Histological Study of the Gills and Gastrointestinal Organs of the Fishes, Inhabiting the Lake Bilikol

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Abstract: There was done a histological study of gills and organs of the gastrointestinal tract of the fishes inhabiting the lake Bilikol in Zhambyl oblast. On the basis of the revealed extensive morphological changes of a destructive nature in the gills, the stomach and intestines of the fishes there was drawn the conclusion about contamination of the water pool with toxicants.

Key words: Pike perch • Crucian carp • Bream • Gills • Stomach • Intestine • Morphology

INTRODUCTION

The lake Bilikol is 75 kilometers to the south-east of the city of Taraz, Kazakhstan. It is the deepest and largest lake in Zhambyl region. The lake is characterized by a unique ecosystem. According to the data of Kazakh Research Institute of Fisheries in 2005 the lake Bilikol inhabited more than 13 species of fish, such as carp, pike, silver trout, grass carp, dace, snakehead, bullhead, vostrobrushka, Amur chebachok. The lake water was characterized by a rich zooplankton, zoobenthos. Over a number of years (1965-1985) the lake Bilikol received conditionally clean water from DPO “Chymprom” and “DSP”, pollutants such as elemental phosphorus, phosphates, fluorides, compounds of nitrogen fell there via Talas - Asa channel. In 1972 and 1983 there were emergency sewage discharges of DPO “Chymprom”, pollutant concentrations were of extremely high level, which led to the death of fauna and flora in the lake, to the mass death of fish in particular. Since 1983, the lake ceased to exist as a pure water reservoir. As a result of the long-term human impact on revenue of pollution from industrial plants for the production of mineral fertilizers and runoff from irrigated areas, water resources of the lake Bilikol are under deep eutrophication. Water shortage from 1974 to 1976 and from 1981 to 1984, the annual flow of the river Asa fell to 50-60 %, resulting in reduced replenishment of water of the lake Bilikol and the lake Akkol has dried up. In 1984, due to the lowering of the water level in the lake and the significant water warming in summer, COD reached the 1124 mgO/l, BOD 60-84 mgO/l, the contents of dissolved oxygen decreased to 1.28 mg/l, which resulted in a large-scale death of fish and in winter there is no dissolved oxygen under a layer of ice. The content of ammonium ions was 20 MACs for phosphorus compounds and exceeded the norm by 10-30 times. This caused a bloom of phytoplankton and higher aquatic vegetation. According to Follenvayder classification the lake Bilikol was referred to hypertrophic water pools in 1984, the biomass of blue-green algae increased to 496 ml/l. Hydrochemical observations of the lake Bilikol resumed after a long break since 2007. Although there are no wastewater discharges into the lake at the time, the lake still refers to the polluted water reservoir. Sulfates are 8-10 MAC, high water mineralization - 875-1900 mg/l, fluoride concentration exceeds MPC more than 2 times, BOD exceeds MCL from 23 to 33 times. Water turbidity is of great importance for BOD5.

The worsening ecological situation of the region and, consequently, of the lake Bilikol located there, has led to a sharp reduction of flora and fauna associated with the...
In particular, in 2012, according to the data of Kazakh Research Institute of Fisheries, the number of species of fish found in the lake Bilikol dropped to 6. Toxic substances which are in the water reservoir, getting into the fish living there, can cause severe morphological changes which may degrade the functioning of the internal organs of fish [1-7]. In this context, the aim of our research was a histological examination of gills and organs of the gastrointestinal tract of fish of the lake Bilikol.

**MATERIALS and METHODS**

The object of the histological studies was gills, stomach and intestines of some fish species. The material was fixed in 10% neutral formalin, conducted by the conventional histological methods and embedded in paraffin. Histological sections were stained with hematoxylin-eosin [6]. Each examined organ was used to prepare sections of at least 5 slides. Sections were stained with overview colors - hematoxylin and eosin [6, 7]. Analysis of histologic preparations was done under a light microscope Micros MC-20. Digital microphotographs were obtained with the use of a microscope “Leica DMLB2” by the digital camera Leica DFC 320.

