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# SIZE OF THE SEA TROUT (*Salmo trutta* L.) EGGS BASED ON THE INVESTIGATION OF SEVEN POLISH RIVERS

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A B S T R A C T. The aim of the paper was to compare size of sea trout eggs from 7 Polish rivers. Length of females varied from 39 to 91 cm. The biggest females were in the Vistula River and the smallest in the Grabowa River, average lenths were 69.9 cm and 60.2 cm respectively. Egg size was correlated with length of the females. There were some differences of egg size among sea trout populations. Egg size from any single river was not bigger in comparison to other populations.

Key words: SEA TROUT, 7 POLISH RIVERS, LENGTH OF FEMALES, DIFFERENCES OF EGG SIZE

## INTRODUCTION

The size of eggs is a characteristic feature of each species. However, relatively big differences can occur in their size, which is related to a number of affecting factors, the main ones being as follows: the fish age (Sklower 1930, Davis 1953, Skrochowska 1953, Bartel 1971, Savostyanova, Nikandrov 1976) the size of spawners (Juszczyk 1951, Pekarkova 1956, Allen 1958, Dumas 1961, Schäperclaus 1961, Sakowicz 1961, Scott 1962, Steffens 1963, Mc Fadden et al. 1965, Szczerbowski 1966, Bulkley 1967, Hardy 1967, Farid Pak 1968, Chełkowski et. al. 1990), the fish age and the size of spawners taken together (Terlecki, Kempińska 1956, Sakowskaja 1973, Chełkowski et al. 1985), and the female fecundity (Määr 1949, Svärdson 1949, Rounsefell 1957, Allen 1958, Pope et al. 1961, Scott 1962).

Some authors indicated changing environmental conditions as a factor affecting the size of eggs. Mc Fadden et al. (1965) concluded that in the case of brown trout there were differences between populations from some rivers and these differences were due to different diameters of eggs, this being reflected in the fecundity. Also Larsson and Pickova (1978) and Anohina, Bakulina (1990) observed differences in eggs size of salmon from various rivers. Määr (1950) related the differences in eggs size in the populations of *Salmo alpinus* to fish size and their fecundity.

The sea trout occurs in all Polish rivers flowing into the Baltic Sea. These populations differ as to the growth rate, the differences being mainly noticeable between the trout population from the Vistula River and the populations of trout from the Middle and Western Pomerania (Chrzan 1959, Żarnecki 1963, Chełkowski 1969, Bartel 1988).

As there are some differences in growth of sea trout from Polish rivers, the question was raised whether there were also differences in the size of eggs in these populations.

## MATERIAL AND METHODS

During the artificial spawning of the Vistula sea trout, performed in November and December of 1983 at Świbno, and the artificial spawning of the Pomeranian trout: from the Łeba River in Łeba, from the Słupia River in Słupsk, from the Wieprza River in Darłowo, from the Grabowa River in Jeżyczki, the Parsęta River in Rościno, the Rega River in Trzebiatów (Fig. 1), some dozens of eggs were collected from part of the females. The eggs were submerged in water to let them swell, and the volume of water dislodged by 30 eggs was measured on the following day. The obtained values were used in subsequent considerations. The eggs were collected from 1826 females (Tab. 1) of the size measured with 1 cm accuracy. These females made up 54.7% of all the females of sea trout spawned artificially in 1983 (Bartel, Zieliński 1986). The percentage ranged from 45.0% for the females from the Grabowa and Rega rivers to 73.5% from the Słupia River. The eggs for the measurements were collected from two spawning in Łeba and Parsęta, to up to seven spawnings in Słupia (Tab. 1).

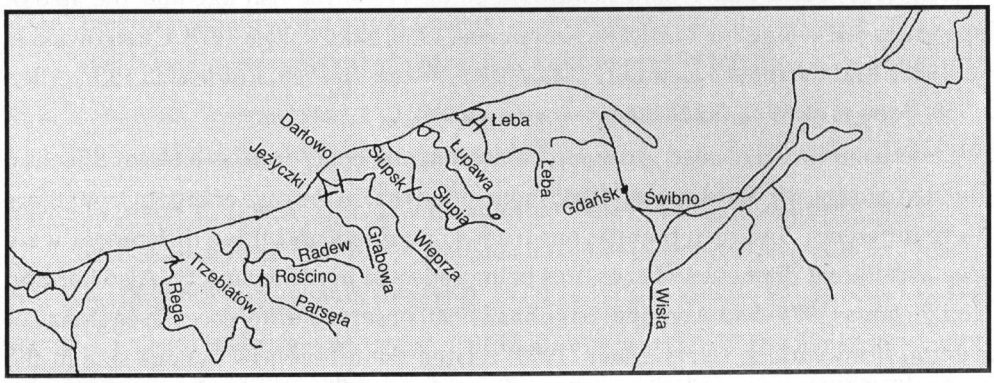


Fig. 1. Places of artificial spawning of sea trout in Poland

TABLE 1

Number of sea trouts spawned in 1983 in 7 Polish rivers and number of sea trouts from which the eggs for size determination were collected

