UDC [597-187:597-142.8]:[597-1.044:597-19(267.33)]
BBK [28.693.32-6:47.222]:28.085(931)

V. N. Kryuchkov, Ahmed Mohammed Al-Buraee,
Saleem Mirza Hadi, A. V. Dubovskaya

CHANGES IN THE CHARACTER OF GILLS OF THE RED SEA FISH

В. Н. Крючков, Аль-Бураи Ахмед Мохаммед,
Хади Салим Мирза, А. В. Дубовская

О ХАРАКТЕРЕ ИЗМЕНЕНИЙ ЖАБР РЫБ КРАСНОГО МОРЯ

The morphological structure of gills of the Red Sea fish, caught in areas with different levels of anthropogenic impact is studied. It is shown that the frequency of pathological changes of the gills is higher in the port area, but it is lower in the relatively clean area. The gills of relatively sedentary fish are more susceptible to the negative effects of the environment, while the gills of active large-scale mullet are less vulnerable. The character of the changes in the gills of the examined fish does not depend on their kind.

Key words: gills, respiratory epithelium, hyperplasia, lamella.

Изучено морфологическое строение жаб рыб Красного моря, отловленных в районах с различным уровнем антропогенной нагрузки. Показано, что частота встречаемости патологических изменений жабр наибольшая в районе порта и наименьшая – в относительно чистом районе. Наиболее подвержены негативному влиянию среды жабры относительно малоподвижных рыб, в меньшей степени – жабры подвижной крупночешуйной кефали. Характер изменений жабр исследованных рыб не зависит от вида.

Ключевые слова: жабры, респираторный эпителий, гиперплазия, ламелла.

Introduction

In comparison with ground animals aquatic animals are characterised by the connection between an organism and environment. This connection is made through different morphological features (the skin, respiratory organs, digestive system) in which epithelial tissues are also included. Epithelial tissues consist of a set of cells with the same origin and function [1]. Phylogenetically epithelial and digestive systems are the oldest ones. The functions of epithelial tissues are varied. For example, for the higher animals they do a barrier function, suction function, respiratory and many other functions. Despite the variety of functions the representation of specialized cells is necessary as epithelial tissues are characterised by a whole bunch of general signs (symptoms) for the system organization.

Fish gills are organs that are always in touch with the environment. In their epithelium the process of breath, the maintenance of osmotic and acid balance and the change of ions take place. Through them the products of metabolism are removed. Their diversity of functions identifies the difficult structure of the organism. Through morphological investigations the existence of two specialized sections in the gills epithelium is identified; they differ in structure and functions. According to this, the gills epithelium is divided into a multilayer filament (primary), linked with arteriovenous circulatory system, and a double-layer lamella (secondary), supplied with blood from arterial system. According to performed functions, the epithelium of the filament is currently classified like osmoregulatory and the lamella one is classified like respiratory [2].

Fishes are like biomarkers of the quality of the environment [3, 4] that are not used frequently. Some authors believe that the primary organs suffering from the impact of petroleum products [5, 6], are liver and gills as the main organs of metabolism and respiration. Usually gills are the main target of pollutants [7].

The material and methods of investigation

We investigated some species of fish, inhabiting the Red Sea; they vary in the taxonomy life style, diet.

Mullet is one of the common fish on Yemen's market because of the quality of the meat and available price. On Yemen's market mullet contains 20 % of the total fish production. For our investigation we look *mullet Liza macrolepsis* (class Mullet *Mugilidae*).

The other object of the investigation was *Aryans catfishes Arius gogora* (class Aryans *Ariidae*). These are typical sea catfish, in distinction with more common freshwater *Arius gogora* they are medium-sized fishes living in coastal waters, the object of small fishing.

The representatives of species mojarra (*Gerridae*) live on coastal shallows near sand coasts. We investigated the typical species – *Moharra Gerres oyena*.

The species of rudderfish (*Lethrinidae*) – are typical residents of coastal zone. Their most favourable parts are coral reefs, rocks, heaps of stones and thickets underwater vegetation. They prefer stony, sandy and rocky ground. The composition of food the rudderfish needs are very varied; they eat fish and also different invertebrates (shellfish, crustaceans, worms). The representative of rudderfish is *Lethrinus lentjan*.

Fishing was made in the southern part of the Red Sea. Sampling was made in 2010 in 3 places. The first place was an island Taif, we defined it like a test zone. Taif is a small island, situated in the southern part of the Red Sea, 1 mile distance from the coast. The waters around the island are full of life, sources of anthropogenic pollution are almost not found in comparison with other parts of the sea.