Morphology of perch gills. In the studied species the perch gills presented with the gill petals and gill small petals departing from them, had the following morphological structure. In the interior of the gill petals there was the hyaline cartilage arc, surrounded by the connective tissue with large blood vessels in it. The gill petal was covered with primary gill epithelium, which is multilayered flat respiratory. The bulk of it was made of respiratory cells, characterized by middle-sized dimensions, the nucleus located in the center, basophilic cytoplasm. In addition to respiratory cells there were found mucous and rod-shaped cells in the primary gill epithelium. These types of cells were arranged in the regions between the gill petals and on the edge of the petal. Mucosal cells were characterized by the large size, the core shifted to the basal part, intensive oxiphilic cytoplasm. The rod-shaped cells were of a regular circular shape in cross section and of an oval shape in longitudinal section, the nucleus shifted into the basal part, slightly oxiphilic cytoplasm. A significant edema marked mainly in the epithelial layer of basal formation was found in the epithelium petals.

On both sides the gill petals let out numerous gill small petals - lamellae. We observed the change of the form of lamellae in the studied species of perch. The ends of the lamellae were bent; the lamellae took the form of a hook. The lamellae were covered with a two-layered flat respiratory epithelium located on the basal membrane under which a vascular layer was localized. The latter is represented with a single row spaced columnar cells, between the side surfaces of which there are the cavities filled with blood. The extensive necrosis of the epithelium of the lamellae was found in the studied species of perch. At the basis of the lamellae in the secondary gill epithelium covering them a swelling was detected. In addition, some lamella had a destruction of a vascular layer, resulting in the formation of hemorrhage and bleeding.

Thus, the studied species of perch had morphological changes of a destructive nature in the gills. They were expressed in the change of the shape of lamellae, extensive necrosis of the secondary gill epithelium and destruction of the vascular layer of lamellae leading to hemorrhage and bleeding.

The morphology of crucian carp gills. Gills were presented with petals and lamellae departing from them in both sides. In the interior of the gill petals there was a hyaline cartilage surrounded by the connective tissue with blood vessels localized in it. The gill petals were covered with multilayered epithelium. It was formed by the respiratory cells that made up the bulk of it, as well as mucous and rod-shaped cells, the mature forms of which were clearly identified in the outer epithelial layer of petals. In the studied species of carp in the primary gill epithelium of the most part of petals there was detected a significant edema.

The lamellae were numerous. In the studied species of carp there was found the change in the form of individual lamellae. There were identified lamellae with the curved ends in a hook form and expanded in the form of a mace. The lamellae were covered with a two-layered flat epithelium formed by the respiratory cells. In the epithelium of the lamellae there was detected a significant edema, more marked at the basis of the lamellae. A number of lamellae had the necrosis of respiratory cells of outer and inner layers of the secondary gill epithelium and their exfoliating from the surface of the lamellae. In addition, there was the destruction of the individual columnar cells of the vascular layer of the lamellae, leading to the unification of small cavities into the extensive capillary blood cavities.

Thus, the studied species in the carp gills had morphological changes of a destructive nature. They were expressed in a significant edema in the epithelium of the
The morphology of the stomach of pike perch. The mucous membrane of the stomach of pike perch forms shallow folds. On the mucosal surface, there are numerous excavations - the gastric pits into which channels of glands go out. The inner surface of the stomach is lined with a single layer of the columnar epithelium. Under the epithelium of the mucosa there are numerous simple tubular glands. In the stomach of pike perch epithelium maintained the integrity, the glands had a normal structure.

The morphology of the intestine of pike perch. The mucosa in the intestine of pike perch forms numerous very high folds. The wall of the intestine is quite thick. The connective tissue of the intestine wall is mostly dense. There is a well developed muscular layer consisting of the smooth muscle tissue. The mucous membrane was covered with a single layer of columnar epithelium, which included goblet cells. There was edema in the mucosa. The muscular coat was unchanged. In some areas there was desquamation of the intestinal epithelium in the back and on the top of folds and necrosis of the epithelium cells. In the less damaged areas of the intestinal mucosa there was noticed the increase in the number of goblet cells, which apparently was a defensive reaction to the action of damaging factors. At the top of the intestine folds there were inflammatory infiltrates. In general, the revealed pathomorphological changes in the small intestine have suggested the action of any damaging agent or toxicant on the normal histological structure of the organ. The small intestine of pike perch was a more vulnerable organ in comparison with the stomach.

The morphology of the intestine of bream. A bream is a member of the carp fish, which do not have the stomach. Bream intestine is the undifferentiated histologically homogeneous tube. A characteristic feature of the bream intestine is the presence of very thin high folds. The epithelium of the intestine mainly kept its integrity, but the ratio of suction and goblet cells was clearly in favor of the goblet ones. This is especially evident in a cross section through the tall thin folds, where there were almost no suction cells. Thus, the changes in the intestine of bream were less marked than in the pike perch one and were reduced to the minor violation of the integrity of the epithelium and the increase in the number of goblet cells, which in violation of the absorption process may lead to more serious consequences in future.

