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Growing Results of Baltic Salmon Smolts in Sea Water of Critical Salinity

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ABSTRACT

The strength of the baltic population of Atlantic salmon, salmo salar in our North-western region at present is minimal and is supported mainly by Salmon-Breeding Factories (SBF). Factory producers of origin return is about 2% of the total number of released juveniles, which testifies to its low survival rate and the need to improve the biotech cultivation (Reports of the college of the RF federal fisheries agency for periods 2009-2014). The greatest waste factory juveniles occur in the final stages of the biotechnical production and especially when its release into the natural environment. It is customary to explain its lack of survival in the environment because the degrees of development and growth of juvenile fish in the river factory, reaching smoltification. It is important that the occurrence and extent of the freshwater salmon dwarf males among factory juveniles are much higher than in nature. The mass planting material-weight standard of juveniles shall be not less than 30 grams. However, many salmon fish factories in all or a significant portion of the recruit let out it at a much smaller mass. That often explain by the high planting densities due to lack of outgrown (basin) areas.

In recent years, also abnormally high summer temperature, which violate all links the process of reproduction, forcing emergency order to produce non-growth juveniles (fingerlings) sample 2 g-8 g, forcing SBF to release them near their territories. The problem of obtaining enough major planting of enhanced bio-technique development can solve-intensive growing of juveniles. So, more trout farms in north region (Karelia) from 1999 grow up 2-years age lake salmon 23 g-50 g. However, changing the conditions of factorial fry (transportation and containing in cages) markedly increases the departure for several days of acclimation. In our northern region the survival of juvenile salmon (smolts) from release to return is only 0.02%-0.43%, survival at sea is about 0.09%-2.16% and waste in the river is between 32%-93%. Experience of growing factory recruits in sea cages in the ocean salinity (35%) also shows the ineffectiveness of the existing biotechnology her cultivation. This is due primarily to the lack of preparedness of juveniles for release in natural conditions and its replacing into the marine environment, because of the lack of pre-adaptation process (stage).

Keywords: Salinity; Salmon smolts; Sea water; Baltic; Environment

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INTRODUCTION

To avoid these deficiencies and improve the efficiency of biotechnical cultivation youngs we offer the control method of growth rate, development and qualification of its maritime lifestyle, of timing of smoltification onset by synchronizing this process. The basis of the proposed method is to grow salmon youngs at the beginning of smoltification in brackish seawater of critical salinity 4%-8% [1].

Critical salinity, as the threshage for the maturation of gametes of marine and freshwater organisms, defines the limit of their physiological stability, as well as a number of important threshages, borders and gradients of the organism's relationship with the external environment. This gulf, estuary medium, natural for foraging of juvenile fish, causes minimal required, physiologically adequate thresh age effects [2].

MATERIALS AND METHODS

Initial experiments were conducted on the most accessible effort unit-caspian roach, *Rutilus caspicus* to determine the overall effect of their impact in critical salinity. More than 350 sexually matured manufacturers 15 cm-21 cm in size and of IV completed Stage of Gonadal Maturity (SGM) were previously contained for 23 days in round basins with running river water without feeding at temperatures -12.4°C-11.0°C.

Then on equal parties individuals the following variants of experiments were conducted: Fish content in critical salinity-5%concentration of the industrial (state standart: 13880-63, salt solution, in 12% concentration of salt solution, in 3%concentration of salt solution, in fresh (river) water-as a control. All of fish were contained there for 58 days at 17, 4°C–23.8°C and oxygen concentration of 6.3 mg-7.1 mg/l [3]. By the end of experiment it was found that the greatest degree of survival (up to 85%) is retained only in critical environment salinity, with the death of all breeders in control to 11 days (**Figure 1**).

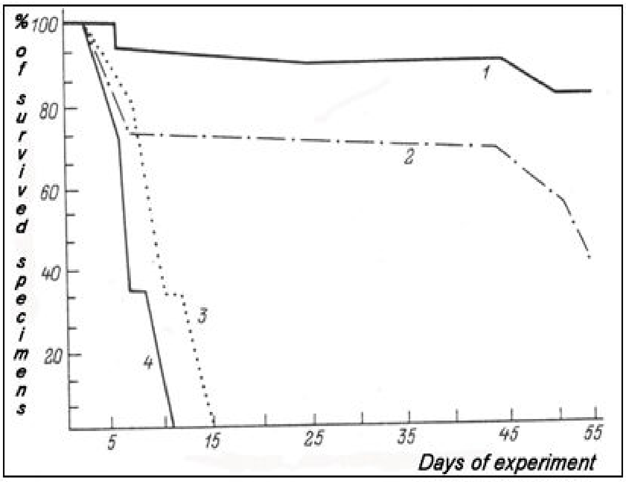

Figure 1: Survival of roach breeders in salt solutions of different concentrations. Note: 1%-5% (critical salinity); 2%-12%; 3%-3%; 4-control (river water).

