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Influence of Water Quality in Yakutia Reservoirs at Fish Organism

(at the example of rivers Vilyuy, Khroma, Indigirka and Kolyma)

ABSTRACT

Objective:

The purpose of this study was to determine the influence of water quality in Yakutia reservoirs at fish organism.

Background:

We have studied the common types of fish that live in rivers of Yakutia (at the example of Vilyuy, Khroma, Indigirka and Kolyma Rivers) and are representatives of the food chain "water - fish - man."

Methods:

In summer, July 2009, we investigated the blood of perch and roach, below the village Syuldyukar (r.Vilyuy) at Haryyalah and Kuranyi rivers (July 2009), after which laboratory analysis showed the following blood picture: leukocytes - from 210 to 499; erythrocytes - 168 - 326; ESR - 0-2; hemoglobin – 3.7-8.9, averaging 6.1 g%. Judging from the literature [1, 2], this type of blood indicates very advanced toxicity processes in fish.

Results:

On the basis of clinical, pathological and hematological parameters of fish we revealed specific reactions and vulnerable «function target «to existing factors. A comparison of the structure of the fish population in the waters of Yakutia, revealed deterioration in water quality and changes in the population structure of invertebrate organisms, which reflected in the state of final producers - fish.

Conclusion:

Changes of the environmental conditions under the influence of chemical contamination, as a result causes tension of adaptation mechanisms, which can lead to the development of pathological changes in the human body.

Keywords: environment, human body, human health, food chain, fish productivity, fat accumulation, reproduction, reproductive period, toxicant, anemia, hematopoiesis, intoxication.

INTRODUCTION

In recent years, the acute problem of environmental pollution with harmful chemicals remains. Among these pollutants, primarily, one can include certain heavy metals of technogenic origin. Environmental pollution with toxic metals above all affects human health. Pathways of

the chemical elements in the human body are varied. It should be noted that most of the chemical elements is ingested with food and water. We have studied the common types of fish that live in rivers of Yakutia, are representatives of the food chain "water - fish - man."

Deterioration of water quality and changes in community structure of invertebrates reflected the state of ecosystem end-producers - fish. The total fish production of the studied reservoirs decreased

The structure of the fish population has changed in the direction of reducing the proportion of whitefish, and also the sig basic biological indicators changed. Due to the toxic load on the fish organism premature death in older age groups occurs also there is inhibition of growth. Along with a reduction in the growth rate metabolism in fish changes aside to fat accumulation instead of plastic substances consumption for protein growth, which is a reaction to adverse living conditions.

Processes of fish reproduction are broken. One of the reactions of fish to changing conditions is the transition to a shorter life cycle and reproduction. However more typical are slowing of fish maturation and frequent, prolonged spawning season passes. In the context of the toxic load fish hardly accumulate energy resources to spawn and are unable to compensate for them: the reproductive period of population is declining.

Whitefish are the most abundant fish species in the rivers of the Far North. On the basis of studying of the changes of morphological and physiological indicators one can see the impact on living organisms of wastewater discharge to subarctic waters, and the most vulnerable organs (called function - target) with respect to those or other toxicants are pointed out. In natural waters - rivers Vilyuy, Khroma, Indigirka and Kolyma, we found lithonephria (nephrocalcinosis), which is associated with the contaminated water. Also pathology in the skeleton of fish - pug snout, bending of gill stamens and ribs, hump and merging of the 2-3 vertebrae in the thoracic department were marked. At the organism intoxication the following liver and kidney abnormalities: cell death and appearance on their site of the connective tissue were detected. The same phenomenon, but in a more vibrant power was described in whitefish of Kola Peninsula as nephrolithiasis [11] and abnormalities of the spleen in Buryatia whitefish [6, 8]. These studies were the basis for the development of theoretical justification of anthropogenic impact on the valuation of the subarctic waters [15].

