Studies on Some Productive and Reproductive Performance in Female Rainbow Trout *(Oncorhynchus Mykiss)* and Brown Trout *(Salmo Trutta Fario)* at Four Years of Age, From Fiad-Telcişor Salmonids Complex, Bistriţa-Năsăud County

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Abstract
Consumer preferences regarding the various species of fish or aquatic organisms are highly variable. The criteria by which they orient are represented by: the price, organoleptic characteristics, healing and nutritional properties of meat. Today it is known that a high consumption of fish meat has a beneficial role in human health. Moreover, statistics indicates a high level of life expectancy in countries with tradition in terms of fish consumption, e.g. North-European and Asian countries. Statistics shows a high consumption of ocean fish and different species of salmonid family. The culture and intensive fish farming represents an alternative to the requirements of the fish market. The salmonids farmers focus their efforts to obtain high yields of high quality, in conditions of maximum economic efficiency. In Romania, the predominant specie encountered in salmonis farms is rainbow trout (*Oncorhynchus mykiss*). It is successfully reared because of its plasticity and resistance to changes in environmental conditions and disease, and efficient feed-conversion. For restocking mountain water with biological material, some trout farms operate successfully brown trout (*Salmo trutta fario*), a less effective specie for meat production, due to slow growth and development and low resistance to changing environmental factors. Profitability of fish production depends on the propagation processes, fish growth and developments, and supplying optimal environmental conditions for enhancement of the biological potential. The artificial reproduction of salmonids, involves several technological operations for achieving outstanding results on fisheries production. Of these operations, critical is the selection and improvement of breeding.

Keywords: Rainbow trout, brown trout, artificial propagation, selection, improvement.

1. Introduction

Natural propagation of fish represents a whole number of processes providing training for new generations and perpetuation of the species[1] and includes: development of sexual elements in the body, spawning and fertilization of eggs, embryonic and post-embryonic development [2]. Artificial reproduction does not change the natural phenomena, essential in propagating, but rather, to ensure a normal operation in specially arranged conditions [3]. The ultimate goal is to increase the herd fisheries of natural and artificial basins and perpetuation of some species with economic value, including salmonids. [4] believes that to obtain the

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increased production of first-class fish meat, very important is the character, attributes and features of there biological material, the fish production being conditioned by the genetic potential in interaction with environmental factors. Economic objectives of the research in salmonids culture are: reducing the specific consumption per unit product, increased accumulation of body mass, improving the quality indices, increase the number of eggs and their size in female breeding and obtaining early breeding [5]. The selection of female by eggs size is one of the fundamental rules for obtaining a performance biological metarial [6]. In this way can be obtained fry well developed and with important reservations by vitelus.

Table 1. Main indices of reproduction in rainbow trout *(Oncorhynchus mykiss)* female (Bud, 1992)

Specification	n	Age		
		3 years	4 years	5 years
Females weight (g)	20	471.02 ± 4.88	606.87 ± 7.38	670.58 ± 10.25
Total number of eggs	20	13.992	20.170	20.956
Total number of eggs per female	20	699.60 ± 7.12	1008.50 ± 15.34	1047.80 ± 14.52
Relative fecundity (eggs/kg female)	20	1485.28 ± 38.46	1661.80 ± 56.24	1562.52 ± 42.14
Egg diameter (mm)	20	3.8 ± 0.22	4.4 ± 0.32	4.8 ± 0.46

Table 2. Main indices of reproduction in brown trout *(Salmo trutta)* female (Estay-Noriega, 2004)

Specification	n	Age		
		3 years	4 years	5 years
Females weight (g)	20	470.80±10.25	735.00±15.01	1263.90±26.34
Total number of eggs	20	23.640	38.080	54.880
Total number of eggs per female	20	1182.00±34,40	1904.00±59.50	2744.00±60.50
Relative fecundity (eggs/kg female)	20	3577.00±47.10	2591.00±90.00	2181.00±36.00
Egg diameter (mm)	20	4.64±0.11	4.77±0.27	5.24±0.12

Another criterion for selection of breeding is the rate of increase in body mass, but this parameter should be correlated with feed-conversion capacity and body size indices that may give clues to the breeding performances, especially for females. In this study we propose to analyze and conclude about influence that some morpho-physiological characters can have on productive and reproductive performances in rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) females. Experiment was conductes in Fiad-Telcişor salmonids complex, Bistriţa-Năsăud County.

