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IMPACT OF ENVIRONMENTAL POLLUTION ON FISH IN THE ARATS RESERVOIR

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ВЛИЯНИЕ ЗАГРЯЗНЕНИЯ ОКРУЖАЮЩЕЙ СРЕДЫ НА РЫБ АРАЦКОГО ВОДОХРАНИЛИЩА

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Abstract. The study was conducted on fish. As a result, it was determined that, depending on the time and type of pollution, similar pathologies, including edema, exudates, and hemorrhages, are observed in various fish species. The reaction to toxicant exposure manifests as various anomalies and pathologies (nephrocalcitosis, and structural anomalies in the gills, fins, internal skeleton, and skull). A decrease in the fish population of the Araz reservoir living in zones of strong technogenic impact, a reduction in spawning potential, or even complete displacement from their habitats was observed. For the first time, methods for the rational management of fish resources have been developed for the region's reservoirs. The organization of fish weight monitoring, assessment of the impact of economic activities on aquatic ecosystems, compilation of an ecological forecast, and development opportunities and prospects for fisheries have been identified.

Аннотация. Исследование проводилось на рыбах. В результате исследования было установлено, что в зависимости от времени и типа загрязнения в организме различных видов рыб наблюдаются сходные или общие патологии, проявляющиеся отеками, экссудатами и кровоизлияниями. Реакция на воздействие токсикантов проявляется в виде возникновения различных аномалий и патологий (нефрокальцитоз, аномалии в структуре жабр, плавников и внутреннего скелета, черепа). Наблюдается снижение численности рыбы в Арацком водохранилище, обитающей в зоне сильного техногенного воздействия, снижение нерестового потенциала или даже полное вытеснение из мест обитания. Впервые разработаны методы рационального управления рыбными ресурсами для водохранилищ региона. Определены организация мониторинга веса рыбы, оценка воздействия хозяйственной деятельности на водные экосистемы, составление экологического прогноза, а также возможности и перспективы развития рыболовства.

Keywords: Lake, ecosystem, fish, mineral substances, anthropogenic factor.

Ключевые слова: озеро, экосистема, рыба, минералы, антропогенный фактор.

Fish species inhabiting the natural and artificial lakes of the Nakhchivan Autonomous Republic are an important food source for the local population. According to fishermen, both the abundance and diversity of fish in these reservoirs have decreased in recent years. The Nakhchivan Autonomous Republic possesses a much richer diversity of fish fauna than other regions of Azerbaijan. Undoubtedly, protecting this wealth is as critical as identifying the species. As this is the first study

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of its kind conducted in Azerbaijan, it is necessary to include recommendations regarding the factors affecting the fish fauna of the region's reservoirs and the measures required for their protection [1-3].

Material and methods

Materials were collected from the water basins of the region, in the most characteristic biotopes during the spring, summer, and autumn seasons of the years 2018–2022. Commonly accepted research methods in ichthyology were used in the collection and analysis of ichthyological materials [3, 4, 8-10, 12].

After the existing samples were collected, they were transported to the Laboratory of the Faculty of Biology at Nakhchivan State University, and scientific research was conducted on those samples. The samples brought to the laboratory were fixed in jars and special containers in a 4% formaldehyde solution. After the samples were identified at the species level, 10-15 individuals of each species and subspecies were taken, and their morphometric and meristic features were studied in the laboratory. Individuals of each species were photographed, and body color and patterns were determined from fresh samples. Relevant literature was used to identify the fish species [1].

Results and their discussion

Some species of economic importance to the local population in the study area (including *Acipenser stellatus kurensis, Rutilus (rutilus) caspicus, Ctenopharyngodon idella, Aspius aspius taeniatus, Luciobarbus capito, L. lacerta cyri, Blicca bjoerkna transcaucasica, Abramis brama orientalis, Cyprinus carpio, Hypophthalmichthys molitrix, Carassius auratus gibelio, Capoeta sevangi, Silurus glanis*, and *Sander lucioperca*, as well as Red Book species) are considered endangered based on their frequency of occurrence and the number of fish caught during the study period. Although some species hold no economic value for the local population, they are still regarded as biological resources.