Fish blood system responds to the deterioration of habitat with large variety of pathological changes forms and the general laws of its transformation have been described. The first response of fish to the toxic agent effect is blood solidification: replace destroying cells in the blood stream young erythrocytes, monocytes, segmented and immature leukocytes ejected. The

concentration of hemoglobin in the blood, erythrocyte sedimentation rate and leukocytes increase [7, 10]. Blood picture is characterized by, along with before hemolized red blood cells, and many young immature cells. Further on, there is a gradual decrease in hemoglobin concentration due to intensive destruction of red blood cells and anemia develops. Changes in the blood system are reversible, until protective functions of hematopoiesis have been exhausted. As a criterion minimum limit of the amount of hemoglobin - 8% g was set. Its further decline is a hallmark of fish toxicity [12, 23, 25]. Based on these data the possibility of using lipid metabolism to assess the state of the Kola Peninsula of whitefish at different degrees of toxic effects is shown [13, 20, 24].

In summer, July 2009, we investigated the blood of perch and roach, below the village Syuldyukar (r.Vilyuy) at Haryyalah and Kuranyi rivers (July 2009), after which laboratory analysis showed the following blood picture: leukocytes - from 210 to 499; erythrocytes - 168 - 326; ESR - 0-2; hemoglobin – 3.7-8.9, averaging 6.1 g%. Judging from the literature [1, 2], this type of blood indicates very advanced toxicity processes in fish.

The general pattern of development of fish toxicity disclosed on the basis of studying the hematopoietic system reaction is characterized by four stages: I - contact, II - mobilization, III - destabilization, IV - degradation. Methodically toxicity stages are differentiated by destroyed (or pathological) and "normal" erythrocytes ratio at different concentrations of hemoglobin in the blood. Transition to irreversible changes and death of the organism is characterized by "critical point" separating "the norm and pathology", i.e. III and IV stage of toxicity at reducing the hemoglobin concentration less than 80% when in the blood mass erythrocyte destruction are observed. Analysis of long-term dynamics of the state of hematological parameters of fish showed a reduction of the fish number in the modern period (compared to 1970-1980.) being at the degradative toxicity stage, that indicates the reduction of toxic exposure.

Excess of heavy metals in aqueous medium leads to their accumulation in fish organism. The greatest accumulating effect in relation to one or another element have that organs which are functionally inherent: nickel accumulates in the kidneys, liver, gills and skin; copper - in the liver, kidney and gill skeleton; strontium - mostly in the bone tissues. Strontium concentration because of its accumulation may be comparable with the content of zinc, which in norm in the soft tissues is much greater. It was revealed that a violation of the microelement composition became one of the causes of fish pathologies. There is a strong dependence in the system: nickel in water → nickel in kidney → fish nephrocalcinosis. Excess of strontium can cause bone pathology.

Fish gills take the first blow caused by chemical changes in the aquatic environment, which often reflects in the biochemical indices in this organ [9].

The spleen is the most interesting as hematopoietic and immunocomponent organ. Many of the occurring in the body physiological and biochemical processes in extreme conditions with a strong change in habitat affect the hematopoietic and immune systems. It is known that any stress usually suppresses immunity of animals, while stress factors activate the body's defenses. [3]

It is interesting to note, that the same, sometimes unexpected results are obtained at ecological and biochemical study, what may be relevant at using eco-systems of biochemical monitoring in the early diagnosis of chronic changes in fish in the pond. For example, in the study of changes in the content of various lipids in different organs of Volga sturgeon in norm and "bundle" of muscles [14].

Violation of the structure and functioning of fish populations, the occurrence of deep pathologies and dysfunctions in their bodies led to a decline of fishery potential reservoirs of Yakutia.

