^- , PO_4^{3-} , F^- , Cl^- , phenols and petroleum products. Water from the Tura River was investigated for the presence of chemical compounds and substances within the time period from 2009 to 2011.

Table 2

The results of chemical analysis of water from the Tura River within the time period from 2009 to 2011

	pH	NO ₂ (mg/L)	NO ₃ (mg/L)	NH ₄ ⁺ (mg/L)	Fe (mg/L)	PO ₄ ⁻ (mg/L)	Cl ⁻ (mg/L)	Surfactants (mg/L)	F ⁻ (mg/L)	Phenols (mg/L)	Petroleum products (mg/L)
1	2	3	4	5	6	7	8	9	10	11	12
The Doc village	7,5	0,02	1	0,2	0,3	0,2	24,85	2	0	0	0,1
The Chelyuskintsev Bridge	6,5	0,02	1	0,2	0,3	0,2	21,3	2	0	0	0,5

1	2	3	4	5	6	7	8	9	10	11	12
The Zalymsky shoal	7,0	0,00	0	0,2	0,3	0,2	21,3	2	0	0,02	1,0
The Kaskara village	6,5	0,10	5	0,2	0,3	0,2	28,4	2	0	0	0,1
3 km after the Kaskara village	6,5	0,02	1	0,2	0,3	0,2	28,4	2	0	0	0,1

The legend: the underscored values exceed the threshold limit value.

Excess of the threshold limit value in the area of the Chelyuskintsev Bridge and the Zalymsky shoal indicates the complexity of the current toxicity in these areas. Physiological and behavioral responses of ciliates fully reflect the state of water at the specified points of the river.

Conclusion:

The method of bioassay allows us to estimate the toxicity of environment for the organism as a whole, rather than for its individual elements, as in other types of experiments. Each test object represents a new mechanism of resistance to stressful environmental factors; therefore it allows a more complete and detailed calculation and description of environmental conditions and subsequent extrapolation to the human organism. The study has revealed that the Zalymsky shoal (a section of the Tura River) is the most polluted area due to its topographic features; in other words, it acts as a protector of downstream areas from high levels of pollution. The Chelyuskintsev Bridge was identified as the dirtiest area with the highest degree of anthropogenic pressure. Judging by the values of a number of parameters, the area downstream the Zalymsky shoal must be taken under control in order to prevent further deterioration of water in the above-mentioned area.

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