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THE RELATIONSHIP BETWEEN EGG SIZE, AND THE SIZE AND AGE OF DANUBE SALMON (*Hucho hucho* L.) FEMALES

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ABSTRACT. The eggs from 78 Danube salmon females at the age of 5, 6 or 7 years were studied. They were ellipsoidal, but in older females became more spherical. The results revealed that measurement of one egg diameter (minimum or maximum) is sufficient, and that egg size depends on female age, and not on the size (length or weight).

Key words: *Hucho hucho*, EGGS

INTRODUCTION

Danube salmon (*Hucho hucho* L.) is a salmonid fish of mountain rivers of Black Sea drainage area. In Poland, autochthonic Danube salmon were observed in Czarna Orawa River (tributary of Vah), and its tributaries, and in Czadeczka stream, draining to Kysuča (also Vah tributary) (Witkowski, Kowalewski 1980).

Supposedly, Carpathian rivers of Baltic Sea drainage basin were stocked with Danube salmon already at the end of the 19th century (Witkowski, Kowalewski 1980). Intensive stocking, however, started in 1955 (Witkowski, Kowalewski 1980, Goryczko 1993).

According to Holčik (1995), Danube salmon is an endangered species. In Poland, most detailed studies on Danube salmon were carried out by Kowalewski and Witkowski (1980, 1983/84).

Methods of pond rearing of this species were first developed by Kowalewski, who - usually together with Witkowski - is the author of many publications on Danube salmon in Polish waters.

Embryonic and postembryonic development was described by Witkowski and Kokurewicz (1981), scale development by Witkowski et al. (1983/84), feeding by Witkowski and Kowalewski (1983/84).

Danube salmon is an interesting species, and an important game fish (Witkowski, Kowalewski 1983/84). It is, however endangered. Thus, biology of this species is an important issue. In the present study the relationship between egg size and the size and age of females was analysed. No such data are available in the literature for Polish Danube salmon population.

In Slovakia, Holčik et al. (1984) published a comprehensive treatise on this species. According to Vlasova (1959), Svaton (1966), Peňaz and Přihoda (1981), eggs of Danube salmon are round, and their size depends on the size of females.

Studies of several other fish species, including salmonids, did not clearly show what the egg size depends on. In sea trout (*Salmo trutta* L.) egg diameter is related to female body length (Papała et al. 1998), but the authors did not report fish age. In rainbow trout, on the contrary, egg size depends on female age (Bartel 1971 b), similarly as in brook trout (*Salvelinus fontinalis* Mitchill) (Dlaboga et al. 1998).

MATERIAL AND METHODS

Eggs from 5 females at the age of 5 years (in 1977), 42 fish of 6 years (in 1978), and 31 fish of 7 years (in 1979) were studied. The females were obtained from Danube salmon eggs brought to Poland in 1972 from Slovakia (Dubna Skala near Ružemberok). Spawning in 1977-79 took place in Czarci Jar Hatchery. Ten eggs from each female were randomly sampled, and two diameters were measured (maximum and minimum). Average diameter was calculated for each egg. The fish were weighed before and after spawning, with 10 g accuracy, and measured (*longitudo totalis*) with 1 cm accuracy.

The following were calculated (Eland 1964):

- maximum, minimum, and average egg diameter for each female
- maximum to minimum diameter ratio
- relationship between egg diameter, and:
- female body length (regression coefficient „b", $y = bx + a$)
- female body weight (regression coefficient „b", $y = bx + a$)
- female age (regression coefficient „b", $y = bx + a$)

Standard deviation was also calculated for each average. Length was measured in cm, body weight in g, and egg diameter in mm.

TABLE 1

Relation between egg diameters and body length of females

Year	Numbers	Age	Female length (cm)			Maximal egg diameter (mm)			Minimal egg diameter (mm)			Regression coefficiet "b" and parameter "a" from the equation y=bx+a		
			X	SD	range	X	SD	range	X	SD	range	mean diameter	maximal diameter	minimaldiameter
1977	5	5	45.6	1.52	44.0-48.0	4.26	0.20	4.11-4.40	4.01	0.20	3.87-4.15	b=0.021 a=3.186	b=0.041 a=2.376	b=0.000 a=3.995
1978	42	6	53.36	5.13	40.0-66.0	4.26	0.87	3.64-4.87	4.12	0.91	3.48-4.77	b=0.011 a=3.826	b=0.011 a=3.896	b=0.011 a=3.756
1979	31	7	57.35	6.57	44.0-71.0	5.01	0.82	4.43-5.59	5.96	2.38	4.27-7.64	b=0.008 a=4.290	b=0.007 a=4.380	b =0.009 a=4.201

TABLE 2

Relation between egg diameters and body weight of females

Year	Numbers	Age	Female mass (kg)			Maximal egg diameter (mm)			Minimal egg diameter (mm)			Regression coefficiet "b" and parameter "a" from the equation y=bx+a		
			X	SD	range	X	SD	range	X	SD	range	mean diameter	maximal diameter	minimal diameter
1977	5	5	1.28	0.08	1.20-1.40	4.26	0.20	4.11-4.40	4.01	0.20	3.87-4.15	b=0.033 a=4.163	b=0.429 a=3.686	b=0.494 a=4.640
1978	42	6	1.46	0.47	0.60-3.00	4.26	0.87	3.64-4.87	4.12	0.91	3.48-4.77	b=0.103 a=4.281	b=0.104 a=4.352	b=0.101 a=4.210
1979	31	7	2.07	0.83	0.55-4.76	5.01	0.82	4.43-5.59	5.96	2.38	4.27-7.64	b=0.070 a=4.602	b=0.059 a=4.649	b =0.081 a=4.556

RESULTS

MAXIMUM TO MINIMUM DIAMETER RATIO

The highest value (1.06) was observed in the youngest (5 years old) females in 1977. In the next year, at the age of 6 years, the ratio decreased to 1.03, and in 7- year old fish - to1.01.