Thus it was shown that this critical medium helps fish survival, providing a bio stimulating effect on the body. The state of the organism and fish behavior only in 5% solution corresponded to the original one, which we assess as the normal physiological state [4]. Total oocyte resorption was observed almost in all fish in river water (control) to 11 days and in majority-in solution of 3% to 15 days of detention. Along with reddening of the skin of the body, most specimens were covered with sores and are amazed by the saprolegnioz [5]. Contents in blood hemoglobin and total protein, no less than of 5 animals in each version, were determined to characterize the general physiological state in experiments.

RESULTS AND DISCUSSION

The assessment showed the greatest or high content in the environment 5% even by the end of the experience and the smallest (total protein)-already on the 1st day in fresh water (**Table 1**).

Table 1: Hemoglobin and total protein in roach after storage in solution of salt and fresh water.

Water salinity (experience, %)	Conditioning period (days of reservation)	Contents (g%)	
		Hemoglobin	Total protein
3	15	$\frac{5.7\text{-}7.9}{6.6}$	$\frac{1.51\text{-}2.28}{1.93}$
5	45	$\frac{7.0\text{-}12.9}{9.0}$	$\frac{2.18\text{-}2.61}{2.32}$

12	45	4.9-7.9 6.3	2.36-3.12 2.84
Fresh water (control)	11	5.6-7.0 6.7	1.51-2.11 1.75

On the basis of these first results, the experiment on cultivation of juvenile atlantic salmon production scale in brackish seawater close to critical salinity was conducted. Juveniles were grown in cages of hatchery farm pribylovo at fishing area in the gulf of Finland (vyborg bay) of the Baltic sea (**Figure 2**).

Figure 2: Coastal hatchery cage farm in Vyborg district near bay village Pribylovo where cultivated salmon juveniles up to the 3-years age. **Note:** A-on the map is o. B-pontoon cage with footbridge and pond fence.

The main targets of growing this economy with total power of 35-40 tons were rainbow trout, *Oncorhynchus mykiss* and whitefish, *Coregonus muksun [6]*. Feeding the fish, including salmon, party produced experimental fodder company biomar at the expense of feed-1.4, 1.3 kg [7].

When abnormally hot temperatures (above 20°C, up to 24° C) was set on a high departure as juveniles and producers, especially vibrioza (*Vibrio anguillarum*). During bonitets water temperature averaged 3°C, oxygen content: 7-8, acidity pH: 8-9. Hydrochemical indicators average in this area according to the hydrological stations are shown in **Table 2**.

Table 2: Key features of hydrochemical in Vyborg bay according to the hydrological stations (salinity S-own hydrochemical samples).

Indicators/biotope	S (%)	pH	Oxygen (mg/L)	Chlorophyll (mg/L)
Surface	2.01-3.06	8.559.95	7.5-9.47	0.2-8.5
Bottom	2.365.45	7.8-9.95	7.43-10.7	0.2-8.6
At the hatchery cages	2.51	8	9.11	-

Pilot batches of young salmon grew up to 1-summer age (0+), the yearling (1-year-age), 2-summer age (1+), 2-years-age (2), 3-summer age (2+). Total over 3000 specimens grown fish. To assess the piscicultural and biological and commercial qualities appraisal conducted reared juveniles [8]. The latter two age groups (less than 20 individuals) were determined following piscicultural and biological morphometric indicators: The length of the head, the length of the snout, eye diameter. The length of the zaglaznicnogo division head, height of the head, the width of the forehead, length from the top of the snout to the dorsal fin, length from the top of the snout to the anal fin, the length of the grounds of the dorsal fin, maximum height of the dorsal fin, the largest height of the anal fin, the length of the anal fin bases, t he greatest circumference of the body [9]. Body mass (g) defined as individual weighing and volume-weight method on a large sample of individuals. Results (raw data) used in tables that define the coefficient of fatness (after Fulton) and relative growth, built a histogram (individually and by age groups) and growth charts. The results obtained are compared with available reporting (long-term, decades) of Salmon-Breeding Factory (SBF) Nevskiy data and standarts on it in the North-west (Leningrad's) region [10]. As a result of cultivation and bonitets youngs salmon in cages by individual weighing and volume-weight methods, it was found that the mass reached the fingerlings in average 15 g (**Table 3**).

