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Introduction of Arctic Char in Aquaculture of Russia

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Abstract

Arctic char has some features making it a promising object for commercial farming. It has relatively good growth rates at low temperatures and can be grown at high density of stocking. The combined effect of low temperature and oceanic salinity is detrimental to char. We believe that directly in the gulfs and bays of the Barents Sea it is impossible to perform year-round commercial farming in stockings of wild original Arctic char, even taken from lakes that connect a river with the sea. On Murman, the use of recirculating aquaculture system (RAS) may be recommended, especially considering that char tolerates high stocking densities from 40 to 100 kg / m^3 during the oxygenation of water. Char can double its weight in just six months while maintaining optimal conditions in recirculating aquaculture system. It is necessary to install a device in recirculating aquaculture system that makes fish constantly swim in a circle at a speed of half the length of their body per second. Char is the most valuable fish on the Earth, since it accumulates heavy metals in its tissues to a lesser extent. Apparently, contaminators that enter a body are easily excreted during fasting period. Taking into account the above mentioned aspect, Arctic char can be introduced into aquaculture in Russia.

Keywords: arctic char, aquaculture, commercial farming, salmon, compensatory growth, autophagy

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1. Introduction

Arctic char is Holarctic salmon species of fish with freshwater and a special intermediate semi-migrating forms. In Scandinavia, it is mainly found in mountainous areas, but it is also common in deep and large lakes in the Alps. This northern fish is generally regarded as the coldest freshwater fish. In Scandinavia, Arctic char has been reared since the beginning of the 90s, and currently the total production is 3,000, 2,300 and 700 tons / year in Iceland, Sweden and Norway, respectively. In Sweden and Iceland, there are rearing programs and the bulk of commercial char production is carried out using offspring from national breeding programs in each country. Arctic char is famous

for its ability to grow at a low temperature and, therefore, is particularly suitable for aquaculture at high latitudes and altitudes. In addition, due to the success of breeding programs, char used in farms grow faster and mature at a larger size and age than the original wild char. Consequently, despite the fact that at present the volumes of cultivation are insignificant, according to forecasts Arctic char aquaculture will grow in all three countries.

2. Materials and Methods

Arctic char Salvelinus alpinus (L.) is a polymorphic species or complex of species that includes many geographical groups and local sympatric forms of char of Europe, Asia and North America [1, 2].Up to the present moment, there are different views on the composition and structure of S. alpinus complex, and the question of its taxonomic subdivision remains controversial. The results of molecular genetic studies make us take a fresh look at the phylogenetic relations of chars [3].In the vast range of arctic char, great variability was noted in external morphological [2, 4] characteristics, environmental features [2], and genetic traits [5].

A characteristic feature of S. alpinus complex is the existence of sympatric forms in a number of lakes, which differ in growth rate, life expectancy, nutrition, preferred biotopes, places and periods of spawning, color, and morphology. To date, the features of interpopulation phenotypic variability of arctic char have been identified, the sympatric forms of char from different parts of the range have been analyzed, and information on their morphological, environmental, and genetic differences has been reported [3].

Arctic char is an indigenous species in all major lakes of Karelia and the Kola Peninsula. Some researchers consider migrating and freshwater char as one species of Salvelinus alpinus (L.) [2, 4, 6, 7].According to K.A. Savvaitova [1, 2], this object ``is a complex set of forms of varying degrees of isolation, starting from groups each time appearing in the ontogenesis of one generation, and ending with double species or the usual clearly distinguishable phenotypic species''. It was proposed to attribute the freshwater form of char, including the trout of the Kola Peninsula and Karelia (Ladoga, Onega, Segozero, etc.) to the S. alpinus (L.) subspecies with the name Salvelinus alpinus lepechini (Gmelin) [8--10].

The lower jaw of trout is slightly pointed and laterally compressed, while the upper jaw extends beyond the eyes. The teeth are sharp. Usually it reaches an average weight of 9-10 kg and a length of 65-75 cm. Trout is a predator, but in the absence of small fish,

it easily switches to crustaceans, larvae and insects. Trout lives in deep and shallow cold lakes with clean, clear water. Manufacturers grow a mass of 700-1200 g at the age of 5-6 years. Trout spawn in the second half of September-October at a temperature of 6-10 °C; some forms, in particular pit, spawn in the spring. Caviar is large, with a diameter of 0.5 cm and light orange in color.

3. Results

In Russia back in the 60s of the last century, the experimental studies were started at the aquatic base of the Murmansk Marine Biological Institute by the employees of two laboratories of physiology and acclimatization and reproduction [11]. The features of biology noted by G. D. Bocharov and L. I. Vasiliev, subsequently formed the basis of commercial cultivation in the Scandinavian countries and Canada.

In the mid-80s, the biology of the Novaya Zemlya Arctic char was studied in the laboratory of salmon fish.It was recommended to carry out genetic selection work and the establishment of a breeding center was justified [12]. In the 90s, the instruction on breeding char was published by Murmansk Marine Biological Institute of Kola Science Center (MMBIKSC) of Russian Academy of Sciences [13].

Since 2016, MMBIKSC has been conduction the works on the adaptation of wild Arctic char to the conditions of RAS continuously and regularly.

