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Lepeophthiriosis caused by *Lepeophtheirus salmonis* in a mariculture of Russia and the world

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Lepeophthiriosis caused by *Lepeophtheirus salmonis* in a mariculture of Russia and the world

E A Zavyalova, D A Alontseva, V V Belimenko, K Y Bulina and A E Droshev

Federal State Budget Scientific Institution «Federal Scientific Centre VIEV», 24/1 Rjazanskij prospekt, Moscow, 109428, Russia

E-mail: asdf1961@yandex.ru

Abstract. Serious problems of a mariculture are infectious diseases of aquatic organisms, and the polyetiological diseases complicated by bacteria or connected with the damages put with parasites are most often meet. *Lepeophtheirus salmonis* (salmon louses, sea louses, "salmon lice") - cancrioid ectoparasites from a subclass of Copepoda (copepods), belongs to order Siphonostomatoida which affect both the wild and grown-up salmon, exert a negative impact on an immune response of the host, increase danger of infection with a virus of an infectious hemopoietic necrosis (IHNV), a virus of an infectious anemia of a salmon (ISAV), a furunculosis and other bacterial infections at injury of epidermis to the place of attachment. Control of a lepeophthiriosis requires combination of efforts of veterinary specialists, workers of an aquaculture and ichthyopathologists for exchange of information about infection scales and also use of international experience of struggle with this problem.

1. Introduction

Nowadays consumption of fresh fish is one of the trends of healthy nutrition of the person. The sea and ocean fish whose some species, for example, an Atlantic salmon, besides are a delicacy is especially important in this respect. According to FAO in different years the norm of consumption of fish hesitates from 15 to 25 kg. Therefore, for satisfaction of needs of the population and saturation of the market of products all developed countries use possibilities of the internal and external seas of the World Ocean. In connection with decrease, for the ecological reasons, the level of world catch of fish all hopes in providing the person with proteinaceous products are turned on one of the most actively developing sectors of agriculture - an aquaculture. Problem of ichthyopathologists and veterinary specialists is control of health of the grown-up fish as different species of sea fishes can be infected by infectious and/or invasive agents that in turn, can constrain their use in food to the person and also cause losses of a livestock, constrain growth rates, exerting a negative impact on economy of the enterprise.

Among infectious diseases viral diseases are widespread in an aquaculture, however the polyetiological diseases complicated by bacteria or connected with the damages put with parasites meet more often.

One of such parasites is copepoda, or copepoda crayfish (Copepoda) - the biggest group of the Crustacea who passed to a parasitic way of life. The total quantity of the types a copepod parasitizing on fishes reached nearly 2000. According to researchers, 75% from them are sea forms [1].



2. Etiology

Lepeophtheirus salmonis (salmon louses, sea louses, "salmon lice") is a cancrioid ectoparasite from a subclass Copepoda (copepod) of order Siphonostomatoida which affect both wild and grown-up salmon (generally from genus *Salmo*, *Salvelinus* and *Oncorhynchus*) (figure 1). Crustaceans quite large: length of females is up to 17 mm, cord-like ovisacs - up to 53 mm, males more small - 5 - 7 mm. [1].

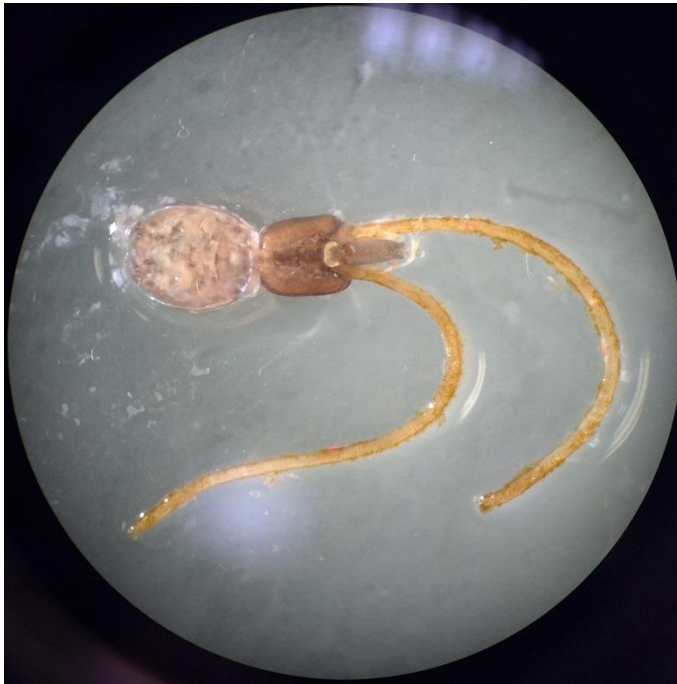


Figure 1. *Lepeophtheirus salmonis*, a female, magnification of microscope $\times 40$.