| No. | River | Locality | Females | | | Number of spawning | | Length of females (cm) | | | | Average volume of 30 eggs (ml) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | spawned | observed | | total | obse-rved | average | min. | max. | SD | |
| | | | No. | No. | % | | | | | | | |
| 1 | Vistula | Świbno | 163 | 118 | 72.4 | | 4 | 69.2 | 57 | 83 | 7.625 | 2.56 |
| 2 | Łeba | Łeba | 273 | 142 | 52.0 | | 2 | 63.0 | 47 | 80 | 9.723 | 2.39 |
| 3 | Słupia | Słupsk | 795 | 584 | 73.5 | | 7 | 63.6 | 44 | 82 | 11.930 | 2.33 |
| 4 | Wieprza | Darłowo | 411 | 241 | 58.9 | | 3 | 64.5 | 48 | 82 | 9.548 | 2.44 |
| 5 | Grabowa | Jeżyczki | 903 | 406 | 45.0 | | 3 | 59.3 | 39 | 82 | 10.928 | 2.20 |
| 6 | Parsęta | Rościno | 188 | 90 | 47.9 | | 2 | 63.8 | 48 | 79 | 8.461 | 2.28 |
| 7 | Rega | Trzebiatów | 545 | 245 | 45.0 | | 3 | 64.7 | 49 | 91 | 11.153 | 2.35 |
| Total | | | 3340 | 1826 | 54.7 | | 24 | | 39 | 91 | | |

One way variance analysis and linear regression were used to study egg size from the 7 Polish rivers. Linear regression was applied in order to find an answer to the question whether there were differences in size of eggs obtained from trout populations from different rivers. For the cases when samples from the 7 rivers were available, the following equation of linear regression was calculated:

$$y = a + b\,x$$

where:

x - volume of sea trout eggs from the river „i", i = 1 ..... 7

y - volume of sea trout eggs from the river „y", j = 1 ..... 7

The hypotheses were verified at the significance level L = 0.01:

$$Ho : b = 1, and\ Ho : a = o$$

This is equivalent to the substantial hypothesis assuming that the volumes of sea trout eggs are the same. The analysis was performed on the basis of mean values and for the range of fish length 57-83 cm. For all the listed rivers, the regression function describing the dependence of egg volume (feature „y") on fish length (feature „x") was determined. Such an analysis was made for both the original data and the mean values.

The Peorson's test $x^2$ was applied to check the agreement between the distribution of the investigated features (egg volume and fish size) and the normal distribution.

Calculations made for the Parsęta River gave the following results:

**TESTING OF THE HYPOTHESIS**

HO: Volume of eggs has normal distribution

x test function = 1.535

x critical value (1,0.05) = 3.841

HO ACCEPTED

**TESTING OF THE HYPOTHESIS**

HO: Volume of eggs has normal distribution

x test function = 1.535

x critical value (1,0.01) = 6.635

HO ACCEPTED

**TESTING OF THE HYPOTHESIS**

HO: Fish length has normal distribution

x test function = 5.647

x critical value (2,0.05) = 5.991

HO ACCEPTED

**TESTING OF THE HYPOTHESIS**

HO: Fish length has normal distribution

x test function = 5.647

x critical value (2,0.05) = 9.21

HO ACCEPTED

The tests confirmed the agreement between the obtained distributions and the normal distribution.

## 3. RESULTS

### 3.1. LENGTH OF ARTIFICIALLY SPAWNED FEMALES

Length of the females which were subjected to artificial spawning fluctuated from 39 cm in the Grabowa River to 91 cm in Rega River. The biggest mean length was observed in the case of Vistula sea trout, viz. 69.91 cm, while the lowest mean length of 60.22 cm was found in the Grabowa River. The mean length of sea trout from the

**TABLE 2**

Average length of females (cm) and share (%) of sea trouts from 57-81 cm length range in five-centimetre-length-classes, and mean volume (mm) of 30 eggs in 7 Polish rivers

| River | Number of females | Percentage of females in length classes | | | | | Average length (cm) | Average volume of 30 eggs (mm) |
|---|---|---|---|---|---|---|---|---|
| | | 57-61 | 62-66 | 67-71 | 72-76 | 77-81 | | |
| Vistula | 117 | 9.4 | 14.5 | 38.5 | 26.5 | 11.1 | 69.8 | 2.60 |
| Łeba | 106 | 20.8 | 27.4 | 37.7 | 7.5 | 6.6 | 62.7 | 2.39 |
| Słupia | 456 | 29.2 | 29.2 | 26.3 | 12.3 | 3.0 | 65.4 | 2.40 |
| Wieprza | 184 | 38.0 | 25.5 | 16.9 | 16.3 | 3.3 | 65.0 | 2.50 |
| Grabowa | 276 | 30.8 | 39.5 | 23.2 | 6.5 | - | 64.0 | 2.29 |
| Parsęta | 77 | 29.9 | 22.0 | 29.9 | 16.9 | 1.3 | 65.7 | 2.31 |
| Rega | 209 | 15.8 | 29.6 | 36.4 | 13.9 | 4.3 | 66.9 | 2.39 |

