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NUMBER OF PYLORIC CAECA AS A POSSIBLE MARKER OF TROUT (SALMO TRUTTA M. TRUTTA L.) STOCKS IN POMERANIAN RIVERS

by

Jozef Domagala, Henryka Sadowska Faryniarz
University of Szczecin,
Szczecin, Poland

ABSTRACT

A total of 482 female trout spawners from Polish rivers (Rega, Parseta, Wieprza, Slupia and Vistula) were examined. The fish body length (longitudo caudalis), number of pyloric caeca as well as the time each individual spent in the river and in the sea were determined. Mean pyloric caeca counts were calculated for each river, for the whole population examined, and in age groups. The results were treated statistically with the chi square, Fisher's F, and Duncan's multiple range tests. The character studied had a distribution close to normal. The pyloric caeca counts produced no significant relationship with either the fish length or the time the fish spent in the river and in the sea. The Rega trout stock differed in their pyloric caeca counts from the remaining stocks.

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Introduction

To increase the trout population in Polish waters, rivers are each year stocked with hatchlings and smolts. Special attention is paid to preservation of the genetic identity of populations in various rivers. Criteria are being sought with which to distinguish between trout stocks in different rivers. So far, both morphological and scale-based identifiers (Sych, 1971; Tuszynska, Sych, 1983) and biochemical markers (Domagala, Sadowska-Faryniarz, 1987, 1989 and others) have been used.

In view of the fact that the pyloric caeca count shows a considerable between-populations variability in.trout, the pyloric caeca count-based criterion seemed promising. Pyloric caeca counts in salmonids have been demonstrated to be related to fish size, weight, origin, and environmental effects (Bergot et al.,1974; Chevassus et al.,1979; Cekov, Angelov, 1984, 1989 and others). No attempts however, have been made to find corresponding relationships in trout populations of the Pomeranian rivers.

For this reason, the present work was aimed at finding out if the trout pyloric caeca count can be used as a possible marker with which to identify stocks inhabiting different Pomeranian rivers.

Materials and methods

Trout females, migrating to spawn in 5 Pomeranian rivers: the Rega, Parseta, Wieprza, Slupia, and Vistula, caughtin November 1991 at Polish Anglers Association's capture sites and by the Fishermen Cooperative at Sobieszewo were examined..

Following the species identification, the fish were measured lateral line between the dorsal and adipose fins as recommended by others authors (Chrzan, 1959; Sych, 1967, 1971). The fish age was determined from scales following Sych (1967, 1971). Intestines were dissected out and the pyloric caeca counted. The data obtained were subjected to a statistical treatment involving the chi square test

(Nowaczyk, 1985) to compare the distribution of the counts with the normal distribution. Subsequently, the individuals examined were grouped into nine 5-cm length classes. Mean pyloric caeca counts for each class from each river and for the entire population were calculated. Mean pyloric caeca counts were calculated also for age groups, separately for the time the fish had spent in the river and in the sea. The significance of differences between mean counts was tested using the analysis of variance (Fisher's F test) (Ruszczyc, 1981). Correlation and regression coefficients were calculated between fish length and the pyloric caeca count for each river. EXCEL 4.0 computer software was used. The multiple range test (Duncan's test; Ruszczyc, 1981) was applied to find out which stocks were responsible for the statistical significance of differences between mean pyloric caeca counts.

Results

Pyloric caeca counts were determined for a total of 482 (465 females and 17 males) measured. The time the fish had spent in the river and in the sea was determined for 422 individuals, the Rega, Parseta, Wieprza, Slupia, and Vistula yielding 89, 86, 94, 96, and 57 individuals, respectively. The data are summarised in Tables 1-6.

The mean fish length was 67.55 $\pm$ 0,34 cm (v=11.15 $\pm$ 0.36%). The pyloric caeca count of the Pomeranian trout was found to range from 28 to 69, the mean count amounting to 45.3 $\pm$0.31. The ranges and means (in parenthese) in individual rivers were as follows: 32-62 (47.6 $\pm$ 0.61) in the Rega; 28 - 62 (44.5 $\pm$ 0.63) in the Parseta; 29 - 64 (44.0 $\pm$ 0.46) in the Wieprza; 32 - 67 (45.3 $\pm$ 0.62) in the Slupia; and 31 - 69 (45.6 $\pm$ 1.09) in the Vistula. The pyloric caeca counts in the individuals examined showed a considerable variability. The coefficient of variation for all the individuals examined was 15.09 $\pm$ 0.49%, the lowest (12.88 $\pm$ 0.91%) and the highest (18.65 $\pm$ 1.69%) coefficients being found in the Rega and Vistula, respectively (Table 1).