Thus, in a result of processing enterprises in the mineral waters of the republic following trends in water quality were traced: salinity was growing, ionic composition changed in the direction of increasing the sulfate content, due to elevated levels of suspended particles water clarity decreased, bottom sedimentation with solid industrial waste occurred and water accumulated toxic compounds. This resulted in a violation of the structural and functional characteristics of biocenosis, and due to the development of pathologies and dysfunctions in the body systems fish mortality was observed, that in general, has led to the depletion of water resources and fish [4, 18, 19, 21]. Currently, the ability of reservoirs to cleanse itself is insufficient to recycle huge masses of pollutants. The highest lead content in all fish species is observed in the liver, as well as in carnivorous and at peace (benthophages and planktophages). The concentration of lead was higher in large individuals, compared with small young fish. Perhaps this is due to the fact that with a constant admission with feed lead does not manage to eliminate from the body and therefore accumulates in increasing concentrations, depending on the age of the fish.

The obtained data allow us to assert that, at cooking, in large specimens of fish it is advisable to remove the liver as the main accumulator of this element.

Often studied fish samples had no apparent pathological abnormalities, characteristic of poisoning with salts of mercury, lead and cadmium. Therefore of particular importance in veterinary-sanitary inspection of fish and fish products is chemical-toxicological research.

However, it should be noted that many researchers observed pathology characteristic for reservoirs polluted with heavy metals, and evidence of toxicity to aquatic environment.

In such fish color changes of the body, muscle turgor reducing, appearance of the anemic ring on the gills and gill rakers bending, the appearance of connective tissue growths and stones in the kidney, skeletal developmental disorder, etc. were observed. These pathologies are also described in fish living in waters of the Kola Peninsula contaminated by heavy metals [5, 12, 16, 17, 22].

Salmon and whitefish fish are narrowly adapted to survive in extreme conditions. Stenobiontic character causes high demands on water quality and prompt responsiveness to changing environmental conditions in the reservoirs [15].

On the basis of clinical, pathological and hematological parameters of fish organism we revealed specific reactions and vulnerable "target function" to existing factors. The lake Imandra fish at the tissue level common pathologies were: edema, exudates, hemorrhages, changes in blood vessels that testified exudate -hemorrhagic inflammation in the gills and furnace, protein and fat (toxic) liver dystrophy, leading to atrophy of the organ, connective tissue proliferation, epithelial changes, etc. Along with common pathologies in fish specific diseases, typical for each of the districts, appear. In the zone of influence of the copper-nickel waste – nephrocalcinosis, and in mixed with apatite-nepheline production sinks flow - myopathy and nephrocalcinosis. In subsequent years, in a period of reduced water pollution by heavy metals the incidence of fish decreased.

For evolutionarily young and "plastic" species *Coregonus lavaretus*, in conditions of more than 6 years of water pollution, changes in population characteristics occurred in the following direction: reduced growth rates, increased variability in the timing of puberty (both a delay, and premature maturation were observed), reducing of the spawning multiplicity and life expectancy. At the basis of these changes is hormonal and biochemical regulation, aimed at improving the support metabolism (increased catabolism) to the detriment of assimilated energy used on the processes of growth and maturation of the gonads.

Thus, for the period of anthropogenic loads ecosystem (as shown in the example of Lake Imandra) has undergone significant changes that affected all of its structural components. In the past - oligotrophic ultrafresh waters with bicarbonate-calcium mineralization with low concentrations of suspended material and trace elements in the period of anthropogenic load its hydrochemical regime transformed: the waters began to comply with class sulfates of technogenic nature, content of suspended solids increased. There was a severe water and sediment pollution with heavy metals. Despite the reduction of pollution, especially with heavy metals and suspended solids in the last decades, the water quality is still unfavorable. New communities with impoverished species composition, formed in a period of strong pollution,

acquired a tendency to increase the number and biomass. There is reason to believe that in the near future, all these processes will be reflected in the waters of Yakutia.

These materials show the main directions of anthropogenic successions of Arctic aquatic ecosystems under the influence of a large complex of anthropogenic factors that may occur in other water systems during the developing of the Arctic regions.

It should be emphasized that the quality of food raw materials, regardless of their origin in the first place depends on the state of the environment. Changes of the environmental conditions under the influence of chemical contamination, as a result causes tension of adaptation mechanisms, which can lead to the development of pathological changes in the human body.

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