Pomeranian rivers ranged from 60.22 to 65.04 cm and was considerably lower than of Vistula sea trout (Tab. 1). These considerable differences resulted from the criterion used during gathering of the spawners in the Vistula mouth at Świbno. Only spawners weighing above 2.5 kg were selected. No such criterion was applied in the remaining rivers. The calculated mean lengths of sea trouts from the length range 57-81 gave a similar result. The mean length of sea trouts from the Vistula was 68.8 cm, while the fish from the remaining rivers had lengths varying from 62.7 cm to 66.9 cm (Tab. 2). These distinct differences in mean length between the sea trouts from the Vistula and the remaining rivers resulted from more common occurrence of trout females in higher year-classes. For example, the number of Vistula sea trouts in the length class 72-76 made up 26.5% of the total weight of Vistula trout used for spawning. In the remaining rivers, the share of this length class ranged from 6.5% in Grabowa River to 16.9% in Parsęta River. The 57-61 cm lenght class gave quite an opposite picture. It made up only 9.4% of the Vistula sea trout, and from 15.8% in the Rega River to 38% in the Wieprza River, the latter two representing Pomeranian rivers (Tab. 2).

The trouts from the Słupia and the Wieprza were observed in 7 and 4 spawnings respectively. In both cases there was a visible decrease in length of the females spawned in subsequent spawnings (Tab. 3 and 4). Similar phenomenon, though not so strongly pronounced, was observed in the case of trouts from Słupia River, of the same (57-83 cm) length range (Tab. 3).

TABLE 3

Average length of sea trouts from Słupia in length ranges 44-85 cm and 57-83 cm spawned in 7 subsequent spawnings, and average volumes of 30 eggs (ml)

| Subsequent spawning | Date | Length of trout females (cm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | from 44 cm to 85 cm | | | | | from 57 cm to 83 cm | | | | |
| | | Number of females | Length (cm) | | SD | Volume of 30 eggs (ml) | Number of females | Length (cm) | | SD | Volume of 30 eggs (ml) |
| | | | average | range | | | | average | range | | |
| 1 | 02.11 | 64 | 65.3 | 48-82 | 6.47 | 2.319 | 60 | 66.1 | 57-82 | 5.64 | 2.332 |
| 2 | 11.11 | 74 | 64.7 | 50-85 | 7.02 | 2.356 | 66 | 65.7 | 57-80 | | 2.386 |
| 3 | 15.11 | 36 | 65.0 | 53-83 | 6.65 | 2.301 | 32 | 66.3 | 57-83 | | 2.357 |
| 4 | 17.11 | 65 | 64.8 | 50-80 | 6.65 | 2.374 | 57 | 66.3 | 57-80 | | 2.403 |
| 5 | 21.11 | 55 | 61.9 | 44-78 | 7.30 | 2.329 | 42 | 64.8 | 57-78 | | 2.387 |
| 6 | 24.11 | 116 | 62.6 | 48-83 | 7.36 | 2.352 | 90 | 65.4 | 57-83 | | 2.424 |
| 7 | 29.11 | 174 | 60.2 | 45-83 | 7.56 | 2.292 | 114 | 64.3 | 57-83 | 5.83 | 2.443 |
| Total | | 584 | 62.8 | 44-85 | 7.40 | 2.326 | 461 | 65.4 | 57-83 | | 2.339 |

## 3.2. EGG SIZE

The egg size determined by volume of water dislodged by 30 swollen eggs ranged from 1.3 $mm^3$ to 3.82 $mm^3$.

The first value refers to the trout from Słupia River, having the length of 58 cm, and the second - to trout from Łeba River, with the length 77 cm.

The biggest mean volume of eggs, calculated for the whole sample for the given river, was found for trout obtained from the Vistula River. It was 2.56 $mm^3$. The lowest one, 2.20 $mm^3$, was found for trout from the Grabowa River (Tab. 1).