The pyloric caeca counts obtained were grouped into 9 classes and the frequencies presented in a histogram (Fig. 1). Using the chi square test, the distribution obtained was compared with the normal distribution:

$$\text{chi square}_{\text{calc}} = 11.560 < \text{chi square}_{p\,=\,0.05}\ 12.592$$

Thus there are no grounds to reject the null hypothesis of the distribution tested being normal. Distributions of the pyloric caeca counts in individual rivers were close to the Gaussian curve as well.

In no river could a statistically significant relationship be found between the fish size and the pyloric caeca count (Tables 3 and 4).

Symilarly, no significant relationship could be found between the pyloric caeca count and the time the fish had spent in the river and in the sea (Tables 5 and 6).

Comparison between mean counts for different rivers brought very interesting results. A statistically significant difference was revealed between the Rega and the remaining stocks (Tables 1 and 2). The problem seems to merit further studies.

Discussion

The pyloric caeca count range, found in the trout individuals studied, was 28 - 69 with a mean of 45,3 $\pm$ 0,31. Similar values are given in the literature for the trout in Pomeranian rivers (30 - 65; Chelkowski, 1970) and in other regions, e.g., 17 - 48 (Suzuki, Fukuda, 1973); 30 - 60 (Scott, Crossman, 1974); 27 - 74, 24 - 63, 30 - 98 in different French populations (Bergot et al., 1976); 17 - 98 (Ulivari, Brun, 1989), with a mean value of about 51 (Kaeriyama, Urama, 1990).

The character under study showed a considerable variability in the population examined, the mean coefficient of variation amounting to 15.09 $\pm$ 0,49%. The coefficient of variation values reported in the literature for trout by other workers were close to 19,71% (Suzuki, Fukuda, 1973) and 16 - 18% (Bergot et al., 1976). Genetic factors seem to be mostly responsible for the variability observed (Chevassus et al., 1979). Heritability coefficients estimated for pyloric caeca counts were rather high: the published h^2 values exceeded 0,84 (Bergot et al., 1976) or amounted to about 0,4 (Blanc et al., 1979). Thus selection for this trait could bring positive results, but the selective value of the trait ought to be checked first.

The published reports demonstrate a relationship between the pyloric caeca count and the length of the rainbow trout (Cekov, Angelov, 1984, 1989 and others). No such relationship, however, was found to date in the trout (Bergot et al., 1976) or in Salvelinus malma and S.alpinus (McPhail, 1961). In the present work, too, no such relationship could be found in any of the rivers from which the trout was caught (Tables 3 and 4).

Literature data on age effects on pyloric caeca count in trout are very scant. No relationship between the time the fish had spent in the river and the number of pyloric caeca could be found in the trout caught in 1982 in the Rega, lower Odra, and Wieprza (Domagala, Sadowska - Faryniarz, 1991).

The present data confirmed the lack of such relationship (Table 5) and failed to demonstrate any relationship between the pyloric caeca count and the time the fish had spent in the sea (Table 6).

Relationships between the variables studied are likely to be complicated and perhaps masked by environmental factors, as suggested by Bergot et al. (1976) and Chevassus (1976) with respect to the trout in other areas.

The between-rivers comparison of mean numbers of pyloric caeca was very interesting. The 1982 samples (Domagala, Sadowska - Faryniarz, 1991) revealed a significant difference between mean counts for trout in the Wieprza on the one hand and the Rega and lower Odra on the other for both sexes taken together. A similar relationship was found in the females. No significant difference could be found between the mean pyloric caeca counts in the Rega and the lower Odra (Sadowska - Faryniarz, 1993), presumably due to the fact that both rivers are regularly stocked with newlyt hatched larvae from the Rega.

In the present work, a statistically significant difference was found between the mean count of the Rega stock and the means in the remaining rivers (Tables 1 and 2), while the means in the latter showed no significant difference. To make sure that the pattern observed is a real one, a long term data series should be checked; the authors intend to do that. At the moment it is difficult to pinpoint a cause of the pattern observed in this work.

The relevant literature contains publications dealing with environmental effects on the number of pyloric caeca. It is generally accepted that the environment may modify gene expression or act in a more indirect manner, by selecting for certain genotypes, whereby populations living in different habitats are different from one another (Ali, Lindsey, 1974; Bergot et al., 1976; Chevassus et al., 1979 and others).

To conclude, the data on pyloric caeca counts in trout from the Pomeranian rivers, discussed with reference to the relevant literature, show the Rega trout stock to differ significantly from the others.