2. Materials and methods

The salmonids complex Fiad-Telcişor, location in which to place our experience, was established in two successive stages. The Fiad trout farm was established in 1983, and the main activity object was represented by salmonid reproduction and obtaining of biological material destined for mountain zone water re-population. In aim to make activity efficient, in this unit exist also basins populated with biological material destined for consumption. With 1.7 Ha surface, the Fiad trout farm is situated to 452 m altitude, and the necessary water is assured from two sources: Sălăuţa Valley with 200 Liters/s debit and Fiad Valley with 100 Liters/s debit. The water temperature in this salmonid farm presents very large variations in last years, presenting a minimum of 0.5^{o}C in January and a maximum about 26.5^{o}C in August. In the last years was observed an increasing of day number during summer period when the water reached values over 20^{o}C. Due to variations in temperature and dissolved oxygen, adversely affecting the smooth operations of breeding and breeding lots maintenance, in 1993 was opened the breeding and hatching station from Telcişor. Located at an altitude of 527 meters and benefiting from an area of 850 m^2, breeding and hatching station from Telcişor is a distance of 15 km from Fiad trout farm. Due to four sources of water, Tăuşoarei Spring, Seaca Walley, Bârlei Creek and a drilling which providing water with a constant temperature by 19.5^{o} C, breeding and hatching station from Telcisor, benefit of very good conditions for

artificial reproduction of salmonids and eggs incubation, thanks to implementation of a good management on the use of water sources, and rotation and mixture of these, according to the biological needs of the trout. Fiad-Telcișor salmonids complex is subordinated to National Forest Autority and belongs to Wine Walley Forestry, Bistrița-Năsăud County.

In the experiment held in December 2009, we studied the main productive, reproductive and morphological indices in a number of 40 breeding females of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) species, ay four years of age. 20 females of both species were randomized studied. Characters considered for the study are: initial body weight, body weight after harvesting eggs, total lenght, maximum height, body depth, great perimeter, relative fecundity, mass/egg, total numbers of eggs, eggs diameter and volume of eggs.

Based on statistical interpretations, the salmonids complex Fiad-Telcișor will begin a major project by selection and improvement of breeding females belonging to both species. For future, we propose to extend the scope of research with issue of fertility rate, lost during incubation and post-incubation development, but also with other research concerning selection and improvement of breeding males, all in the context of obtaining performance of breeding lots.

3. Results and discussions

Analyzing the phenotypic correlation coefficient values of the main morpho-physiological traits of rainbow trout (*Oncorhynchus mykiss*) females at four years of age, some significant correlations between body weight, maximum height, body depth, great perimeter, relative fecundity and number of eggs collected were found. Between initial body weight and total length exists an average correlation with a value of 0.222. Other values of correlation coefficients are reported between initial body weight and weight of eggs (0.173), and between initial body weight and eggs diameter (0.109). As expected, correlations are insignificant (<0.2).

Not significant average correlation is found between total length and body depth (0.215), and between weight of eggs, number of eggs collected, diameter and volume of eggs. A significant correlation exist between number of eggs collected and maximum height (0.875), body depth (0.712), great perimeter (0.624), respectively. Between total length and relative fecundity, we found a negative and very insignificant correlation (-0.092).

A very significant correlation (0.911) exists between relative fecundity and number of collected eggs, while for the relative fecundity and eggs volume we find a low average value of correlation of 0.321. Another significant correlation we found between eggs diameter and weight (0.661), while between number of eggs collected and eggs weight, the correlation is almost nonexistent (0.078). An average correlation between eggs diameter and number of collected eggs (0.271) was found, while between eggs diameter and volume the correlation reached values of 0.600, a significant value.

Phenotypic correlation coefficient values of the main morpho-physiological features in brown trout female (*Salmo trutta fario*) at four years of age, within the same breeding trout farm, was very significant between initial body weight and body weight after collected eggs (0.884). Very significant correlations exist between initial body weight and great perimeter (0.995), initial body weight and total length (0.810), initial body weight and maximum height (0.833), initial body weight and body depth (0.928).