The second point was on the territory of the Al – Hodeidah seaport. It is situated berths for a lot of fishing ships; this region is subject to pollutions from fishing waste and water cleaning (peeling).

The third part of fishing is 15 km from the coast (depth – approximately 14 m).

The samples of gills were fixed in Buena's solution or in 10 % neutral formalin. The pouring was made into paraffin blocks; the slice thickness is for 5–7 mcm, the colour is hematoxylin-eosin. The analysis and photographing of the micropreparations were made with the microscope "Olympus BH-2", with the help of eyepiece – micrometers the main morphometric parameters were identified.

The results of the investigation and their discussion

A relative mass of the studied fish gills were different in more degrees by physiological characteristics of different kinds. The biggest mullet and Aryans catfish had the highest value of gills index, respectively 3.45 ± 1.16 and 3.70 ± 0.94 %.

For mojarra and rudderfish the gills index values were respectively 2.52 ± 0.72 and 2.74 ± 0.52 %. It is quite obvious that more mobile mullet and some Aryans catfish have relatively bigger gills than mojarra and rudderfish; they are more bounded with reefs and coastal zones. We didn't reveal the significant gills index change in connection with the size of the investigated fishes.

The frequent occurrence of certain gills changes, for example of mullet or rudderfish are shown in the table.

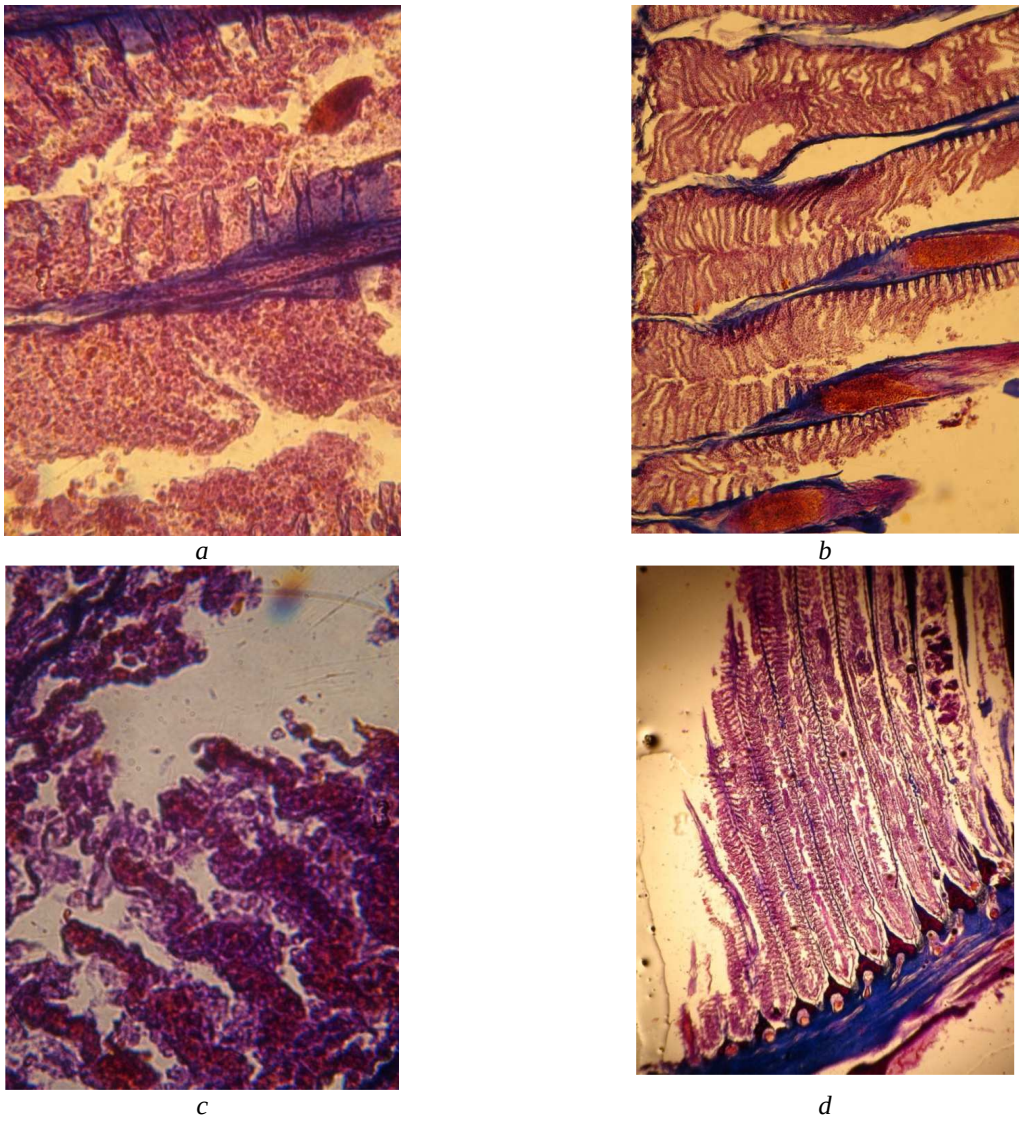
Type and frequency occurrence chance for gills, %, mullet/rudderfish