These parasitic crayfish live and eat slime, tissues and blood of the host (figure 2), reducing efficiency of transformation of food to a gain and causing damages of covers of a body which are secondary affected by bacteria and mushrooms and also cause the general immunosuppression of the organism, at the same time crustaceans can be carriers of dangerous diseases so at a high level of infection fish can be lost. For ectoparasites with free living stages of life, such as *L. salmonis*, search of the owner is an adaptive and evolutionary process which is crucial for end of a life cycle and survival of a species. Salmon louses use a combination of mechanical, visual and chemical touch signals for identification and detection of potential owners.



Figure 2. Place of attachment of *Lepeophtheirus salmonis* to the host (Atlantic salmon).

Sea louses have the difficult life cycle consisting of three planktonic mobile consecutive stages: nauplius I, nauplius II and copepodids. After that the organism enters a parasitic phase and is attached to the owner - a stage of chalimus I and II stage, at this time it eats epidermis of fishes. Then, by a consecutive molt the organism develops in mobile preadults I and preadults II of forms before finally fading to a puberty stage when the adult female is larger than a male. A life cycle depends on temperature and can borrow of 28 days at 14 oC up to several months at colder temperatures. Planktonic stages and stages of chalimus I and II cause the smallest damage to the owner, at the same time in "youthful" (preadults) and adult stages sea louses are most dangerous to fish when they are mobile and males can move from fish to fish, especially. There are data that the attached stages of chalimus exert a negative impact on an immune response of the owner, increasing danger of infection to other pathogens and consecutive infections at injury of epidermis to the place of attachment [6, 13]. There are scientific data that sea louses are reservoirs and carriers of causative agents of diseases, including a virus of an infectious hemopoietic necrosis (IHNV) [11], a virus of an infectious anemia of a salmon (ISAv [14]) and a furunculosis [13]. These researches describe identification of the causative agent from the owner and at the same time in adult individuals of salmon louses, but do not investigate the transfer mechanism. [13, 14] The basis of pathological process is that mobile phases of life destroy a large number of an epithelial tissue of fish, creating a big wound surface through which consecutive infection gets. Therefore it is logical to assume that the individuals who are fed on the infected fish, moving to an intact individual infect it.

3. Epizootology

From the middle of the 70th years in the aquaculture of Norway one of the most serious problems is defeat of the grown-up Atlantic salmon by Copepoda crustaceans of a species *Lepeophtheirus salmonis* (salmon louses). Data on an adverse effect of these parasites on a wild salmon and sea trout (*Salmo trutta* L.) appeared later, in 1992 [18]. Now salmon louses are constantly found problem at cultivation of an Atlantic salmon (*Salmo salar*) worldwide: in Canada, Scotland, Ireland, England, Chile, Russia and other countries that manages the industries in enormous financial expenses annually, because of real loss and at the expense of investments in prevention.

Not only the enterprises which are growing up fish sustain losses because of a louse, this disease is dangerous also to wild populations of the fishes migrating through water areas and coastal areas where fish farms are located. Therefore, control sea louses is a priority task of salmon breeders, veterinarians and scientific community around the world.

4. Negative impact of a lepeophthiriosis on development of the industry

One more significant pathogen of salmon industry the virus of an infectious anemia of an Atlantic salmon (ISAv) is, at the same time in its epidemiology parasitic sea louses, in particular *Lepeophtheirus salmonis* are important. Researches of foreign scientists demonstrate influence of infection with sea louses on importance of ISAv-infection and mortality at this disease in experimental conditions at the grown-up Atlantic salmon (*Salmo salar*).

A number of experiments which showed potential danger of salmon louses was conducted. The received results demonstrate that primary infection with Copepoda and also simultaneous infection with parasites and a virus considerably increases mortality of an Atlantic salmon, in comparison with the groups which are not infected and infected with ISAv.