Normally, correlations between body weight after collected eggs and total length (0.706), maximum height (0.755) and body depth (0.757) have lower values compared with previous, but these are all significant. Between initial body weight and weight of eggs, we find a low and negative correlation (-0.164). Also, we find insignificant and negative correlations between weight of eggs and total length (-0.195), weight of eggs and body depth (-0.132), weight of eggs and great perimeter (-0.167). In the same time, we find significant but negative correlations with values between -0.594 and -0.759 between weight of eggs and relative fecundity, between weight of eggs and number of eggs collected, respectively. Just as with rainbow trout, correlation is significant and positive between eggs diameter and its weight and
brown trout (0.811). In rainbow trout, correlation is insignificant concerning the number of eggs collected, eggs diameter and weight of eggs (0.078 0.271, respectively). In brown trout, these correlations are significant but negative, with values of -0.759 between number of eggs collected and weight of eggs, -0.924 between number of

eggs collected and eggs diameter, respectively - 0.450 number of eggs collected and eggs volume.
Regarding the correlations between the main productive and reproductive features, we conclude that, if in brown trout we recorded a lower growth rate compared with rainbow trout, reproductive legally and physiologically, this have features (number of eggs collected, eggs diameter, eggs volume) very close to those of rainbow trout.

Table 3. Phenotypic correlation coefficient values of the main morpho- physiological features of rainbow trout *(Oncorhynchus mykiss)*

Specification	Initial body weight (kg)	Body weight after spawning (kg)	Total lenght (cm)	Maximum height (cm)	Body depth (cm)	Great perimeter (cm)	Relative fecundity (gr)	Eggs weight (gr)	Number of eggs collected	Eggs diameter (mm)	Eggs volume (mm^3)
Initial body weight (kg)	-	0.895	0.222	0.881	0.839	0.847	0.736	0.173	0.705	0.109	0.362
Body weight after spawning (kg)	0.895	-	0.367	0.668	0.665	0.745	0.357	-0.072	0.373	-0.162	0.289
Total lenght (cm)	0.222	0.367	-	-0.006	0.215	0.078	-0.092	0.104	-0.184	-0.143	-0.273
Maximum height (cm)	0.881	0.668	-0.006	-	0.743	0.751	0.830	0.111	0.875	0.232	0.304
Body depth (cm)	0.839	0.665	0.215	0.743	-	0.794	0.749	0.226	0.712	0.097	0.324
Great perimeter (cm)	0.847	0.745	0.078	0.751	0.794	-	0.644	0.158	0.624	0.094	0.402
Relative fecundity (gr)	0.736	0.357	-0.092	0.830	0.749	0.644	-	0.471	0.911	0.476	0.321
Eggs weight (gr)	0.173	-0.072	0.104	0.111	0.226	0.158	0.471	-	0.078	0.661	0.324
Number of eggs collected	0.705	0.373	-0.184	0.875	0.712	0.624	0.911	0.078	-	0.271	0.207
Eggs diameter (mm)	0.109	-0.167	-0.143	0.232	0.097	0.094	0.476	0.661	0.271	-	0.614
Eggs volume (mm^3)	0.362	0.289	-0.273	0.304	0.324	0.402	0.321	0.324	0.207	0.614	-

Table 4. Phenotypic correlation coefficient values of the main morpho- physiological features of brown trout *(Salmo trutta fario)*

Specification	Initial body weight (kg)	Body weight after spawning (kg)	Total lenght (cm)	Maximum height (cm)	Body depth (cm)	Great perimeter (cm)	Relative fecundity (gr)	Eggs weight (gr)	Number of eggs collected	Eggs diameter (mm)	Eggs volume (mm^3)
Initial body weight (kg)	-	0.884	0.810	0.833	0.928	0.955	0.783	-0.164	0.664	-0.441	-0.243
Body weight after spawning (kg)	0.884	-	0.706	0.755	0.757	0.917	0.589	0.58	0.440	-0.255	-0.098
Total lenght (cm)	0.810	0.706	-	0.794	0.817	0.800	0.581	-0.195	0.508	-0.335	-0.152
Maximum height (cm)	0.833	0.755	0.794	-	0.906	0.785	0.525	0.044	0.378	-0.123	-0.086
Body depth (cm)	0.928	0.757	0.817	0.906	-	0.849	0.685	-0.132	0.570	-0.314	-0.219
Great perimeter (cm)	0.955	0.917	0.800	0.785	8.849	-	0.756	-0.167	0.645	-0.485	-0.258
Relative fecundity (gr)	0.783	0.589	0.581	0.525	0.685	0.756	-	-0.594	0.971	-0.855	-0.399
Eggs weight (gr)	-0.164	0.058	-0.195	0.044	-0.132	-0.167	-0.594	-	-0.759	0.811	0.442
Number of eggs collected	0.664	0.440	0.508	0.378	0.57	0.645	0.971	-0.759	-	-0.924	-0.450
Eggs diameter (mm)	-0.441	-0.255	-0.335	-0.123	-0.314	-0.485	-0.855	0.811	-0.924	-	0.469
Eggs volume (mm^3)	-0.243	-0.098	-0.152	-0.086	-0.219	-0.258	-0.399	0.442	-0.450	0.469	-