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Table 1. Summary of analyses made on the trout spawners

River	n	Fish length (cm)			Pyloric caeca count		
		min. - max.	$\bar{x}$	V [%]	min.-max.	$\bar{x}$	V [%]
Rega	101	50 - 83	66.4	11.89	32 - 62	47.6	12.88
Parseta	110	48 - 84	66.9	11.42	28 - 62	44.5	14.85
Wieprza	110	44 -82	66.4	14.41	29 - 64	44.0	15.54
Slupia	100	55 - 80	68.4	7.01	32 - 67	45.3	13.62
Vistula	61	56 - 82	71.5	8.63	31 - 69	45.6	18.65
Total	482	44 - 84	67.5	11.15	28 - 69	45.3	15.09

Between-rivers F value for the mean count: $F^{**} = 4.551$

** = difference significant at p = 0.01

Table 2. Between-rivers comparisons of mean pyloric caeca counts: results of the multiple range (Duncan's) test

River pair	Significance level
Rega - Vistula	5 %
Rega - Slupia	5 %
Rega - Parseta	1 %
Rega - Wieprza	1 %

Table 3. Relationship between trout length (x; [cm]) and pyloric caeca count as expressed by correlation and regression coefficients

River	n	Correlation coefficient	Regression coefficient	Nature of correlation
Rega	101	0.019	0.015	almost nonsignificant
Parseta	110	0.172	0.148	almost nonsignificant
Wieprza	110	0.120	0.091	almost nonsignificant
Slupia	100	0.202	0.261	clear, but poor
Vistula	61	-0.005	-0.007	almost nonsignificant

Table 4. Pyloric caeca counts in trout length classes

Fish length class [cm]	River															All rivers		
	Rega			Parseta			Wieprza			Slupia			Vistula					
	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]
40 - 44	-	-	-	-	-	-	1	36.00	-	-	-	-	-	-	-	1	36.00	-
45 - 49	-	-	-	2	41.00	34.49	2	43.00	13.16	-	-	-	-	-	-	4	42.00	21.12
50 -54	7	47.43	11.86	2	41.50	8.52	7	42.43	10.53	-	-	-	-	-	-	16	44.50	12.03
55 - 59	14	47.93	10.50	14	42.86	18.14	18	44.72	17.74	2	46.00	9.22	2	51.00	13.86	50	45.40	15.75
60 - 64	21	47.05	14.58	28	43.39	14.69	19	41.68	20.91	17	44.41	13.08	6	46.83	19.35	91	44.30	16.33
65 - 69	22	47.68	14.35	21	45.29	16.67	16	44.50	15.85	41	44.02	13.05	13	45.08	22.78	113	45.16	15.73
70 - 74	18	48.72	12.41	24	45.96	12.50	20	44.30	14.30	31	46.39	14.79	20	44.75	21.74	113	46.01	15.34
75 - 79	16	47.13	12.22	15	46.07	12.21	20	45.70	12.11	8	48.50	11.92	13	43.77	13.93	72	46.06	12.46
80 - 84	3	46.00	19.32	4	42.50	12.82	7	43.14	12.08	1	52.00	-	7	49.86	8.70	22	45.95	13.17
	F = 0.178 NS			F = 0.745 NS			F = 0.594 NS			F = 1.326 NS			F = 0.689 NS			F = 0.774 NS		

Table 5. Pyloric caeca counts in trout after different periods in the river

Period in the river [years]	River															All rivers		
	Rega			Parseta			Wieprza			Slupia			Vistula					
	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]
1	-	-	-	2	43.50	8.13	-	-	-	14	45.21	12.67	2	48.00	17.68	18	45.33	12.34
2	75	47.24	13.61	73	44.99	14.83	79	44.22	16.30	71	45.75	14.17	48	44.83	19.26	346	45.43	15.52
3	14	48.00	9.32	11	46.55	17.33	15	42.80	12.46	11	43.55	11.64	7	48.71	17.85	58	45.62	14.05
	F = 0.179 NS			F = 0.309 NS			F = 0.522 NS			F = 0.601 NS			F = .0.709 NS			F = 0.021 NS		

Table 6. Pyloric caeca counts in trout after different periods at sea

Period at sea [years]	River															All rivers		
	Rega			Parseta			Wieprza			Slupia			Vistula					
	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]	n	$\bar{x}$	V [%]
1 +	32	47.72	12.70	40	44.03	15.56	45	43.49	18.81	32	45.09	12.77	17	46.71	14.63	166	45.07	15.56
2 +	51	47.08	13.33	40	46.35	14.80	45	44.60	12.58	63	45.49	14.26	37	45.11	20.95	236	45.75	15.09
3 +	6	47.83	13.58	6	44.67	10.94	2	48.00	-	-	-	-	3	42.00	17.14	17	45.71	12.47
	F = 0.123 NS			F = 1.202 NS			F = 0.600 NS			F = 0.086 NS			F = 0.443 NS			F = 0.479 NS		

Fig. 1. Distribution of the pyloric caeca counts in trout