## 3.3. EFFECT OF FEMALE SIZE ON THE EGGS SIZE

The results from the 7 investigated rivers showed that the size of eggs increased with increasing length of females (Fig. 2). Calculation of the dependence between eggs size and female size was limited to the length range 57-83 cm, and gave positive correlation, the correlation coefficients being as follows (Fig. 3):

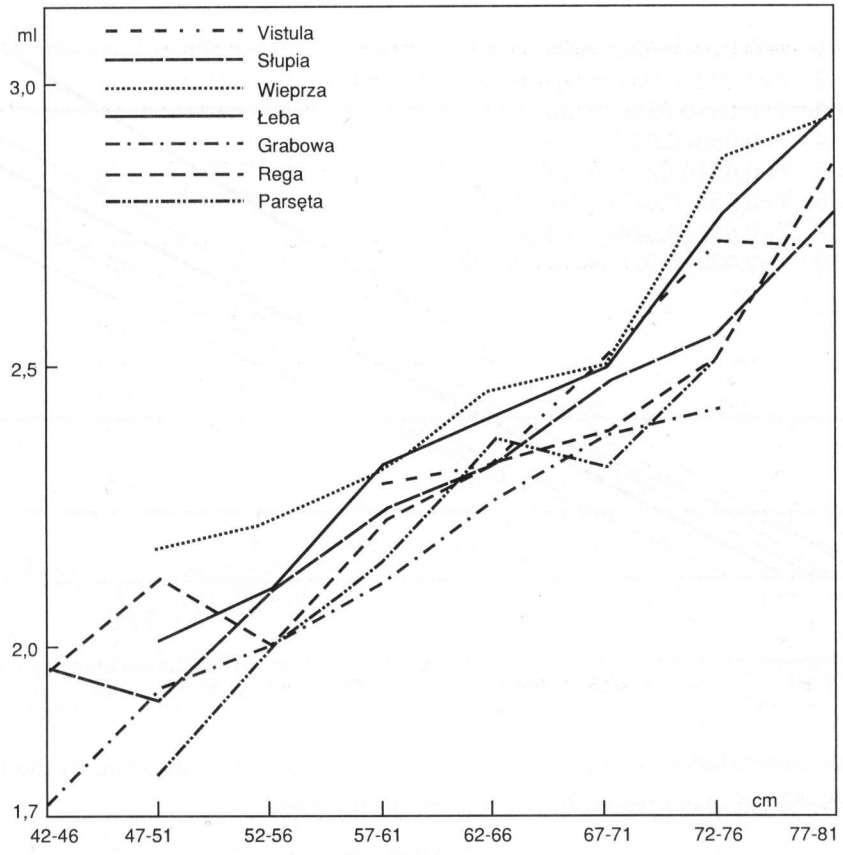


Fig. 2. Average volume (ml) of 30 eggs against length in 5 centimeter classes of sea trout from 7 Polish rivers

$r_1$ = 0.906 Wieprza River

$r_2$ = 0.937 Słupia River

$r_3$ = 0.650 Grabowa River

$r_4$ = 0.814 Łeba River

$r_5$ = 0.835 Rega River

$r_6$ = 0.782 Parsęta River

$r_7$ = 0.746 Vistula River

$r_8$ = 0.866 the whole material.

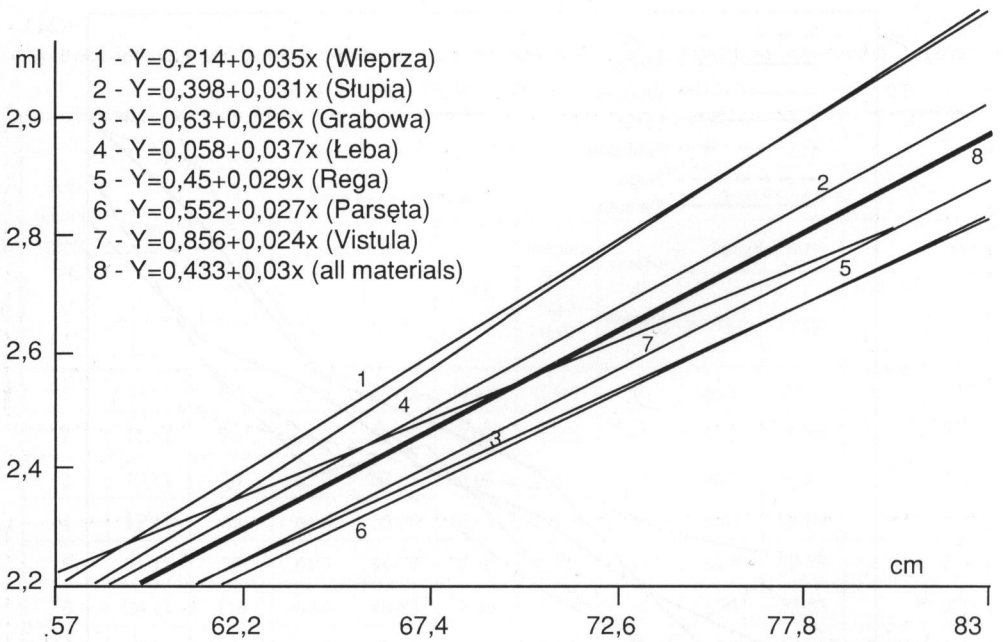


Fig. 3. Relationship of a volume (ml) of 30 eggs against sea trout length in 7 Polish sea trout populations

