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Nosological Description of Fish Pathologies in RAS

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Abstract.

When valuable fish species are cultivated in recirculating aquaculture systems, pathologies of various etiologies may occur and evolve. In this connection, our study is aimed at specific pathologies of various etiology in fish in the conditions of recirculating aquaculture systems based on the ichthyo-pathological monitoring. Based on clinical-epizootological and laboratory examination, the characteristics of infectious and parasitic pathology of sturgeons have been studied in recirculating aquaculture systems, and clinical forms and occurrence reasons for the development of various nosological entities have been identified. The factors have been revealed that promote a complicated epizootological situation in cultivation of sturgeons in recirculating aquaculture systems.

Keywords: RAS, sturgeons, nosological profile, aeromonosis, pseudomonosis, myxobacteriosis, diclybothriosis, argulosis

INTRODUCTION

Currently, a perspective technology for sturgeon breeding is a recirculating aquaculture system (RAS). Its technological capabilities permit growing fish all year round while the yield of commercial fish per 1 m^2 is increased by several times as compared to the conventional method.

A RAS represents almost enclosed space where the maximum favorable conditions must be created for fish management and breeding with respect to gas, temperature conditions, placing density, accumulation of metabolite, organics decomposition products, and intensification of breeding processes. In case one of the above indicators is disturbed, massive diseases and death of fish may occur [1-5].

The diseases are an external consequence of a disturbed immunity function and general resistance (adaptive potential) caused by the influence of adverse environmental factors on the health of fish and reflection of pathologic processes at the molecular, cellular, tissue, organ and organism levels occurring as a response to the action of pathogenic organisms, toxic agents and impaired habitat conditions.

Various fish species are managed and farmed in RAS. More often, a RAS is intended to manage and farm valuable fish species, sturgeons, etc. Due to the business need of our university to provide scientific and practical support to commercial farms and provide education in the discipline, management and farming of carps is also practiced, including a decorative species of koi carps.

Sturgeons are characterized by significant resistance to various pathologies and, provided that the management technology is observed and no causal agents are brought from the outside, a RAS is a perfect place to farm healthy fish. However, the development of aquiculture and the expansion of production and international links bring about specific issues of infectious and parasitic diseases of sturgeons [4, 6].

Pathologic processes in fish have the same principles as in superior vertebrates. However, they have substantial differences related to anatomic and physiological features and the evolutionary development of fish as inferior aqueous vertebrates.

Fish farming in RAS will not solve the disease issues, so it is impossible to achieve successful operation of a fish farm without ichtio-pathological monitoring. This paper is intended to study the nosological characteristics of pathologies of various etiologies in fish in the RAS based on the ichtio-pathological monitoring.

MATERIAL AND METHODS.

The studies were undertaken from 2014 to 2016 in the aquaria room of the biotechnology laboratory of the West Kazakhstan Agrarian-Technical University named after Zhangir Khan. The university scientists have been engaged in the farming of sturgeons in the RAS for more than 7 years, this period being sufficient for forming a diverse collection of sturgeons. In order to select and update the fish gene pool, sturgeons from fish farms have been brought in.

However, along with newly brought specimen, various pathologies of infectious and parasitic etiology may occur. The circulation of agents of these diseases is promoted by the technology of enclosed water recirculation in the basins.

The study was aimed at juveniles, fingerlings, yearlings, two-year-old and three-year-olds of the Russian sturgeon (*Acipenser gueldenstaedtii*), Siberian sturgeon *(Acipenser baerii)*, Fringebarbel sturgeon and their hybrids as well as carp species.

In the epizootological studies, the methods of comparative-historic, comparative-geographic description,

clinical-epizootological examination and laboratory and production experiment methods were used [6-9].

The comparative-historic description suggested the analysis of statistic materials by grouping epizootological data in chronological order and revealing the development principles of the epizootological situation in time.

The comparative-geographic description was intended to reveal the features and principles of occurrence and propagation of infectious diseases in fish, and the nosological profiles of individual areas of fish suppliers into the aquatic complex.

Clinical-epizootological examinations were used to study the focuses of infectious and parasitic pathology, to reveal causes of occurrence and penetration routes of agents, and to identify the diagnosis of nosological entities.

The physiological condition and clinical inspection of fish were undertaken according to K.V. Burlachenko and L.I. Bychkova. For intravital indicators, the changes of fish behavior, reduced appetite and further stop of nourishment, and above-level mortality were taken into account [8].

Parasitologic and microbiological studies of sick and dead fish were undertaken according to L.I. Grischenko, M.Sh. Akbayev, etc. [10].

RESULTS

A sufficiently large number of various sturgeon species is formed and farmed at the university's aquiculture center. The sturgeon species include Russian sturgeon, Siberian sturgeon, sterlet, great sturgeon, Fringebarbel sturgeon and their hybrids. Apart from sturgeons, mirror carps and decorative koi carps are also farmed in the aquiculture.