**CONCLUSION**

Morphological study was done in the gills and digestive tract of such species of fish as pike perch, crucian carp, bream and carp. Almost all the studied species of fish had morphological changes of a destructive nature in the gills. They took the form of the petals and the lamellae, the necrosis of respiratory cells of the secondary gill epithelium with denudation of the petals, the destruction of the vascular layer of the lamellae with the formation of hemorrhages.

The morphology of carp gills. The secondary gill epithelium covering the gills petals was multilayered. The bulk of it was made of respiratory cells characterized by middle-sized dimensions, a round nucleus located in the center, basophilic cytoplasm. In the outer layer of the primary gill epithelium there were revealed the mature forms of mucous and rod-shaped cells. Mucous cells, providing the production of mucus, were characterized by the large size, the nucleus shifted into the basal part, oxiphilic cytoplasm. The rod-shaped cells also involved into the production of mucus, had the correct oval shape, the nucleus shifted into the basal part, oxyphilous rod-shaped secretory granules in the cytoplasm. The rod-shaped and mucous cells in the primary gill epithelium of the studied species of carp were numerous. In the basal layer of the primary gill epithelium there was detected edema.

The lamellae were numerous. A number of lamellae changed their shape. There were identified lamellae with the curved ends in a hook form and expanded in the form of a mace. The secondary gill epithelium covering the lamellae was formed by the two layers of respiratory cells of flattened shape. In the secondary gill epithelium of the studied species of carp there was a significant edema. A number of lamellae had the necrosis of respiratory cells of outer and inner layers of the secondary gill epithelium and their exfoliating from the surface of the lamellae, resulting in denudation of a vascular layer. In addition, there was the destruction of the individual columnar cells of the vascular layer of the lamellae, leading to the unification of small cavities into the extensive capillary blood cavities within a vascular layer and in the case of necrosis of the secondary gill epithelium - to hemorrhage.

Thus, the studied species of carp had morphological changes of a destructive nature in the gills, expressed in the significant edema in the epithelium of the lamellae, necrosis of the respiratory cells of the secondary gill epithelium leading to denudation of the vascular layer of the lamellae, as well as in the destruction of the vascular layer of the individual lamellae.

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large edema in the epithelium of the gill petals and, to a greater extent, in the epithelium of lamellae, the change in the form of lamellae, in the necrosis of the respiratory cells of the secondary gill epithelium and their desquamation from the surface of lamellae, which led to denudation of the inner vascular layer; in the destruction of the columnar cells of the vascular layer, leading to the unification of small cavities into the extensive capillary blood channels within the vascular layer and in case there is the necrosis in the secondary epithelium - to hemorrhage. The studied areas of necrosis of respiratory epithelial cells of lamellae, as well as individual columnar cells of the vascular layer of lamellae indicate the presence of a strong toxic effect of the external environment, causing death of the cells. The defined change in the form of lamellae also indicates the presence of toxicant exposure. Bending of the ends of lamellae in the form of hooks can be caused by the necrotic changes in the secondary gills epithelium. Mace-shaped expansion of the ends of lamella can be the indication of violation of the integrity of the vascular layer. The observed destructive changes of the morphology of the gills were extensive in nature, indicating a strong toxic impact on the fish species.

Note, that the changes of a destructive nature were observed in lamellae, while the gill petals were predominantly of the steady structure. It is known that the gill lamellae are more susceptible to the adverse effects because their structure suggests their greatest vulnerability. The secondary gill epithelium covering them is formed by two layers of flattened respiratory cells beneath it there is a vascular layer of lamellae formed by the row of columnar cells that divide the capillary space. This lamellar structure is adapted to the active transportation of dissolved gases into the blood of fish. Being the most permeable, it is in the same time more vulnerable to adverse effects and, thus, more able to be damaged.

The significant changes in the stomach of pike perch were not detected. In the intestines of all the studied species of fish there were pathomorphological changes in the form of edema, increasing the number of goblet cells, epithelial desquamation, necrosis and inflammation of the gland cells.

Thus, on the basis of the identified extensive morphological changes of a destructive nature in the gills and intestines of all the studied species of fish, we can conclude that there has been a strong toxic effect on the part of the environment, leading to severe pathomorphological changes and, as a consequence, to a violation of the functioning of organs.

REFERENCES