Analyzing the average value and variability of the main traits, in both rainbow trout and brown trout, we found in breeding females, of four years of age that initial body weight and body weight after collected eggs have values of 1.85 ± 0.05 compared with values cited by literature in rainbow trout 1.57 ± 0.04, respectively, and variability coefficient is lower (11.99% and 10.24%, respectively) which shows that biological material taken in the study is homogeneous. Values of the main traits, respectively total length, body depth, maximum height and great perimeter in this species, have a lower variability coefficient, which shows the homogeneity of the population. Relative fecundity is appropriate, having value at 280 ± 0.02 g, but in this trait, variability presents value over 37%, showing that it should be put on selection of breeding females. Also, high variability coefficient and total number of eggs collected are reported. With regard to eggs diameter, weight and volume, we have average values framing between the limits of this species, and variability have lower values.
In brown trout, at four years of age, initial body weight of breeding females is 0.439 ± 0.02 g, with a variability coefficient of 16.92%, and after

collecting eggs body weight have value of 0.340 ± 0.01 g with a variability coefficient by 15.15%.
Analyzing this trait and making a comparison with rainbow trout, we consider normal and we can say that the population is homogeneous. In terms of reproduction, we find a relative fecundity of 105.55 ± 7.03 g, with an average egg weight of 0.068 ± 0.01 g, which shows a very good gonad index. Same homogeneity is found if we analyze the value of total length, maximum height, body depth and great perimeter, where variability is less than 10%. Also, eggs diameter (4.10 ± 0.02 mm) is within values cited by literature, and value of variability coefficient of 2.01% demonstrates the homogeneity of the population for this trait. Eggs diameter require a large volume, with an average value of 65.70 ± 1.03 mm^3 and a lower variability coefficient (6.99%) compared with rainbow trout eggs (12.47%).

Table 5. Average values and variability of the main characters for rainbow trout *(Oncorhynchus mykiss)* **and brown trout** *(Salmo trutta fario)*

Issue	n	Rainbow trout			Brown trout			t
		$X\pm_{sx}$	s	V%	$X\pm_{sx}$	s	V%	
Body weight (kg)	20	1.85±0.05	0.22	11.99	0.439±0.02	0.07	16.92	26.98
Body weight after spawning (kg)	20	1.57±0.04	0.16	10.24	0.34±0.01	0.05	15.15	32.47
Total lenght (cm)	20	53.60±0.35	1.57	2.93	33.10±0.43	1.92	5.79	37.01
Maximum height (cm)	20	13.70±0.19	0.83	6.08	8.18±0.13	0.59	7.22	24.16
Body depth (cm)	20	8.60±0.11	0.48	5.53	5.51±0.12	0.56	10.08	18.90
Great perimeter (cm)	20	33.55±0.57	2.53	7.54	21.65±0.41	1.84	8.52	17.01
Relative fecundity (gr.)	20	280±0.02	0.11	37.65	105.55±7.03	31.46	29.80	7.12
Eggs weight (gr.)	20	0.0648±0.01	0.01	13.74	0.0680±0.01	0.01	9.25	1.31
Total number of eggs	20	4335.04±321.59	1438.18	33.18	1586.59±123.34	551.6	34.77	7.98
Eggs diameter (mm)	20	4.02±0.04	0.19	4.68	4.10±0.02	0.08	2.01	1.86
Eggs volume (mm^3)	20	53.90±1.50	6.72	12.47	65.70±1.03	4.59	6.99	6.49

4. Conclusions

Analyzing the two populations of breeding females from the same trout farm, of the same age and reared under identical environmental, we found that from morpho-physiological point of view, the population frames within the known limits. Brown trout presents higher values in terms of homogeneity and semen quality. By "t" test shows significant differences between parameters of both population.

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