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Activities for Prevention of Gyrodactylus Salaris Distribution in the Kola Peninsula Rivers

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Abstract

Monitoring of distribution of monogenean ectoparasite *Gyrodactylus salaris*, dangerous for wild populations of the Atlantic salmon in northwest Europe, is carried out by Veterinary Services and the profile scientific organizations in different European countries. In Murmansk area, *Gyrodactylus lavareti* was first found in a trout farm in Tuloma River in 1996. From now on, representatives of genus *Gyrodactylus* are annually identified in farmed fish in Tuloma River, according to ichthyopatholocic observations of salmonid farms in Murmansk area. Species *G. salaris* was indicated in 2016 in farmed trout in Tuloma River and in wild salmon smolts in Pak River of the Nizhnetulomsky water basin. Throughout a number of years, the experts of Regional Veterinary Service and the scientific organizations of Murmansk area discuss necessity of working out of measures to prevent *Gyrodactylus salaris* introduction in the rivers of the Kola Peninsula with wild populations of the Atlantic salmon. Any transport of smolt and live fish from the freshwater objects of Baltic Sea basin to the water objects of the Barents Sea basin sea would become the most significant threat by parasite *Gyrodactylus salaris* distribution and might cause a damage of natural populations of the Atlantic salmon of Kola Peninsula.

Keywords: *Gyrodactylus*, Atlantic salmon, Kola Peninsula

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1. Introduction

Over last years, there is an expansion of freshwater ectoparasite *Gyrodactylus salaris* (Monogenea) inhabitancy, representing a danger for wild populations of the Atlantic salmon in northwest of Russia. The native area of this species is the fresh basins of the Baltic Sea where it is a natural component of parasite fauna of salmonids [1]. Fast parasite invasion in the northwest of Russia and infection strengthening is connected with increase in cultivation volume of farmed trout, with purchase and transportation of salmonid smolt from region in region. *G. salaris* is recorded on cultivated rainbow trout and salmon in Scandinavian countries as Finland, Sweden, Norway [2-4]. The disease

in the wild Atlantic salmon was found in the rivers in Norway in 1970th, that has caused enormous reduction of salmon stocks in the Norwegian waters [2, 5, 6].

In Kareliya, parasite *Gyrodactylus salaris* is distributed in the rivers of Onega and Ladoga lakes and it is indicated in rainbow trout farms. It is considered, that it has been delivered to trout farms with a purchase of infected juveniles [7, 8]. Gyrodactylosis disease of the Atlantic salmon is recorded in the Karelian rivers (White Sea basin). *G. salaris* on the Atlantic salmon has been found out in Keret River in 1992, and later in Pista River [7-10]. In Keret River, disease has led to reduction of salmon population by 20 %. It is supposed, that the parasite might be introduced with juvenile salmon which cultivated in fish-breeding factory (basin of Onega Lake), and then have been transported to the native river.

In Murmansk area, *Gyrodactylus lavareti* was found for the first time in 1996 in trout farm in Tuloma River [11]. From now on, the Murmansk Veterinary Service is engaged in the gyrodactylosis control in all fish farms located in freshwater reservoirs of the Murmansk area. By the order of the Ministry of Agriculture of the Russian Federation from December, 19th, 2011 № 4, gyrodactylosis is included in the list of the especially dangerous fish diseases. Representatives of genus *Gyrodactylus* are annually found in trout farms in the Tuloma River by experts of the Department of fish physiology and diseases in aquaculture (Murmansk regional station for animal diseases control). Since 1996, a monitoring of *Gyrodactylus salaris* infection of the juvenile Atlantic salmon is carried out in the rivers of Kola Peninsula by parasitologists of Polar scientific research institute of oceanography and marine fishery (PINRO). *Gyrodactylus sp*. has been found in the atlantic salmon smolt in Pak river, later in Shovna river (basin of Tuloma river) in 2015-2017 [12]. Till 2015, parasite G*yrodactylus salaris* has not been found in Tuloma River.