RELATIONSHIP BETWEEN FISH BODY LENGTH AND EGG SIZE

Only in 1978 statistically significant ($p<0.05$) relationship between body length of the female and egg size (maximum, minimum, and average diameter) was observed. In three cases regression coefficient „b" was equal to 0.011 (Table 2). In 1977 and 1979 no significant relationship occurred, and coefficient „b" ranged from 0.000 to 0.041 (Table 1).

RELATIONSHIP BETWEEN FISH BODY WEIGHT AND EGG SIZE

No significant relationship was found between these parameters (Table 2). Regression coefficient „b" ranged from 0.494 to 0.429 (Table 2).

RELATIONSHIP BETWEEN FISH AGE AND EGG SIZE

Highly significant relationship ($p<0.01$) was found between age of the females and egg diameters. Regression coefficient „b" for the relationship between age and average egg diameter was equal to 0.314, for the age – maximum egg diameter relationship it amounted to 0.267, and for the age – minimum egg diameter: to 0.361 (Table 3).

TABLE 3

Relation between egg diameters and age of females

Regression coefficiet "b" and parameter "a" from the equation y = bx + a		
mean diameter	maximal diameter	minimal diameter
b = 0.314**	b = 0.267**	b = 0.361**
a = 3.805	a = 3.971	a = 3.638

*** highly significant (p < 0.01) regression coefficient*

DISCUSSION

The ratio of maximum to minimum egg diameter considerably decreased with fish age, from 1.06 in 5 years old females, to 1.01 in 7 years old ones, showing that Danube salmon eggs became more round with spawner age. Similar changes of egg

shape were observed in other salmonids: Vistula trout (Skrochowska 1953), lake trout (Goryczko 1960, Winnicki, Bartel 1967), brown trout (Hardy 1967), rainbow trout (Bartel 1971 a), and brook trout (Papała et al. 1998).

Relationship between fish body length and egg diameters was significant only in 1978 (for 6 years old females), and between body weight and egg diameters it was in all cases insignificant. Hence, it may be concluded that in Danube salmon there is no relationship between the size of females and egg size. There is, however, highly significant relationship between fish age and egg size, similarly as in rainbow trout (Bartel 1971 b).

It should be stressed that eggs of the same fish were studied for 3 successive years. This means that the data are very reliable despite small number of 5 years old spawners. Most of Danube salmon females were mature at the age of 5 years. The results revealed also that the relationship between female age and each egg diameter was the same. Thus only one diameter is sufficient to calculate regression significance.

The results of the present study differ from those reported by Holčik et al. (1984). These authors, however, did not mention how the eggs were measured, and what is more important, how old were the females.

Thus, it seems that the results of the present study concerning Danube salmon egg shape and factors affecting their size are more reliable.

CONCLUSIONS

- Eggs of Danube salmon are ellipsoidal, and become more round with fish age.
- One egg diameter is sufficient to establish the fish age – egg size relationship.
- Size of Danube salmon eggs depends on fish age, and not size (length or weight).

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STRESZCZENIE

ZALEŻNOŚĆ POMIĘDZY ROZMIARAMI IKRY A WIELKOŚCIĄ I WIEKIEM GŁOWACICY (*Hucho hucho* L.)

Badano zależność rozmiarów ikry od rozmiarów i wieku samic. Ikrę otrzymano od 78 samic głowacicy w wieku 5, 6 i 7 lat. W każdym ziarnie ikry mierzono 2 średnice (największą i najmniejszą). Samice ważono przed i po tarle i mierzono ich długość całkowitą – longitudo totalis. Otrzymane dane posłużyły do następujących obliczeń:

– średniej maksymalnej, średniej minimalnej i średniej średnicy ikry dla każdej samicy
– stosunku średnicy maksymalnej do minimalnej
– zależności pomiędzy średnicami ikry a:
  – długością samicy (współczynnik regresji „b'', y = bx + a
  – masą ciała samicy (współczynnik regresji „b'', y = bx + a
  – wiekiem samicy (współczynnik regresji „b", y = bx + a

Stwierdzono, że ikra głowacicy jest elipsoidalna, ale jej kształt z wiekiem upodabnia się do kuli. Badania wykazały dalej, że przy pomiarach ikry wystarczy brać pod uwagę tylko jedną z dwóch badanych średnic, to znaczy albo maksymalną, albo minimalną oraz, że u głowacicy wielkość ikry zależy nie od rozmiarów (długości i masy) samicy, ale od jej wieku.

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