This dependence, for particular rivers and for the whole material in the length range 57-83 cm, is expressed by the following equations:

$$y_1 = 0.214 + 0.035 \text{ x Wieprza}$$

$$y_2 = 0.398 + 0.031 \text{ x Słupia}$$

$$y_3 = 0.630 + 0.026 \text{ x Grabowa}$$

$$y_4 = 0.058 + 0.037 \text{ x Łeba}$$

$$y_5 = 0.450 + 0.029 \text{ x Rega}$$

$$y_6 = 0.552 + 0.027 \text{ x Parsęta}$$

$$y_7 = 0.856 + 0.024 \text{ x Vistula}$$

$$y_8 = 0.453 + 0.030 \text{ x the whole material}$$

As can be seen from the above functions, the dependence of egg volume on fish is in each case significant at the confidence level L = 0.1, and is similar in the case of all rivers.

**TABLE 4**

Average length (cm) of sea trout females and average volumes of 30 eggs of Vistula sea trout in 4 subsequent spawnings

| Subsequent spawnings | Date | Number of females | Length (cm) | | | Average volume of 30 eggs | SD |
|---|---|---|---|---|---|---|---|
| | | | average | range from - to | SD | | |
| 1 | 02.11 | 19 | 70.4 | 62-77 | 4.76 | 2.653 | 0.311 |
| 2 | 14.11 | 28 | 69.0 | 57-80 | 5.17 | 2.540 | 0.329 |
| 3 | 28.11 | 60 | 70.6 | 58-83 | 6.06 | 2.560 | 0.301 |
| 4 | 19.12 | 11 | 67.6 | 61-72 | 3.38 | 2.441 | 0.315 |
| Total | | | 69.1 | 57-83 | 5.49 | 2.559 | |

**TABLE 5**

Comparison of average volumes of sea trout eggs from 7 Polish rivers

| | Vistula | Parsęta | Rega | Wieprza | Łeba | Grabowa | Słupia |
|---|---|---|---|---|---|---|---|
| Vistula | - | 0.07 | 0 | -0.14$^x$ | -0.16$^x$ | 0.11 | -0.05 |
| Parsęta | - | - | -0.07 | -0.21$^x$ | -0.23$^x$ | -0.04 | -0.12 |
| Rega | - | - | - | -0.14$^x$ | -0.16$^x$ | 0.11 | -0.05 |
| Wieprza | - | - | - | - | -0.02 | 0.25$^x$ | 0.09 |
| Łeba | - | - | - | - | - | 0.27$^x$ | 0.11 |
| Grabowa | - | - | - | - | - | - | -0.16$^x$ |
| Słupia | - | - | - | - | - | - | - |

*NIR = 0.13*

*x - differences at the significance level p = 0.01*

## 3.4. DIFFERENCES IN SIZE OF EGGS OBTAINED FROM VARIOUS TROUT POPULATIONS

The calculated mean volumes of trout eggs from the 7 rivers, and for fish length in the range 57-83 cm, were visibly differentiated (Tab. 1 and 3). At the same time, the mean lengths of the spawned females from the 7 rivers differed considerably (Tab. 1, 2). As there was a dependence between length of trout females and egg volume (Chapter 3.3), the analysis of the possible differences in egg size from various populations was based on the mean egg volumes for the fish of length range 57-83 cm.

TABLE 6

One way analysis of variance
Feature: volume of eggs
Factor: river — 1 - Vistula, 2 - Parsęta, 3 - Rega, 4 - Wieprza, 5 - Łeba, 6 - Grabowa, 7 - Słupia

| Table of analysis of variance | | | | |
|---|---|---|---|---|
| Factor of | DF | MS | F emp | |
| blocks | 24 | 0.25 | $10.49^{xx}$ | |
| factor | 6 | 0.25 | $10.65^{xx}$ | |
| error | 144 | 0.02 | | |
| **Mean vector** | | | | |
| 2.46 | 2.39 | 2.46 | 2.6 | 2.62 |
| 2.51 | | | | |
| | | | NIR = 0.13 | |

$^{xx}$ - *L = 0.01*

It was found that trout eggs from any one river were not bigger compared with the eggs from the remaining rivers. A considerable differentiation was, however, observed between volume of eggs obtained from populations from some rivers (Tab. 5).

One way analysis of variance (characteristic - egg volume, factor - river) confirmed the differentiation in egg volume depending on the river, therefore, on the environment (Tab. 6).

## 4. DISCUSSION

Populations of the sea trout from Polish rivers contain spawners which have passed one season in the sea (A.0+), two or three seasons (A.1+; A.2+), or older. The females at the age of A.1+ and A.2+ represent the biggest share in the spawning. The share of individuals aged A.0+ is lower and, of those aged A.3+ or older is even less (Chełkowski 1969, Żarnecki 1963).