Two species, *Gyrodactylus lavareti* and *G. salaris,* are distributed in Inari lake (Finland) [13]. As Inari Lake and Verhnetulomsky basin represent the common water system, a question was raised on species identification of *Gyrodactylus* found in trout cages and in salmon smolt in the Tuloma River. Detections of *Gyrodactylus* have caused a necessity of developing of monitoring program and an organization of timely carrying out of treatment-and-prophylactic actions in fish freshwater farms in Murmansk area. The purpose of work is the working out of measures to prevent the distribution and infection by *Gyrodactylus salaris* the fish farms and wild Atlantic salmon populations in the rivers of Kola Peninsula.

2. Materials

A long-term epizootic and ichthyopathologic research (2013-2019) in farmed fish of Murmansk area was carried out by the experts of Department of fish physiology and diseases in aquaculture of Murmansk regional station for animal diseases control. The objects of observations were trout freshwater farms and fish-breeding salmon factories of Murmansk area. Taking out of parasite samples, including representatives of genus *Gyrodactylus*, had been done annually, 3-4 times per year. More precise species identification of *Gyrodactylus* was carried out by the Institute of Biology of the Karelian scientific center of the Russian Academy of Sciences (KarSC RAS), Petrozavodsk, and the Republic of Karelia and further by National Veterinary institute of Norway (Oslo).

3. Results and Discussion

The disease caused by *Gyrodactylus* infection, gyrodactylosis, is considered to be one of threats to juvenile atlantic salmon in natural spawning reservoirs and cultivated salmon in freshwater farms. *Gyrodactylus salaris* is a freshwater ectoparasite, but can survive in brakish water for some time, cold-water adapted species. It is hermaphrodite, viviparous, with short life cycle. It can survive on several salmonid species including rainbow trout, Arctic char, and grayling [14].

It was experimentally established, that salmon in Baltic Sea basin (native area) is not sensitive to *Gyrodactylus salaris*. But the Norwegian and White Sea salmon populations are extremely susceptible to *G. salaris* [1, 15, 16]. The experiments of Kola Peninsula Rivers were not performed; however the probability of such susceptibility is very high. In Murmansk area, the cultivation of juvenile salmon at fish-breeding factories and its release in a mass scale in the spawning rivers is organized for maintenance of wild Atlantic salmon stocks. So, it is considered, that salmon number, not having immunity to parasite *G. salaris,* has sharply increased.

In response to the serious threat posed by *G. salaris*, the special researches of species identification of *Gyrodactylus* in farming trout and in wild Atlantic salmon smolts in Tuloma Basin Rivers have been carried out. Samples (2017-2019) collected by experts from cage-farm trout and from wild salmon smolts of the water area of the Nizhnetulomsky basin have been sent to the Institute of Biology KarSC of RAS (Petrozavodsk, Republic Kareliya) for species determination and also to National Veterinary Institute of Norway (Oslo). Studies of morphological and molecular-genetic signs have revealed that *Gyrodactylus*, parasitizing on cage trout and salmon parrs in Tuloma basin rivers,

belong to isolates RBT 1 of polymorphic species *Gyrodactylus salaris*, registered also in trout farms in neighboring Finland [4, 17].

Monitoring of *Gyrodactylus* distribution in Murmansk area, spent by experts of Veterinary Service in freshwater farms and by parasitologists of PINRO in Kola Peninsula Rivers, testifies the presence of *Gyrodactylus salaris* species and its distribution increase in northern part of Russia. So, *G. salaris* was diagnosed from both farmed rainbow and wild salmon in area of Tuloma River. Before *Gyrodactylus salaris* in Keret River (Kandalaksha Bay, the White Sea) was considered as the most northwest finding point.

Data on *Gyrodactylus* occurrence on rainbow trout in farm located in the Nizhnetulomsky water basin are presented in Table 1. *Gyrodactylus* is occurred on different age fishes, with infection up to 50-100 %. Seasonal dynamics of parasite number was observed. *Gyrodactylus* was occurred sporadic in the winter, at low water temperature. The increase in number was observed in spring. Its decrease was in summer when temperature rose and there was an increase in fish immunity. Invasion was low in autumn. The spring invasion increase in trout farms is connected with active parasite reproduction. Data on seasonal occurrence variation show that *Gyrodactylus* is cold-adapted parasite. Parasite detections should be considered in trout farms in 2018 as parasite carriage, since clinical disease displays were not carried out.