Despite the evolutionary resistance and ability to endure high concentration of contaminations of various nature for short periods, sturgeons are subject to diseases of various etiology. While such pathologies cannot always be visualized in the natural environment due to evident circumstances, they are quite visible in the RAS conditions.

The nosological profile of fish diseases is represented by invasive and infectious fish pathologies according to the retrospective and operative epizootological monitoring and analysis of pathologies recording in the RAS (Table 1).

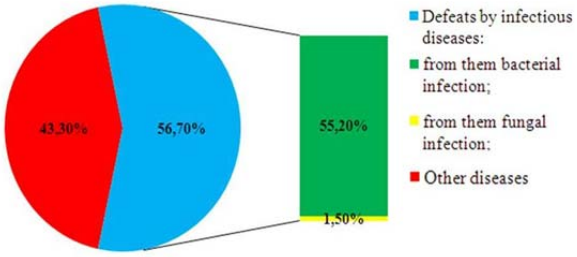

Figure 1 – Linear-radian model-diagram of the nosological profile by primary groups of fish pathologies

The obtained results were used to develop a linear-radian model-diagram of the nosological profile of primary fish pathologies in RAS basins (Figure 1).

These linear-radian model-diagrams of the nosological profile for sturgeons show the structure and types of pathologies depending on the etiological origin.

The highest specific weight is attributed to the diseases of infectious pathology, bacterial and fungal nature. They are represented by the following nosological units: aeromonosis, pseudomonosis, myxobacteriosis and saprolegniosis.

In our studies, we identify the following most frequently recorded diseases of bacterial etiology.

Aeromonosis is an infectious disease of many fishes, including sturgeons. Aeromonosis agents are mobile aeromonads belonging to the *Aeromonas* genus of the *Vibrionaceae* family. Contamination routes are damaged skin and gills. Sick fish becomes weak, inactive, weakly reacts to external irritants, lays down on the basin bottom and stops eating. An acute form is expressed in rapid reddening of integument in sick fish, with the reddening mainly developed on the abdominal side. The anal orifice swells and becomes red (Figure 2).

Figure 2 – Ulcer damages on the Siberian sturgeon abdominal side

Table 1 – Nosological profile of sturgeon pathologies in the RAS

No.	Nosological entity	2015 – 2016			Incidence (EI per 1000 of specimen)	Share in total fish pathology (%)
		Specimen studied	Specimen revealed	%		
1	Aeromonosis	345	79	22.8	228	20.1
2	Pseudomonosis	405	85	20.9	209	21.6
3	Myxobacteriosis	372	57	15.3	153	14.5
4	Saprolegniosis	15	2	13.3	133	0.5
5	Argulosis	50	5	10	100	1.3
6	Pisciculosis	10	1	10	100	0.3
7	Diclybothriosis	70	9	12.8	128	2.3
8	Ichthyophthiriasis	350	150	42.8	428	37.8
9	Nitrite poisoning	57	5	8.7	87	1.3
10	Mechanical damage	18	1	5.5	55	0.3
	n = 10	1692	394	23.2	232	100

As a result of ulcer wash-off from the surface and further cultivation on the MPA agar, the agent's culture was segregated. The microscope revealed that the agent is gram-negative, immobile microorganisms of coccoid shape (Figure 3).

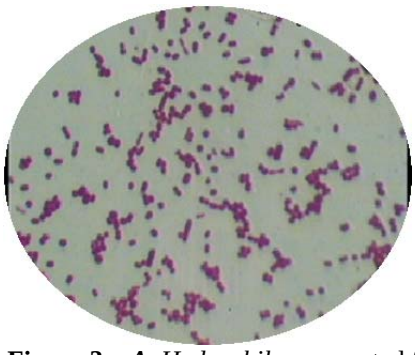

Figure 3 – *A. Hydrophila* segregated from the wound (900X)

Our studies show the propagation of various kinds of pseudomonas in the RAS that can initiate fish diseases. The clinical symptoms can vary and depend on the development degree of the pathological process. The initial stage of the pathological processes frequently exhibits damages of dorsal denticles, blood strokes on the sclerae and pupils becoming crescent shaped (Figure 4).

Figure 4 – Damage of dorsal denticles, crescent shaped pupil and blood stroke

In case of the medium degree of damage, fish show insignificant reddening of the rostrum, anal orifice, point blood strokes in the abdominal part of the body. It cannot always be observed in the conditions of the RAS basin. More often, in the production conditions, a strong degree of damage is observed, which is characterized in the following clinical symptoms. Sick fish is passive and tends to stay near the water surface. Examinations reveal fin damages. Damages in the form of blood strokes and ulcers are more often observed at the bottom of fins, so called fin rot (Figure 5).