It is known from the scale reading that the trouts from Pomeranian rivers reach the length from 41 cm to 58.6 cm after their first year of stay in the sea; from 60 cm to 68.9 cm after the second year, and from 67.8 cm to 77.5 cm after the third year of sea life (Chrzan 1959, Chełkowski 1969, 1974).

The Vistula sea trout reached from 45.2 cm to 55.2 cm at A.0+, from 62.9 cm to 67.7 cm at A.1+, from 76.6 cm to 79.9 cm at A.2+ (Żarnecki 1963, Sych 1970).

The tagging experiment showed that the trouts from the Vistula reached 47.4 cm - 53.7 cm after the first season, 68.3 - 69.5 cm after the second season, and 75.3 - 79.4 cm after the third season in the sea (Backiel, Bartel 1967, Pałka, Bieniarz 1983, Bartel 1988).

The tagged trouts from the Grabowa River reached on the average 51.2 cm (range 40-65 cm), 62.3 cm (range 40-77 cm) and 68 cm, after the first, the second and third year of sea life respectively (Bartel 1987).

Taking the above data into account, it can be said that individuals at the age A.1+ and A.2+ prevailed in the collected material from the Vistula River. The share of older age groups was insignificant. The materials gathered from the Pomeranian rivers included also the age group A.0+, but its share was small.

As the age of femals from which the eggs for size determination were gathered was not defined, and as, at the same time, the length distribution of the trout made it impossible to segregate fish into age classes, it was difficult to determine the influence of female age on the egg size. However, the effect of female length on egg size observed by numerous authors (Juszczyk 1951, Pekarkova 1956, Allen 1958, Dumas 1961, Schäperclaus 1961, Sakowicz 1961, Scott 1962, Steffens 1963, Mc Fadden et al. 1965, Szczerbowski 1966, Bulkley 1967, Hardy 1967, Farid Pak 1968, Chełkowski et al. 1985) was also noticed in the case of trout from Vistula and Pomerania.

Some differences were observed in the size of eggs originating from various trout populations. A similar phenomenon was observed in salmon from three Swedish rivers (Larsson, Pickova 1978) and in salmon from Russian rivers (Anohina, Bakulina 1990). Some authors related these differences to fucundity of brown trout (Mc Fadden et al. 1965) or to the size of *Salmo alpinus* L. females and their fucundity (Määr 1950). However, in the case of trouts from Polish rivers, domination of egg size of any one population was not observed though some differences between populations were noted.

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# REFERENCES


Allen G.H. 1958 - Notes of the fecundity of silver salmon (*Oncorhynchus kisutsch*) - Progress. Fish-Cultur. 20 (4): 163-169.

Anohina V.S., Bakulina L.E. 1990 - Sravnitelnaya kharakteristika razvivayushcheysya ikry i rannego potomstva atlanticheskogo lososya (*Salmo salar* L.) raznykh rek. In. Biologiya atlanticheskogo lososya na evropeiskom severe SSSR - Trudy Komi nauchnogo centra U r o AN SSSR 114: 88-93.

Backiel T., Bartel R. 1967 - O efektach zarybienia smoltami troci na tle wyników ich znakowania (Effects of trout stocking in the light of tagging results) - Rocz.Nauk Rol. 90, H, 3: 365-367.

Bartel R. 1971 - Czynniki decydujące o wielkości jaj pstrąga tęczowego /*Salmo gairdneri* Richardson/ (Key factors affecting egg size in rainbow trout / *Salmo gairdneri* Richardson/) - Rocz.Nauk Rol. 93, H, 4: 7-34, (In Polish, English and Russian summary).

Bartel R. 1987 - Distribution, migrations and growth of tagged sea trout (*Salmo trutta* L.) released into the catchment area of Wieprza River - Bull.Sea Fish.Inst. XVIII, 3-4 (101-102): 14-22.

Bartel R. 1988 - Trouts in Poland - Pol.Arch.Hydrobiol. 35 (3-4): 321-339.

Bartel R., Zieliński Z. 1986 - Gospodarka łososiowa w Polsce w 1983 roku (The salmon fishery in Poland in 1983). Gosp. Ryb. 38 (11/12): 5-11.

Bulkley R.V. 1967 - Fecundity of Steelhead Trout (*Salmo gairdneri*) from Alsea River, Oregon. J.Fish.Res.Bd.Can. 24 (5): 917-926.

Chełkowski Z. 1969 - Pogłowie troci (*Salmo trutta trutta* L.) rzek przymorskich Pomorza (The sea trout /*Salmo trutta trutta* L./ of the Pomeranian coastal rivers and their characteristics). Przegl. Zool. XIII, 1: 72-91 (In Polish, English summary).

Chełkowski Z. 1974 - Studia nad biologią troci (*Salmo trutta* L.) rzeki Regi (Studies on biology of sea trout /*Salmo trutta* L./ in Rega River). Rozprawy Akad. Rol. Szczecin, 37.

