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Morphological and Functional Changes of Internal Organs as the Qualitative Evaluation of the Caspian Sprats Population

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ABSTRACT

The analysis of a morphological and functional condition of internal organs of the Caspian sprats on the basis of histologic, histochemical and histoenzymatic researches is presented. We found pathological changes in liver, muscular tissue, gonads of sprats in the form of blood microcirculation disorder, the phenomena of fatty and albuminous degeneration, tissue hypoxia, and also augmentation of regeneration signs. The presented complex of data could be regarded as an indicator of fish population adaptation in modern conditions of the reservoir.

KEY WORDS: Caspian sprats, liver, muscle, gonads, pathological alteration, degeneration, tissue hypoxia, regeneration, adaptation.

INTRODUCTION

Life of any organism and population closely depends on the environment in which qualitative indicators are changing with various intensities during certain time periods. External factors of high intensity caused disappearance of species, and the organism managed to adapt to the factors of low intensity, with organism variability as a leading process [12]. At the present stage, under the pressure of anthropogenic influence, the number of died out species has increased with a sharp decrease in their population.

Among all factors of human activity the greatest danger for biota (regional flora and fauna) is the inflow of various chemical compounds including xenobiotics with toxic effect on hydrobionts into open reservoirs. In this regard the Volga-Caspian reservoir is not an exception.

The last twenty years of ichthyologic researches data testify a noticeable population decrease of target fish species of this region [8,6,13,11]. Using the example of the Caspian sturgeon it was proved that one of the reasons for population decrease of this kind is cumulative toxicosis [14,15,3,2,4,7]. We carried out similar supervisions over a qualitative condition of the Caspian sprats on a selective basis using researches of the year 2003 when regeneration signs clearly appeared against small structural disorders. The present work shows these data based on the morphological and functional analysis of internal organs of ordinary sprats and anchovy sprat (Clupeonella engrauliformis).

Purpose of this Work

The use of morphological and functional indicators of internal organs of the Caspian sprats to estimate the population.

Objects and Research Methods

A total of 71 samples of sprat were analyzed. 34 of them are anchovy sprat (Clupeonella engrauliformis) and 37 are ordinary sprats, were caught during the international Caspian shooting in winter 2003 in regions of the Middle (water area of Kazakhstan) and the Southern (water area of Turkmenistan) Caspian Sea. Samples of liver, gills, skeletal muscles of a back, gonads of sprats were processed to define general structure [1], histochemical compound of the general lipids, ribonucleoproteid (RNP), succinat dehydrogenase - (SDG), lactate dehydrogenase (LDG) and cytochrome oxidase (COX) [9] with the use of cryostat (-20ºC). The estimation of pathological changes was carried out due to the standard five-point system, the material is processed statistically. We studied and photographed 1284 samples at light-optical level on using microscope «Olympus BX 40» (Japan).

RESULTS AND DISCUSSION

The changes in a liver of an Clupeonella engrauliformis around the Middle Caspian Sea are 2,56± 0,21. This indicator is equal to 2,73± 0,15 at the Southern Caspian Sea. However, the revealed distinctions were not statistically reliable. The changes in liver of an ordinary sprat caught around the Southern Caspian Sea, practically

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didn't differ at Clupeonella engrauliformis: 2,75 ±0,06. Thus, regional and interspecies distinctions in a liver were missing. In a morphological pattern of a sprat liver we paid attention to the blood-shunting; the increase of proportion of hemosiderin pigment in the form of small, irregularly diffused assemblies. In some marked cases we observed hypostasis and presence of small-focal blood bleeding. The nucleuses of hepatic cells were often large enough, accurately outlined, with light cytoplasm more often with one nucleus. However, we could find both small dark nucleuses and two-nuclear hepatic cells. We found out that cytoplasm of hepatic cells was vacuolated in 30 % cases. Besides, it was found that Clupeonella engrauliformis in 12% cases and ordinary sprat in 14 % cases had a connective tissue at parenchyma strand formed on a place of died earlier or pathologically changed hepatic cells that testified of the development of compensative–adaptive processes in a liver of sprats.