Table 3: Average weight of young salmon of different age groups, cultivated in cages Vyborg bay, on Nevskiy SBF and according to regulations.

	Age, grams			
	One-summer age: 0+	1-year age: 1	2-summers age: 1+	3-summers age: 2+
Experimental fish farm Pribylovo	15	160	280	694
Nevsky SBF	11.3	$\frac{26}{10\text{-}35}$	41.6	-
The standart for region	5-7	9-18	20-25	-

At the same time, the average mass of yearlings, grown in Nevskiy SBF amounted to 11.3 g and the same in the Leningrad region: 5 g-7 g. For comparison, growth dynamics for SBF fingerlings cultivation amounted during July: from 0.6 g to 2.2 g, by September: 6.9 g, by October: 10 g. Average weight of yearlings in cages in brackish water has reached 160 g, while in SBF it was 26 g (for multi-year reporting data) [11].

The normative value of this indicator: 9-18, 2010. The average weight in cages-year-ages stood at 280 g, SBF-41.6 g, at the norm: 20 g-25 g and finally, the 2-years age smolts in cages in brackish water reached almost commodity quantity-694 g [12]. It is important that the compared dynamics of seasonal changes in temperature in these areas are similar (Figure 3).

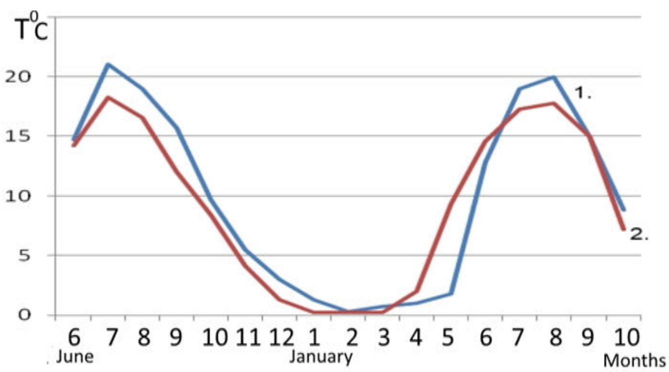

Figure 3: Dynamics of changes of water temperature by months (2008-2012) in the areas of 1) fish-breeding cages 2) salmon breeding farm-SBF.

Averaged results of morphometry assessment in fish and commercial qualities of cultivated juvenile last two age groups are presented in Table 4.

Table 4: The average values of morphometric indices-year-ages and trehletok salmon on all parties, grown in cages the Vyborg region.

Indicators	Designations	The average indicators	
		1+ (2-summer age)	2+ (3-summer age)
The length of the head	ao	4.6 ± 0. 19	7. 4 ± 0.32
The length of the snout	an	1. 8 ± 0. 08	2.2 ± 0.17
The diameter of the eye	np	1. 26 ± 0. 10	1.3 ± 0.11
For the eye division head	po	2. 88 ± 0. 14	4. 2 ± 0.10
Head height	lm	4. 0 ± 0. 17	5.38 ± 0.24
The width of the forehead	oz	2.01 ± 0.09	3. 4 ± 0.19
Body length	ab	28.7 ± 3.35	39.1 ± 1.55
Body length without caudal fin	ad	26.2 ± 1.93	35.06 ± 1.50
The maximum height of the body	gh	6.42 ± 0.31	8.7 ± 0.33
The minimum height of the body	ik	2.19 ± 0.17	3, 32 ± 0, 26
From the top of the snout to the dorsal fin	ag	13.1 ± 0.19	15.92 ± 0.35

From the top of the snout to anal fin	ay	19.16 ± 0.28	25.01 ± 3.42
The dorsal fin base length	qs	2.74 ± 0.16	4.88 ± 0.16
Overall height of the dorsal fin	tu	2.0 ± 0.15	2.9 ± 0.21
Max height of the anal fin	h	1.82 ± 0.12	2.3 ± 0.14
The anal fin base length	l	2.6 ± 0.18	2.67 ± 0.13
Mass	m	280 ± 20.08	694.97 ± 96.59

Based on these bonitet indicators the following comparative dynamics of growth of young salmon grown in cages in brackish water and in SBF in river water is provided (**Figure 4**).