Chełkowski Z., Domagała J., Trzebiatowski R., Woźniak Z. 1985 - The effect of the size of sea trout (*Salmo trutta* L.) females from Rega River upon the size of eggs. Acta Ichthyol. Pisc. 15 (1): 37-71.

Chełkowski Z., Domagała J., Woźniak Z. 1990 - The effect of the size of sea trout (*Salmo trutta* L.) females from Pomeranian rivers on the size of eggs. Acta Ichthyol. Pisc. 20 (1): 59-71.

Chrzan F. 1959 - Łosoś i troć w polskich połowach na Bałtyku w latach 1945-1955 (Salmon and sea trout in Polish catches in the Baltic in the years 1945-1955). Prace Mors.Inst.Ryb. Gdynia, 10 (1): 273-340 (Engl. summ.).

Davis H. 1953 - Culture and Diseases of Game Fishes. Un. of Calif. Press-Berckeley. Los Angeles, 332.

Dumas R.F. 1961 - Effect of light, diet and age of spawning brown trout upon certain characteristics of their eggs and fry. New York Fish and Game Jour.Cons.Departm. 8 (1): 49-56.

Farid Pak. 1968 - Plodovitost lososia (*Salmo trutta caspius* Kesll.) iranskogo pobierezha Kaspiya. Vopr. Icht. 2, 2 (49): 274-282.

Hardy C.J. 1967 - The Fecundity of Brown Trout from six Canterbury Streams. New Zeland Marine Department. Fish.Tech.Rep. Wellington, 24: 14.

Juszczyk W. 1951 - Ilość ikry pozostającej w jamie brzusznej samic troci (*Salmo trutta* L.), pstrąga tęczowego (*Salmo irideus* Gibb.) i krzyżówki pstrąga potokowego (*Salmo trutta m. fario* L.) z trocią (*Salmo trutta* L.) po sztucznym wytarciu. PAU, Pr.Rol.Leś. 59: 18.

Larsson P.O., Pickova J. 1978 - Egg size (*Salmo salar* L.) in correlation to female age and weight in three river stocks - Laxforskningsinstitutet Meddelande, 1978: 2.

Määr A. 1949 - Fertility of Char (*Salmo alpinus* L.) in the Faxalven Water System, Sweden - Inst.Freshw.Res., Drottningholm, 29: 57-70.

Määr A. 1950 - Supplement to the fertility of Char (*Salmo alpinus* L.) in Faxalven Water System. Swede. Inst. of Freshw. Res., Drottningholm, 31: 127-136.

Mc Fadden J.T., Cooper E.L., Andersen J.K. 1965 - Some affects of environment on egg production in brown trout (*Salmo trutta*) - Limn. and Oceanogr. 10: 88-95.

Pałka W., Bieniarz K. 1983 - Wędrówki, wzrost i eksploatacja troci dunajeckiej (*Salmo trutta* L.) na tle wyników znakowania (Migration, growth and exploitation of sea trout (*Salmo trutta* L.) from the Dunajec River). Rocz.Nauk Rol. H, 100: 71-94 (English summ.).

Pekarkova K. 1956 - Počet liker a jejich velikost ve wztahu k velikosti samic pstruha obecneho (*Salmo trutta morpha fario* L.) a duhoveho (*Salmo gairdneri irideus* Gibb.). Univ. Carolina, Biol. 2 (1): 39-56.

Pope J.A., Mills D.H., Sharer W.M. 1961 - The fecundity of Atlantic Salmon (*Salmo salar* L.) - Edinburgh. Dep. of Agric. and Fish. for Scotland., Freshw. and Salmon Fish. Res.: 12.

Rounsefell G.A. 1957 - Fecundity of North American Salmonidae - Fish Bull. the Fish and Wildl. Serv. 57 (122): 451-468.

Sakowicz S. 1961 - Rozród troci (*Salmo trutta morpha lacustris* L.) z jeziora Wdzydze - Rocz.Nauk Rol. 93-D: 501-556.

Sakovskaya V.G. 1973 - Zavisimost velichiny ikrinok azovskoy tarani ot razmera i vozrasta somok - Ryb. Khoz. 9: 16-17.

Savostyanova G.G., Nikandrov V.Y. 1976 - Dependence of some biometrical indicis of eggs on age of rainbow trout females - Izv. GosNiorKh, 113: 3-7.

Schäperclaus W. 1961 - Lehrbuch der Teiwirtschaft. Paul Parey - Berlin und Hamburg: 582.

Scott D.P. 1962 - Effect of Food quantity of Rainbow Trout, *Salmo gairdneri* - J.Fish.Res.Bd.Can. 19 (4): 715-731.

Sklower A. 1930 - Beziehungen zwischen der Eigrosse und dem Alter Mütter bei Bachforellen - Fisch. Ztg. 33 (47): 599-600.