Type of the pathology	Island Taif	Fisheries area	Al-Hodeidah seaport
General type of gill's petal structure	29.0/52.0	11.3/16.6	3.57/7.14
The initial changes lamellae (hypertrophy of cells, the appearance of distortions)	44.5/42.0	34.0/40.6	30.36/38.1
Cells hyperplasia of respiratory epithelium	18.6/8.0	51.7/56.3	60.71/71.4
Distortion of the lamella	16.2/8.0	30.3/36.6	26/38.1
The lack of lamella from one petal side or from 2 sides of the petal	0/4.0	1.3/4.3	3.57/9.5
Integrity dislocation of respiratory epithelium	0	2.7/0	3.57/0
Shortness of the lamella	0	15.0/9.3	14.28/4.8

The most widespread were different forms of cell hyperplasia of both respiratory epithelium and filament's epithelium. The initial stages of changes in lamella's forms, lamella's curvature were also frequently met. According to the table the increasing frequency of changes of fish gills depending on fishing place was observed. In the region of island Taif more than half of the rudderfish that was caught had gills in the norm, as in the part of the seaport this index was already 7.14 %. There is a sig-

nificant difference in frequency of such serious pathology like the lack of lamella from one or both sides of gills petal. So on the island Taif such pathology was detected only at 4 % of rudderfish, but in the seaport the gills with such changes was found already in 9 % of the fish. A similar pattern was identified in large-scaled mullet. At the same time, the difference in the frequency of occurrence of the changed gills in dependence of the fishing place at mullet is less than that of rudderfish. We associate this with the circumstance that mullet are more mobile fish, and when changing feed locations they leave the contaminated (dirty) parts of the sea. In such way they are less in contact with the effects of contamination than less mobile rudderfish, more mullets gravitating on the specific territory.

Fish gills, caught in the point, defined as a test one, had a different manifestation of the pathology changes (fig.).



a *b* *c* *d*

Fish gills of the Red sea: *a* – proliferation of respiratory epithelium of Aryans catfish gills. *b* – proliferation of respiratory epithelium and disorders of blood circulation on Moharra's gills; *c* – the form and size changes of the Aryans catfish lamells; *d* – the violation of the rudderfish gills integrity

Nevertheless, the most fish gills had a normal morphological structure. The gills structure has already been described in details, in particular, in the work of V. E. Matei [2], there was also noted that all bony fish gills have a single structure plan. So there is no need to make a detailed analysis of the gills structure of the 4 fish species we investigate. We just recommend to read the mentioned work. It's just necessary to note that both primary and secondary lamellas had a typical structure, epithelium structures weren't violated, gills epitheliums were clearly subdivided into afferent and efferent zones.

Mobile fishes (mullet, Aryans catfish) had more and longer respiratory lamellas than rudderfish and mojarra. Secondary lamellas had the form typical for unchanged gills, epithelium cells covered the primary and secondary lamellas; they had typical forms and sizes, epithelium layers were not damaged.

The increase in number of cell elements (hyperplasia) both in the primary and secondary epithelia, that was observed in polluted areas in 70% of fish that made no territorial movements such as rudderfish, can be considered as one of the most widespread gills pathology on the cellular level. The initial stages of hyperplasia were observed mainly in lamellas basis. Step by step the cells filled the space between lamellas that brought to the diminution of respiratory surface. We believe that in this case we were investigating the proliferation of the epithelium filament.

Hyperplasia of the secondary epithelium occurred hazardously, disorderly at different levels of lamellas located between the gills sides where the epithelium did not have any signs of proliferation. Mostly at the top of lamellas there were expansions which formed bottle-shaped swellings. Sometimes these masses from neighbouring or placed opposite lamellas combined between each other forming long strips from effused respiratory epithelium.

The increase of the common cells number in filament's epithelium is usually considered like an essential component for adverse reaction to toxic effects of different nature [2, 5].