According to PINRO data, the Institute spends annual inspection of Kola Peninsula rivers, ectoparasite *Gyrodactylus sp.* was found in population of juvenile Atlantic salmon in Pak river (Tuloma river basin) in 2015-2017 and it has not been found in 2018 [12]. Data on *Gyrodactylus sp* infection indicators of juvenile salmons in natural population in Pak River in 2017 are presented in Table 2. Invasion extensiveness was from 0 to 100 % (in October), infection intensity might be enough high.

Probably, biological and ecological features of *Gyrodactylus salaris* life cycle forward to fast invasion.

Throughout a number of years experts of Regional Veterinary Service and the scientific organizations of Murmansk area discuss necessity of working out of measures and actions to prevent *Gyrodactylus salaris* invasion and distribution in the rivers of Kola Peninsula with wild populations of the Atlantic salmon. Among such actions by the most effective there can be following:

1) Working out of morphological test-system for species identification of monogenean *Gyrodactylus*; that is necessary for the epizootic control in fish farms.

2) Working out of program to prevent the gyrodactylosis distribution in fish farms in Murmansk area.

TABLE 1: Occurrence of *Gyrodactylus* on rainbow trout in a farm in the Nizhnetulomsky water basin.

Month	Water temperature, °C	Fish age					
		0+		1+		2+	
		N_f, %	N_p, specimen	N_f, %	N_p, specimen	N_f, %	N_p, specimen
2013							
April	+2	70	2-7	40	1-3	-	
May	+4	-		-		-	
July	+15	-		100	1-4	80	1-4
October	+4	0		0		0	
2014							
February	+1	0		0		-	
June	+5	-		0		100	1
August	+12	0		100	1-2	66	1
2015							
March	+0,5	100	2-106		-	-	
May	+6	-		1	1-3	-	
August	+8	0		60	4-7	-	
October	+5	0		20	1	-	
2016							
February	+0,4	90	3-12	100	3-9	-	
May	+3	-		100	2-9	20	2-3
July	+13	100	1-2	10	1-2	0	
October	+7	0		100	1-2	-	
2017							
March	+0,4	-		57	1-5	100	1-2
May	+1,5	-		66	1	33	1-2
August	+9	47	1	40	1	-	
October	+7	47	1	0		-	
November	+2	8	1	-		-	

Notes: 10-25 specimens of fish were analyzed per each season; fishes of 2 + age were selected in number of 1-3 specimen. ``-``-- sample was not selected, ``0'' -- parasite was not found out.

N_f -- invasion extensiveness, number of infected fish to total fish number in sample (%);

N_p -- invasion intensity, number of parasite per infected fish, min-max (specimen).

3) Estimation of trout farming impact to epizootic situation in wild fish (salmonid) populations in Murmansk area.

4) Proposals into operating regional fish health legislation to prevent further spread of *G. salaris,* for actualization and harmonization with acquis communautaire of the Office of International Epizootic and NASCO recommendations (The North Atlantic Salmon Conservation Organization).

Table 2: Indicators of *Gyrodactylus sp.* infection of juvenile Atlantic salmon, Pak river, 2017 [12].

Month	Extensiveness, %	Infection intensity, specimen (min-max)	Abundance index, specimen
May	-	-	-
July	50	1-33	7,2
August	50	1-34	4,8
October	100	9-899	112,5

Clear identification of *Gyrodactylus salaris, G. salaris* RBT and *G. lavareti* is necessary, as well as a reliable diagnostic method of pathogenic and not pathogenic parasite forms. Based on modern observations, *G. salaris* is considered to be polymorphic species. Application of molecular-genetic methods in the systematics of *Gyrodactylus* species was increase [15, 16]. Apart from the traditional ways of parasite identification on fish, another diagnostic method of invasion beginnings in the water is possible. The given technology (eDNA) is based on detection of the smallest fabric slices, slime, parts of parasite body in water, without dependence from host presence. The Norwegian colleagues have been shown the direct dependence of parasite occurrences in water with their subsequent detection on fish and on the contrary [18].1

The program and plan of the activities on prevention of gyrodactylosis distribution in fish-breeding farms in Murmansk region are based on monitoring of *Gyrodactylus salaris* (*G. salaris* RBT) in wild populations of the Atlantic salmon in the rivers of Kola Peninsula. The key issues include:

- Annual monitoring of the rivers, lakes and fish farms, having hydraulic communication with the base rivers with natural populations of Atlantic salmon.