The research on branchial epithelial tissue didn't reveal authentic regional and interspecies distinctions. Morphological changes in the gills of sprats and the most characteristic like deformation of filament and lamella were observed; vascular disorder and various changes of respiratory epithelial tissue [10]. The changes at the morphological pattern of a muscular fabric of two species of sprats were estimated on an average of 2,5 p. Sex differences were shown by insignificant increase of pathological changes in muscles of males in comparison with females. The decrease of pathological changes of a muscular tissue can be connected with the regenerative processes occurring in muscles of sprats. Results are represented in Table 1.

Table 1. Assessment of histologic indicators in liver, gills and muscles of sprats

Species of a sprat	Average Caspian Sea			Southern Caspian Sea		
	liver	gills	muscles	liver	gills	muscles
Clupeonella engrauliformis	2,56±0,21	2,84±0,05	2,4±0,75	2,73±0,15	2,70±0,13	2,55±0,18
Ordinary sprat	-	-	-	2,75±0,06	2,77±0,09	2,65±0,11

Note: $^{*}p < 0,05$, $^{**}p < 0,01$.

The histologic analysis of sexual glands of both species of sprats from 2 regions showed that the major part of species was at the II stage of development which is generally represented by oocytes of the phase of a single-layered follicle. Existence of males with gonads at the IV-II stage and morphological and functional pattern of female gonads testifies that the fish has spawned. The destructive changes in sex glands of females and males were not noted. One species at the IV maturity stage in 8 % of oocytes had the compression of cytoplasm and its peeling off from an internal vitelline membrane and the swelling and thickening of a vitelline membrane were also observed. Two male species at the II - III and III stage, had the hyperemia of spermarium blood vessels [10].

According to the results of the histochemical analysis, Clupeonella engrauliformis has small morphological and functional disorders in a liver:

- 13% of selected species has the accumulation of the general lipids in hepatic cells 2,0 p.,
- 37% of cases has the decrease in the maintenance of RNP in 2,3 p.,
- 19-21% of selected species has the decrease in activity of SDG and COX 2,4-2,9p., respectively,
- 50% of selected species has the decrease in LDG activity 1,5 p.

The following histochemical changes were defined in a skeletal muscle of the back of sprats:

- 12 % of cases has the small congestion of lipids in muscular tissue and intermuscular spaces 1,2 p.,
- 18 % has the decrease in activity of SDG and COX 3,0 – 2,6 p.,
- 43 % of selected species has the decrease in activity of LDG 1,6 p. Data are represented in table 2.

Table 2. Frequency of occurrence of pathological histochemical indicators in internal organs of Clupeonella engrauliformis (%).

Indicators	Liver	Muscle
Lipids	13	12
RNP	37	31
SDG	19	18
LDG	50	43
COX	31	25

Analyzing morphological and functional condition of the sprats caught in the Caspian Sea, we should pay attention that against small structural (blood microcirculation disorder), dystrophic (fatty and albuminous degeneration) and oxidation-reduction changes (decrease in activity of SDG, LDG and COX), the regeneration phenomena developed in the internals in the form of two-nuclear hepatic cells and proliferations of a connecting tissue on place of destroyed or pathologically changed cells. These changes could be regarded as adaptation indicators in modern conditions of water pollution.

Conclusion

Estimating received results on morphological and functional changes in the internals of the Caspian sprats, we emphasize that the presupposed concept of cumulative toxicosis in fish organism on the basis of use of its non-specific display in the form of pathological alterations in microstructures of internals of different types of fish is

proved. It is important to note that last ten years nominated principles of chronic toxicosis study of fish in natural environment become widely used. The pathological changes of blood corpuscle in blood of Coregonus have been found due to different types of pollution by apatite-nepheline and copper-nickel production discharge at fresh-water reservoirs, [5]..

The results presented in this work, and long-term own data on the sturgeon completely correspond with works of other authors. Pathomorphological changes in internals of the Caspian sprats indicate heterogeneity of population in the sense of stability to reservoir pollution. Therein we have two groups of species: the first – more stable (conditional norm) without the alterations, the second – less stable with obvious pathological alterations in internal organs. Theoretically the species of the second group have equal chance of dying or survival. The lethal outcome can come under the influence of other factors strengthening progressive nature of pathomorphological changes, and the survival of fish can result because of the development of regeneration processes. Similar suggestions demand to carry out additional researches.

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