It has been observed that certain taxa, which contribute to species diversity and serve as vital links in the ecosystem's food chain, are facing similar threats. Environmental pollution factors — including the gradual decline in aquatic ecosystem quality, significant changes in fish biomass, species diversity, density, and distribution, and the altered oxygenation of algal food resources — are weakening the food chain. Population growth and technological development have exacerbated environmental pollution; without intervention, the rich diversity of fish fauna in the region will be seriously affected. Pollution resulting from the production and consumption activities of individuals and companies has a detrimental impact, particularly on fish spawning and fertilization. Such studies are of great importance, as fish act as bioindicators of water pollution and represent a critical link in the transfer of toxic elements into the human body [11].

Currently, the diagnosis of toxicosis and the prognosis of its outcome allow for a comprehensive assessment of the condition of fish, accounting for the severity of the pathological process, including the state of the germinal system and its reproductive capacity.

It should also be noted that fish are a primary food source for humans; therefore, assessments of their condition must comply with veterinary and sanitary expertise requirements. Concepts regarding the stability of hydrobionts — the ability of organisms to resist the effects of pollutants in a reservoir—are not yet fully established. Recent studies have shown that many aquatic organisms survive in areas of economic activity, maintaining relatively high population sizes.

In this context, survival implies not only individual longevity but also the continuation of generations. It has been proven that pathologies of the gonads indicate significant impairment under the influence of pollutants. Furthermore, pathologies of female gonads are most diverse and prevalent in spawning grounds. The loss of females leads to a decrease in the total population size without

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necessarily affecting qualitative characteristics; conversely, the loss of some males may not affect population numbers but can alter the quality of the offspring, potentially aiding adaptation to new conditions and driving species evolution.

A sharp decrease in water levels in the reservoirs of the autonomous republic, alongside ecological changes in local fish species (such as shifts in age composition dynamics, absolute and relative productivity, sexual maturity, and spawning timing), has led to the drying out of spawning grounds and the death of developing eggs. In the initial stages of reservoir formation, a large volume of flooded trees and grasses created anoxic zones. Throughout the research period, fish with developmental anomalies (e.g., shortened snouts, deformed spines) were frequently observed in the reservoir.

On the other hand, the decrease in water level in the reservoir during the fish breeding season often leads to a further reduction in the already limited breeding grounds of phytophilic fish; it has been observed that the gonads of fish that cannot spawn undergo a resorption process, ultimately disrupting the natural recovery process of fish stocks in the reservoir. There are several approaches to assessing the effects of toxicants on fish. We used the expert assessment method to identify ecological crisis zones in areas polluted by heavy industry.

The description of clinical and pathoanatomical signs of fish intoxication was carried out within the first hour after the fish were caught. During the external examination of the fish, attention was paid to the intensity of coloration (the state of pigment cells—melanophores), the integrity of the fin lines and rays, and the general composition of mucus on the surface of the fish. Hyperemia, the condition of the scale cover, the presence of subcutaneous hemorrhages or ulcers, changes in body covers, deformation of the oral cavity, anus, and skull bones, and scoliosis were observed. Examining the eyes, attention was paid to their size, the presence of mucus, and the condition of the iris and cornea.

During the study, we used a simplified diagnostic scheme of up to 3 points and the application of the index of unfavorable state of the fish organism proposed by Yu. S. Reshetnikov and others. This method is not considered 100% accurate, but it can help in the development of a research program. The method is simple and can be widely used in ordinary ichthyological studies of ecosystems under any type of anthropogenic influence. According to the method, it is possible to quickly analyze the general state of fish in a large area and identify zones of ecological crisis and ecological danger. The method of expert assessment of the state of fish populations based on morphological anomalies in the affected area was used.

The study is based on the field method of visual assessment of changes in morphological parameters of fish used in ichthyological studies. All changes (anomalies) in the external morphology of fish occur due to the presence of heavy metal deposits in the muscles, liver, and skeleton.

The respiratory (gills) and digestive (liver) systems are the main "gates" into the fish's body and the places where pollutants accumulate. All these organs were examined as thoroughly as possible. First of all, the external appearance of the fish was checked — changes in the skin, various deformations of the bone skeleton (skull, fins), and deviations from the norm (number of rays on the fins, etc.). Muscle turgor, curvature, and shortening of the body size of the fish were observed.

After the fish were dissected, all internal organs were sequentially examined: stomach, liver, intestines, kidneys, bladder, spleen, heart, and gonads. At the same time, attention was paid to the color, size, and shape of all organs. The condition of the spine was determined by curvature of the spinal column, fusion of the vertebrae, or other anomalies.

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