- Annual monitoring of the fish farms, located in the area of the White Sea basin in places with lowest salinity and in estuaries of the base rivers where there are natural populations of a wild Atlantic salmon.

- The record and registration of newly-formed fish farms in the rivers with natural populations of Atlantic salmon.

In order to control further impact of trout farming on epizoothic situation in wild populations of valued fishes (salmonid) in Murmansk area it is necessary to continue applied researches with a view of informing of business structures and supervising service on *Gyrodactylus salaris* -- its distribution, invasion, genetic, ecology, biology and interrelations of genetic salmon characteristics on a susceptibility to *G. salaris.* It is important to develop a new ecological ways of treatments applied in the rivers and lakes for gyrodactylosis prevention, for example, to use of aluminium salts, easily decomposed organic acids, hydrogen peroxides.

The proposals to include in acquis communautaire of regional fish health legislation, according to `Road Map' developed by NASCO are following:

- Aquaculture objects should be under constant veterinary supervision.

- Actions on disinfecting of aquaculture objects are carried out only in artificially created inhabitancy.

- Actions for the prevention and liquidation of infectious and other diseases of aquaculture objects are carried out by fish-breeding company jointly with experts of regional veterinary service.

- Aquaculture objects are transported on the routes coordinated with experts of state veterinary service according to the requirements under the prevention of occurrence and distribution of animal diseases.

Preventive management and actions in procedural works and at extreme situations with concern the spread of *G. salaris* in Murmansk area are as follows:

-- to apply approved disinfection methods for prevention of *G. salaris* distribution through the fishing equipment, boats, etc.

-- to implement new effective ecologically safe treatments into a practice minimizing the toxic impact on cultivated hydrobionts, but effective for diseases control of gyrodactylosus from aspects of efficiency and simplification of disinfection methods of fish-breeding equipment, floating carriers, etc.

-- to make a list of physical barriers or hydraulic engineering constructions interrupting fish migrations within infected area and outside the limits of infected area.

-- to use the treatment-and-prophylactic preparations, and also instructions on treatment, restraint and destruction of a parasite according legally base after all-round research workings out and the statement.

-- to make a decision on carrying out of actions for fish farming in infected rivers or lakes should be accepted on the basis of an estimation of high risks of parasite introduction into not infected rivers (for example, during migrations and other transportation).

It is obviously important to enhance co-operation of regional and international institutes and the organizations, veterinary services on monitoring, research and information dissemination on the parasite *Gyrodactylus salaris* to prevent its spread in the northern Europe. Such example is the working group on gyrodactylosis which has been organized in 1996 by Murmansk Veterinary Committee. Since 2017 the working group unites representatives of veterinary services of four countries (Norway, Sweden, Finland and Russia) as frontier cooperation.

The notes should be taken for explanatory work among fishermen, local people, tourists that it is necessary to fix the facts of fish diseases in the rivers of Murmansk area, and also about necessity of disinfection of fishing equipment.

4. Conclusion

Any transport of live fish from freshwater objects of Baltic Sea basin to the water objects of Barents Sea basin would become the most significant threat of *Gyrodactylus salaris* introduction and might cause a damage of natural populations of the Atlantic salmon of Kola Peninsula. Throughout a number of years experts of regional veterinary service and the scientific organizations of Murmansk area discuss necessity of working out of prevention measures on *Gyrodactylus salaris* invasion and distribution in the rivers of Kola Peninsula with wild salmon populations. Among such measures the most effective are the following. Legislatively to forbid the import of smolts and live fish in Murmansk area for needs freshwater fish farming from northwest regions of Russia and from abroad where zoning assumes to be the dangerous centers of gyrodactylosis distribution. Jointly to develop the regional instruction under the control and prevention of *G. salaris* distribution, taking into account specificity of salmonid farming, amateur and sports fishery in Murmansk area. To involve for the co-operation of experts of various departments and the local authorities supervising formation of new fish farms and release of licensures for fish farming, sports fishery. It is necessary to combine the efforts of scientific institutes and regional veterinary services of the Northwest of Russia in monitoring on spread of *Gyrodactylus salaris*.

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Conflict of Interest

No potential conflict of interest was reported by the authors.

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