The state of the antioxidant system of goby fish

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Abstract. A comparison of the functional state of goby fish caught at the ecological monitoring station in the locations of oil-producing wells is carried out. The results of the assessment of the antioxidant system and the processes of lipid peroxidation of aquatic organisms are presented. Biochemical markers are used in biomonitoring studies to analyze the toxicity of polluting factors in the aquatic environment. Low indices of malondialdehyde content in fish liver from 1.1 to 9.6 nmol were found at three studied stations. A significant increase in the content of the product of lipid peroxidation in the liver and muscle tissue of fish was revealed at certain stations in the Northern Caspian. In general, indicators that exceed the conditional norm for the accumulation of MDA in the liver and muscle tissue of aquatic organisms were noted at 5 out of 31 studied stations. The data obtained indicate the development of oxidative stress and the enhancement of the protective properties of the fish organism under conditions of high anthropogenic load.

1. Introduction
Pathological conditions, due to which the content of lipid peroxidation products (LPP) increases and the reactivity of antioxidant systems changes, are often called “free radical”. The connection between the activity of LPP processes and the state of antioxidant systems is clearly seen in experiments with the effect of toxic substances on aquatic organisms. So the authors of Rabdanova A I, Gabibov M M, Chalaeva and others [1-2] found that chronic intoxication of a mixture of heavy metals (Cd2 +, Pb2 +, Mn2 +) is accompanied by activation of LPP processes, inhibition of superoxide dismutase activity and a compensatory increase in catalase activity. From organ pathology, morphofunctional changes in skeletal muscles predominate.

Reactive oxygen species induce lipid peroxidation, which is a universal marker of tissue damage. Lipid oxidation product malondialdehyde (MDA) appears in the body during the degradation of polyunsaturated fatty acids and is a marker of lipid peroxidation and oxidative stress.

Goby fish are found in a wide range of biotopes and are typical benthophages. The main food for feeding gobies is mollusks, the secondary objects are crustaceans and worms. In turn, gobies are an object of food for many species of fish. Due to the low migratory activity, this fish species can be used as an indicator object for monitoring studies of the quality of the aquatic environment in a specific survey area.

Purpose of the work: comparative assessment of the antioxidant system and lipid peroxidation processes in goby fish caught at various stations in the North Caspian during environmental monitoring.
2. Material and methods
Material for research was collected in the water area of the Northern Caspian (figure 1) at the locations of oil producing wells. For biochemical studies, the samples were assembled, following the methodological necessity of their minimum amount and the possibility of taking them from the object under study. For biochemical analyzes, muscle and liver samples were taken from gobies from 219 individuals without dividing them into species.

The processing of these materials for physiological and biochemical parameters was carried out using standard research methods. The rates of lipid peroxidation (LPP level) were determined by a method based on the reaction of the end product of lipid peroxidation - malondialdehyde with thiobarbituric acid [3-5]. The research results were statistically processed using a t-test at a significance level of 0.05.

3. Results and discussion
The research results are shown in figure 2. It has been established that in the liver of individual specimens of goby fish caught at monitoring stations near the location of oil-producing wells, lipid peroxidation processes are activated, which can be judged by an increase in the concentration of malondialdehyde (MDA), as well as activation of antioxidant defense systems. So, if at some stations the indicator of MDA content in fish liver was rather low 5.66 ± 1.05 nmol station K8, 6.05 ± 3.1 station F5 (the coefficient of variation (C) of this indicator was 80%), 8.56 ± 3.5 station F2 (C = 71%), then on others this indicator was several times higher and amounted to 83.75 ± 25.6 nmol station K16 (C = 81%); 84.01 ± 29.1 nmol station K4 (C = 69%); 81.16 ± 13.0 nmol station K6 (C = 45%). At the sampling sites, according to the grid of the monitoring study, background stations were identified, which are located at some distance from the oil producing well, these are stations K15 and K16. At station K16, a rather high indicator of the LPP marker was revealed. Statistically significant differences in the MDA level in the liver of gobies were revealed between stations K16 and F4, F8, K13, F5 (p ≤ 0.05).
It should be emphasized that the most pronounced differences in the content of lipid components and the degree of LPP were found in the liver of fish, which is possibly determined by the high metabolic activity of this organ. In fish muscles, the content of peroxidation products was found to be much lower. This is explained by the fact that peroxide processes in fish muscles are less active than in the liver.

Figure 3 shows the frequency of occurrence of bottom stations depending on the MDA content in the liver of goby fish. Indicators of MDA content from 18.3 to 26.8 nmol are the most common. The coefficient of variation of this indicator at these stations varied from 53% to 110%. Quite low values from 1.1 to 9.6 nmol were found only at three studied stations. However, the highest MDA values were also recorded at three stations. In general, indicators that exceed the conditional norm were noted at 5 stations out of 31 studied.

Figure 3. Frequency of occurrence of stations by the content of MDA in the liver of goby fish.
Various stress factors lead to an increase in the formation of free radicals, lipid peroxidation products, and - to compensate for these processes - an increase in the activity of antioxidant enzymes and the concentration of low molecular weight antioxidants. Chronic exposure leads to depletion of the resources of the antioxidant system and a decrease in its activity, which is accompanied by a sharp increase in the intensity of lipid peroxidation. Thus, an increase in the amount of LP products may indicate the impact of adverse factors.

The experimental data available to date confirm that the state of adaptation of an organism to its chemical environment depends on the optimal functioning of the systems of enzymatic biotransformation and detoxification of pollutants together with the antioxidant defense system. Their action during anthropogenic stress in marine organisms is of a protective nature and is aimed at increasing the resistance of the organism, at returning it to a state of homeostasis.

When studying organisms from natural populations, it is often difficult to interpret the results of molecular biomarkers, since their activity depends on a number of factors: physiological state, nutrition, age, season and associated fluctuations in abiotic environmental factors. Nevertheless, these data carry important information about the real state of organisms in specific conditions of their natural habitat, and create the basis for further study of water pollution.

The data obtained indicate the development of oxidative stress and the enhancement of the protective properties of the fish organism under conditions of high anthropogenic load. The accumulation of lipid peroxidation products serves as a trigger for the modification of cell membranes: the resulting hydroperoxides disrupt the regular packing of membrane lipids and can cause an uncontrolled change in the permeability of cell membranes, leading to cell necrosis and apoptosis.

In the basins of the Volga and Ural rivers, in the water area of the Northern Caspian, the inflow of pollutants will only increase in accordance with the level of development of economic sectors. The share of pollution of the sea water area will also increase through atmospheric air pollution, emergencies occurring in the sea, as well as due to filtration of waters coming from various objects located in the coastal zone, due to the direct discharge of conventionally treated wastewater into the sea itself.

References
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