It should be noted that fish gills from contaminated parts had violation of the integrity of respiratory epithelium, detachment of the epithelium layer from underlying tissues, hypertrophy of the cells respiratory epithelium. The result of the morphometric measurements showed that in contaminated parts in fish gills the length and width of lamellas are less ($p < 0,05$), respectively 11.5 and 9.7 % than that of fishes from the test group. The distance between lamellas also was reduced, the main image in the connection with the thickening of respiratory epithelium on the basis of hyperplasia. Despite the species differences the observed changes had a similar character.

The morphological changes of the gills were accompanied by circulatory disorders as an extension of the capillaries, in special cases thrombus formation.

Generally we can note that possible toxic substances contribute to the evolution of different pathological gills condition. As it is noted in the article of T. I. Moiseenko [8], in extremal conditions of contaminations the common biological mechanisms reacting to stressful situations start working. When the changes are out of the adaptive form capabilities, pathologies and functions take place.

Hypertrophy, the amplification of the functional activity and increase of the common cells number in the filament's epithelium is the principal element of the adverse reaction to toxic impact of different origin.

REFERENCES

1. *Zavarzin A. A.* Osnovy sravnitelnoy gystologii. – L.: Publishing House of Leningrad University, 1985. – 400 p.

2. *Matei V. E.* Funktionalnaya morphologia zhabernogo epithelia presnovodnyh kostistyh ryb // Physiologia, biokhimia i toxicologia presnovodnyh zhyvotnyh. – L.: Nauka, 1990. – P. 104–136.

3. *Tom M., Myers C. R., Waterman M. R.* Competitive ELISA utilizing membrane-free recombinant fish CYP1A as standard for evaluation of its microsomal homologue molar concentrations // Aquat. Toxicol. – 2002. – 59. – P. 101–114.

4. *Monitoring* of hepatic metallothionein mRNA levels in the fish Lithognathus mormyrus-evaluation of transition metal pollution in a Mediterranean coast / M. Tom, E. Jakubov, B. Rinkevich, B. Herut // Mar. Pollut. Bull. – 38. – P. 503–508.

5. *Engelhardt F. R., Wong M. P., Duey M. E.* Hydromineral balance and gill morphology in rainbow trout Salmo gairdneri, acclimated to fresh and sea water as affected by petroleum exposure // Aquat. Toxicol. – 1981. – 1. – P. 175–186.

6. *Khan R. A.* Influence of petroleum at a refinery terminal on winter flounder, Pleuronectes americanus // Bull. Environ. Contam. Toxicol. – 1998. – 61. – P. 770–777.

7. *Alazemi B. M., Lewis J. W., Andrews E. B.* Gill damage in the freshwater fish Gnathonemus petersii (Family: *Mormyridae*) exposed to selected pollutants: an ultrastructural study // Environ. Technol. – 1996. – 17. – P. 225–238.

8. *Moiseenko T. I., Yakovlev V. A.* Antropogennye preobrazovania vodnyh ecosystem Kolskogo Severa. – L.: Nauka, 1990. – 220 p.

The paper is submitted to the editorial board 29.06.2012

INFORMATION ABOUT AUTHORS

Kryuchkov Victor Nickolaevich – Astrakhan State Technical University; Doctor of Biological Sciences; Professor of the Department "Hydrobiology and General Ecology"; kvn394@rambler.ru.

Крючков Виктор Николаевич – Астраханский государственный технический университет; д-р биол. наук; профессор кафедры «Гидробиология и общая экология»; kvn394@rambler.ru.

Dubovskaya Anisiya Victorovna – Caspian Scientific Research Institute of Fishery, Astrakhan; Senior Research Worker of the Laboratory "Physiology and Genetics of Fish"; kaspiy@astranet.ru.

Дубовская Анисия Викторовна – Каспийский научно-исследовательский институт рыбного хозяйства, Астрахань; старший научный сотрудник лаборатории физиологии и генетики рыб; kaspiy@astranet.ru.

Al-Buraee Ahmed Mohammed – Astrakhan State Technical University; Postgraduate Student of the Department "Hydrobiology and General Ecology"; kvn394@rambler.ru.

Аль-Бураи Ахмед Мохаммед – Астраханский государственный технический университет; аспирант кафедры «Гидробиология и общая экология»; kvn394@rambler.ru.

Hadi Saleem Mirza – University of Karbala, Veterinary College, the Republic of Iraq; Candidate of Biological Sciences; Head of the Department "Pathology"; hadisaleem25@hotmail.com.

Хади Салим Мирза – Университет Кербела, ветеринарный колледж, Республика Ирак; канд. биол. наук; зав. кафедрой «Патология»; hadisaleem25@hotmail.com.