The reason for the modest success and low volumes of salted char production in the world, despite the developed biotechnologies for growing salmon is not found. We believe that there are two ecological forms of arctic char. The freshwater form constantly lives in lakes and rivers. Along with the freshwater form, in our opinion, there is a special ecological intermediate semi-migrating form. They also live in lakes, but in spring and summer they can go for feeding period in the estuary for only two months. Adult age-old fish that have adapted to salinity in previous years of life can move for a short time into the water of oceanic salinity, but they are not able to go there year-round, as Atlantic and Pacific salmon do. Currently in Sweden there are special breeding programs to increase the tolerance of char to salinity.

In our opinion, the high rate of char growth at low water temperatures is greatly exaggerated. Char growth rates are quite comparable to those of trout [14]. Indeed, the char growth rate in the early stages of ontogenesis exceeds that of other fish [15], but this is characteristic only of the early stages of juvenile fish development. However, it is known that at a low water temperature of 1 to 3 °C, char reaches a mass of 100 g in three years (personal communications).

In Norway, the fjords with freshened water up to 15-26% char is grown in stocking, but it is necessary to take into account that under the influence of the Gulf Stream, the water temperature in fjords is higher than in bays on Murman. In addition, in Norway, for the cultivation of Arctic char, as well as other marine fish, ground-based pools are used, in which salt water comes from a depth of 150-200 meters and even in the winter season has a temperature of up to 7-10 °C. In Iceland, char is also grown in water freshened up to 20-26% and geothermal springs are used to increase the temperature.

The combined effect of low temperature and oceanic salinity is detrimental to char. We share the opinion of those authors who believe that there is no migrating char in the White and Barents Seas [14].According to this opinion, we believe that directly in the gulfs and bays of the Barents Sea it is impossible to perform year-round commercial farming of wild original Arctic char, even taken from lakes that connect the river with the sea. On Murman, the use of recirculating aquaculture system (RAS) may be recommended, especially considering that char tolerates high stocking densities from 40 to 100 kg / m^3 during the oxygenation of water.

Char can double its weight in just six months while maintaining optimal conditions in recirculating aquaculture system. It is necessary to install a device in recirculating aquaculture system that makes fish constantly swim in a circle at a speed of half the length of their body per second.

The main advantage of Arctic char is that it can live without food for a long time, after which compensatory growth occurs. Using the char's abilities for auto- and hyperphagia, compensatory hypertrophy can be artificially induced, which is economically viable since less feed is consumed. Taking into account the morphological features of the char stomach, fish should be fed more often than salmon, distributing the daily norm for 6-10 feedings, since their stomach is small and they cannot store food. This is especially important to consider during the farming in stockings, since they have a slower reaction rate than salmon and the excess feed will fall to the bottom of the reservoir under a stocking, in a larger volume than salmon and trout. However, unlike salmon and trout, char pick up food from the bottom of the tank and this feature can be used in the conditions of RAS and coastal basins.

The biggest advantage of arctic char is the ability to convert vegetable protein to animal protein while maintaining excellent quality of higher unsaturated fatty acids (HUFA). Salmon and trout do not have this ability. During the production of artificial feed for char, up to 50% of its composition can be replaced with vegetable protein.

Char is the most valuable fish on the Earth, since it accumulates heavy metals in its tissues to a lesser extent. Apparently, contaminators that enter a body are easily

excreted during fasting period. Taking into account the above mentioned aspect, Arctic char can be introduced into aquaculture in Russia in non-freezing areas of the Baltic Sea, in Siberia and even in the Black Sea, of course, using the appropriate special developments. Talking about the RAS, char can be grown with the help of it wherever there is clean water.

4. Discussion

Arctic char belongs to the salmon family (Genus Salvelinus) has the most northern distribution of all freshwater and anadromous fish species, and, according to some assessments, there are more than 50,000 char populations in the world, most of which inhabit the lakes of the Scandinavian countries and Canada. Arctic char is extremely polymorphic in terms of environmental and phenotypic variability with great diversification in the life cycle characteristics between and within different strains. Optionally, anadromous Arctic char usually remains in salt water only in the summer months, where they grow rapidly and reach a significant degree of fat content in a relatively short time. Then they spend the rest of the year in fresh water, i.e. live in autumn and winter in food-poor and cold freshwater environments.

Despite its wide distribution, Arctic char is not highly populated anywhere, and judging by the available literature, its global annual catch is only 1,500 tons. With its commercial farming, the most advanced countries in the field of aquaculture in 50 years (work was started in the 70s) the minimal success was achieved, only 10 thousand tons were grown all over the world in the best years, and the average annual global cultivation was 3, 5 to 5 thousand tons. At the same time, arctic char at all stages of ontogenesis turned out to be very demanding on abiotic conditions. For its cultivation, reference-grade water extracted from wells is required. Particular conditions for char are needed with regard to temperature and light, especially during spawning. However, they are needed under controlled environmental conditions. Char is capable of doubling their weight in six months. Taking into account the above mentioned aspects, in our opinion, it is important to conduct experimental and pilot industrial work on the commercial farming of Arctic char in different regions of Russia.

5. Conclusion

Arctic char has some features that make it a promising object for commercial farming. It has relatively good growth rates at low temperatures, and can be grown at high stocking

densities. The reason that global Arctic char production remained low is caused by the factors such as limited temperature tolerance, limited tolerance of sea water of oceanic salinity, variable growth and limited markets for products. The success in the aquaculture of char in the Scandinavian countries over the past 30 years has made it possible to solve some problems and ensure a slow but steady development. In the polar regions of Russia, the attempts to keep char in closed water supply facilities make it possible to recommend Arctic char as an aquaculture object.

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