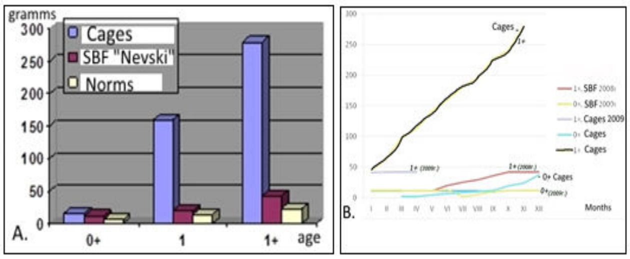

Figure 4: A) Comparative indicators of body weight young salmon (fingerlings, yearlings, 2-summer age) grown in cages (in brackish water), in SBF and according to regional norms; B) Estimated comparative dynamics of their growth in cages and in SBF for year-round.

Thus, comparison of juvenile mass grown in brackish water with that in fresh shows a very significant difference especially in yearlings and 2-summer age. It is important that the dynamics of seasonal changes in temperature compared to similar areas [13]. Therefore, increased salinity we may consider the leading determinant of positive results of growing juveniles in this environment. A large part of recruits in SBF already from an early age have starts an asynchronous process of spontaneous *i.e.,* an unmanaged smoltification that is associated with an increase in waste and a wide range of biotechnological difficulties [14]. It is important that such cultivation and massive appearance of river dwarf males salmon are also characteristic of factory products. On the contrary, process of smoltififcation in brackish water is synchronous and emergence of dwarf males salmon exclude. Comparison of the characteristics of juvenile mass grown in cages in brackish water with that in SBF shows very significant differences especially in the age of yearlings and two year age-to 5x-7x.

With a view to optimize processes of smoltifikacii and growth of juvenile farmed-fish 2 directions to improve biotechnology growing juveniles were proposed to combine. However, if the use of the new synthetic fodder, feeding regimes, biostimulants, etc. Reinforce the degree of adaptability of juveniles to life in the natural environment, then it applies the method of accelerated development and growth of juvenile fish in the ecological and physiological against optimum complex conditions (**Figure 5**).

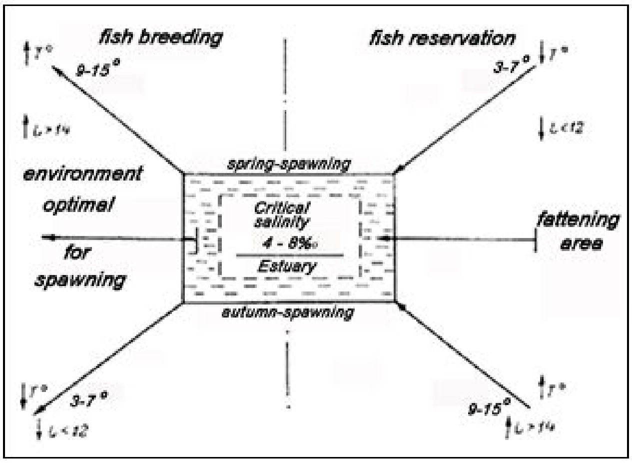

Figure 5: Principle of management breeding and accelerating growing by triad of leading ecological factors: Signal (temperature-T^0, photoperiod-L) and phylogenetic (critical salinity) values, as the primary mechanism for example fish migrations (by: authors certificate USSR No 682197 method of fish population reproduction).

The main factor is the critical salinity in this triad complex of environmental factors of signal and phylogenetic significance, reflecting the underlying mechanism of migrations of anadromous fish [15]. These factors determine seasonal physiological cycles and physiological balance of the organism to the environment-critical salinity. In nature this medium provides vital physiological mechanism-pre-adaptation migrant juveniles and manufacturers to move into new habitats.

CONCLUSION

In general, the effects of brackish sea water (12%) on growth and survival of game fish has long attracted the attention of researchers and fish farmers. In Russia professor suvorov for the first time raised the possibility of hidden features of growth of fish in brackish water and recommended it for use commercial fish farming, especially salmon-farming. Breeding of salmon in this environment is widely used abroad, for example in Japan, Norway, USA, Scotland, Denmark etc. Effect of increasing the survival rate of juveniles, feed assimilation with and especially the yearling growth set for many other species and it is also used during their transportation. It can be concluded that completed innovations of complex physiological (biostimulati ng, eustress) effects of the impact of this environment on fish breeding and reproduction is especially important for aquaculture development.

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