In immunological reactions influence of louses on the antiviral answer and in general oppression of immune system of the owner which increases success of implementation of a parasite and susceptibility to ISAv is revealed.

Economic effects for the industry from these diseases vary from 500 million US dollars to about 1 billion dollars of losses worldwide [4, 8, 12, 15, 17].

5. Lepeophthiriosis as factor of ecological danger

In recent years, quantity of individuals in population of wild Atlantic salmon (*Salmo salar* L.) and sea trout (*Salmo trutta* L.) in Northern Atlantic decreased [5, 7]. Besides, in the late 1980s, unpredictable sharp recession of a sea trout in Scotland matched almost full breakdown of stocks of a sea trout in the western Ireland [5] and reduction of the Atlantic salmon in Norway [7]. The reason of this phenomenon is unknown so far, but the main feature decrease in stocks of salmon in all cases is an early return to the rivers of the exhausted sea trout which is strongly infected with juvenile stages of a salmon louse of *Lepeophtheirus salmonis*. In the same time at industrial cultivation of the Atlantic salmon infectiousness level on farms sharply rose. Thus, remains not clear or parasites of the cultivated fish cause mortality of wild fishes or on the contrary, and the infectiousness of wild populations is secondary attribute in a multifactorial problem as there are proofs confirming both hypotheses [5].

6. International experience of fight and prevention of disease.

In 1997 in Norway it was developed and became effective "The national plan of action against a sea louse on salmon" which at regional and local level helped farmers to coordinate efforts for implementation of a task [10].

Since then the Norwegian authorities repeatedly changed and finished rules and control programs in order to control invasions in salmon farms. [9, 16] A basis of the document are legislative restrictions for the maximum median number of parasites for one grown-up fish, obligatory bringing number of louses to data of the veterinary controlling service, the organization of prevention, treatment and monitoring of infection with Copepoda wild fishes. Established by rules the maximum threshold value of 5 adults of sea louses on fish in the summer and in the fall, with decrease to 2 adult females in the spring - when the majority of silver steels are out of migration. Later, in 2000, new restrictions were set: on average 0,5 adult females or 4 juvenile individuals or adults of a male during the period from December to June.

In addition to management and regulation, Norway allocates considerable investments, for development and use of medical-prophylactic drugs for farms of any level. The strategy of prevention includes use of peroral treatment by medicamentous drugs, bathtubs for disinsection by means of chemicals, and some biological control methods of number of sea louses. Similar researches are conducted and in Russia - they are directed to use of a pinagor (*Cyclopterus lumpus*) for control of number of sea louses (*Lepeophtheirus salmonis*) [3].

7. Conclusion

Fish historically plays a serious role in economy of many states. Now most actively the industrial aquaculture in the delc cages located in fresh natural reservoirs or pools where the water is pumped which is based on cultivation of valuable species of salmon and a mariculture - cultivation of an Atlantic salmon and iridescent trout in the sea develops. It is undoubted that infection with sea louses is inevitable as they a natural part of a biocenosis, but the fish enterprises, at the expense of a production intensification, create ideal conditions for strengthening of growth of number of parasites from which the migrating juveniles of a wild salmon and humpback salmon can suffer. Periodically on the Internet there is information from fish breeders and the fishing enterprises about a high level of infection with a parasite: The northeast of Sakhalin (The east Sakhalin sea subband) - 2011; The Barents Sea (water area of Ur lip) - 2015, i.e. in water areas where the valuable and delicious salmon is in large quantities grown up and caught. At the same time in the country there is no normative documentation on accounting of parasites and also fight and prevention, in official statistics there are no data on cases of detection of a disease [2].

In the aquaculture of the whole world pay a close attention to control over parasites at industrial cultivation of a salmon, but after studying of the existing information becomes clear that it is necessary not only to protect cage populations, but also not to allow distribution of parasites among a

wild salmon. For this purpose it is necessary to study and estimate attentively the level of infectiousness *Lepeophtheirus salmonis* among cultivated and also free living salmon.

The solution of this problem requires combination of efforts of veterinary specialists, aquaculture workers and representatives of the fish-breeding industry for obtaining complete and exact information about infection scales and also acceptance on arms of international experience of control and prevention against this problem.

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