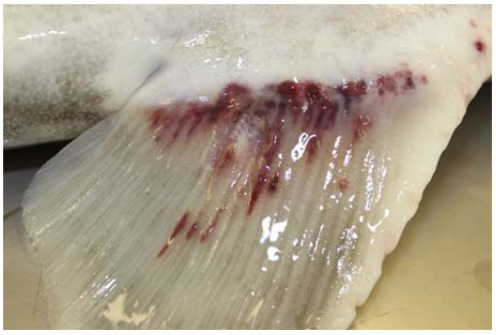

Figure 5 – Blood strokes and ulcers at the bottom of fins (fin rot)

Heavy pseudomonosis can be expressed as the abdomen swelling and ulcers penetrating deep layers of muscular tissue.

There can be single or multiple ulcers. We found parallel ulcers on the side of the abdomen of sick fish. Palpation in the edema area shows fluctuation (Figure 6).

Figure 6 – Edema and ulcers of the abdominal wall side surface

When the swelled area is slightly pressed, a mucous suspension escapes from the wound, which includes a destructed muscular red tissue. This suspension can be taken through a blood-sampling needle for further microbiological assay. When the wound is opened, there is

decomposition of muscular tissues under the skin, with deep pockets (Figure 7).

Figure 7 – Wound suspension sampling and deep pockets in the wound

The microscopy of smears colored according to Gramm and made from the wound suspension revealed gram-negative rod cells morphologically identified as bacteria belonging to the *Pseudomonas* genus (Figure 8).

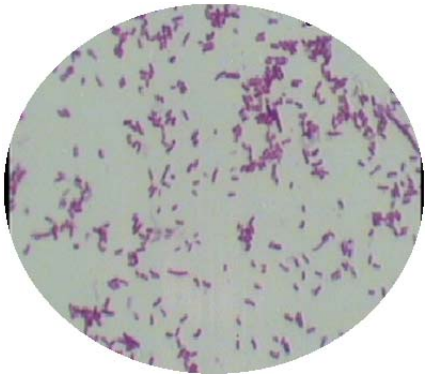

Figure 8 – Pseudomonosis agent from the wound suspension (900X)

Apart from bacterial pathologies, the sturgeons in the RAS also have invasion diseases caused by various kinds of parasites.

From helminthiases in the sturgeons, we found monogeneans from the *Diclybothrium* genus of the *Diclybothriidae* family. The agents of this class have caused diclybothriosis. Sick fish affected by *Diclybothrium armatum* monogeneans were weak and inactive. They had pale gills abundantly covered with mucus. An agent can be found with the naked eye on the periphery of gill filaments. Gill epithelium on the ends of gill filaments is destroyed, with visible destruction of the gill tissue. The changes in the structure of gill tissues cause their function to impair and as a consequence, fish dies due to asphyxia (Figures 9, 10).

Figure 9 – Localization of *D. armatum* on gill filaments

Figure 10 – High level of intense invasion level of gills

Apart from helminthiases in sturgeons in RAS, invasion pathologies have been found, the agents of which are the representatives of arthopods *(Arthropoda)* and crustaceans *(Crustacea)*.

In the RAS, we recorded cases of decorative koi carp affected by parasitic crustaceans from the *Argulus* genus. The damaged fish behaves anxiously, reluctantly takes fodder and shows retarded growth. Examinations of various parts of the body show blood strokes, damaged sites and accumulations of high amount of the agent on the body. In scrapes on the Petri dish when the normal saline solution is added, an intensive motion of argulosis can be seen with the naked eye. Intensively affected fish dies (Figure 11).

Figure 11 – Intensive damage of the abdominal part with the argulosis agent

DISCUSSION

Farming of sturgeons and other valuable species in RAS allows for constant visual monitoring of their physiological condition irrespective of the natural and climatic conditions, the impact of which is typical in the habitat.

Irrespective of the fact that in fish farming in RAS maximum favorable conditions are created for farming and feeding, this does not always prevent occurrence and development of pathologies of infectious and parasitic etiology. According to the results of our studies, the nosological profile shows nosological entities of infectious origin – aeromonosis, pseudomonosis and myxobacteriosis. By using epizootological, clinical and laboratory methods, we have diagnosed these diseases and identified their agents, which is visualized in the photographs.

Apart from nosological forms of infectious pathology, parasitic diseases are also found in RAS, the agents of which were archaeal and helminths – monogenean flukes from the *Diclybothrium* genus. As a result of clinical examination and anatomical pathological study, typical forms of diclybothriosis and argulosis have been identified and diagnosed.

The analysis of occurrence and propagation of pathologies of infectious and parasitic etiology in fish in RAS shows that the primary reason is carrying over of disease agents from the outside with the fish seed. The epizootic situation is also complicated when the veterinary-sanitary conditions and the hydrobiological and hydrochemical conditions of farming in the RAS are violated.

CONCLUSION

The occurrence and propagation of mass diseases in fish depends on various reasons. Each disease has peculiar features but for most of them there are some common reasons and principles of development and propagation. The primary of them include:

- agents carried over together with the fish seed imported in the farming of valuable fish species;
- disease agents being present in the RAS system;
- organism susceptibility, e.g., no specific or acquired immunity;
- failure to observe the level of fish density in the basin;
- adverse ambient changes (hydrobiological, hydrochemical factors, conditions and quality of nutrition);

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