Skrochowska S. 1953 - The rearing of Sea-trout *Salmo trutta* L. in artificial ponds - Bull. d. l'Acad.Pol.Sc. et Lett. B-1951: 179-226.

Steffens W. 1963 - Eigrossen und Eizahlen der Regenbogenforelle (*Salmo gairdneri*) - Deutsch.Fisch.Ztg. 10 (9): 253-261.

Svärdson G. 1949 - Natural Selection and Egg Number in Fish - Annual report for the year 1948, Inst.of Freshw.Res.Bd. Drottningholm, 29: 115-122.

Szczerbowski J.A. 1966 - Relation between the body of salmon trouts females (*Salmo trutta m. lacustris* L.) and the diameter of its eggs - Zool. pol. 16 (34): 195-201.

Sych R. 1970 - Some comparisons on the background of an eleven-year study on the growth of sea-trout (*Salmo trutta* L.) - Acta Hydobiol. 12/2/3: 225-249.

Terlecki W., Kempińska H. 1956 - Sieja i sielawa - Warszawa

Żarnecki S. 1963 - Występowanie populacji sezonowych u łososia atlantyckiego (*Salmo salar* L.) oraz u troci (*Salmo trutta* L.) w rzece Wiśle. (Differentiation of Atlantic salmon (*Salmo salar* L.) and of sea trout (*Salmo trutta* L.) from Vistula River into seasonal populations) - Acta Hydrobiol. 5 (2-3): 255-294 (In Polish, English summary).

# STRESZCZENIE

ROZMIARY IKRY TROCI (*Salmo trutta* L.) Z SIEDMIU RZEK POLSKICH

Celem pracy było porównanie rozmiaru ikry troci z 7. rzek polskich, w których w 1993 r. przeprowadzano sztuczne tarło (rys. 1). Wycierane samice mierzono z dokładnością do 1 cm. Z każdej samicy pobierano 30 ziarn, których objętość mierzono w biurecie przez określenie ilości wypartej wody.

Zebrano materiał z 1826 samic (tab. 1). Dla określenia różnic w rozmiarach ikry troci z polskich rzek zastosowano regresję liniową. Na poziomie istotności 0,01 testowano hipotezę zerową, że nie ma różnic w objętości ikry troci z różnych rzek. Analizę prowadzono na średnich wartościach dla troci o długościach od 57 do 83 cm. Dla wszystkich rzek opisano równaniem regresji zależność: „objętość ikry - długość troci". Były one liczone dla pomiarów indywidualnych i dla średnich wartości. Test Persona $x^2$ użyto dla stwierdzenia zgodności między rozkładem badanych cech objętości jaj i długością ryby, a rozkładem normalnym. Przeprowadzone obliczenia wykazały, że zarówno długość troci jak i objętość ikry miały rozkład normalny. Długość samic troci wahała się od 39 cm do 91 cm. Największą średnią długość 69,91 cm posiadały trocie z Wisły, a najmniejszą z Grabowej - 60,22 cm. Średnia długość troci z rzek pomorskich wynosiła od 60,22 cm do 65,04 cm (tab. 1). W Wiśle na tarlaki zatrzymywano ryby o masie powyżej 2,5 kg. Dla przedziału długości samic troci od 57 do 81 cm średnia długość samic z Wisły była 68,8 cm, a z rzek pomorskich od 62,7 do 66,9 cm (tab. 2). Średnia długość samic wycieranych w kolejnych tarłach zmniejszała się (tab. 3 i 4). Objętość 30 ziarn ikry wahała się od 1,3 $mm^3$ do 3,82 $mm^3$. Największą średnią objętość ikry obserwowano u troci z Wisły 2,56 $mm^3$, a najmniejszą z Grabowej 2,20 $mm^3$ (tab. 1). Rozmiar ikry zwiększał się wraz ze wzrostem długości samic (rys. 2). Obliczenia zależności między rozmiarem ikry a rozmiarem samicy były ograniczone do długości 57-83 cm. Dały one pozytywną korelację (rys. 3) i zależność tę opisano równaniami. Zależność ta była istotna dla wszystkich rzek na poziomie istotności 0,1.

Średnie objętości jaj z 7 rzek dla ryb o długościach 57-83 cm były wyraźnie różne (tab. 1 i 3), równocześnie średnie długości wycieranych samic z 7 rzek znacznie się różniły (tab. 1 i 2). Nie stwierdzono, aby ikra troci z jednej rzeki była wyraźnie większa niż z pozostałych rzek, chociaż obserwowano istotne zróżnicowanie między objętościami jaj troci z różnych rzek (tab. 5).

Jednoczynnikowa analiza wariancji (objętość ikry - rzeka) potwierdziła różnice w objętości ikry zależnie od rzeki (tab. 6). Może się to wiązać z warunkami środowiska.

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