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Interrelation between the Feeding and Growth of the Young of Latvian Salmon and the Strength of Salmon Year-classes

by

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It is known that the strength of year-classes of Latvian salmon is, to a considerable extent, determined by the conditions of their early life in fresh water (M.N. Lishev, 1959; M.N. Lishev & E.Ja. Rimsh, 1961; A.P. Mitans, 1963). Interrelations between the feeding and growth of young salmon and the strength of year-classes have been investigated to find out the possibilities of using the distinguishing characteristics of young salmon in order to forecast the strength of the year-classes and the eventual catch.

The research was carried out in 1959-1963 on the Daugava and Salatsa Rivers flowing into the Riga Bay. 2.000 specimens were investigated for growth and 600 for stomach content. As a rule all the digestive tracts contained food, though in winter months when the water temperature was as low as + 2°, the percentage of empty digestive tracts amounted to 25-50%.

1. Food Composition of Young Salmon

The qualitative and quantitative composition of the food of young salmon depends largely on the availability of the corresponding food items and varies with the age of young salmon and the season of the year. During the main feeding season (from May to September) young salmon of all age-groups feed primarily on larvae of amphibiotic insects - Ephemeroptera, Trichoptera and Chironomidae (71-98% in weight). The pupae of insects in the food of the young occur in considerably smaller quantities, and adult winged insects (imago) are encountered only during their mass flight.

Of Ephemeroptera it is the larvae of Baetis sp. sp., Ephemerella ignita Poda and Heptagenia sulphurea Müll. that are of the greatest significance in the nutrition of the young salmon; of Trichoptera - it is freely living (without houses) larvae of Hydropsyche sp. and Tinodes waeneri L. and larvae with houses of Hydroptila sp, Leptocerus sp. and Brachicentrus subnubilus Curt. Of Chironomidae - it is small larvae of the sub-family Orthocladiinae that are important.

The fry of salmon start feeding on benthos soon after the absorption of the yolk sac and emergence from the gravel. In late May the fry (their average length being 28 mm, and average weight 202 mg) feed exclusively on benthic organisms-small larvae of Chironomidae and Ephemeroptera. From June to August larvae of Ephemeroptera (up to 72% in weight) are predominant in the food of fingerlings (0+9), though larvae of Trichoptera are also encountered. As from September these latter larvae prevail in the food, amounting to 80% of its weight.

In the autumn-winter period marine invertebrates-molluscs Theodoxus fluviatilis L. and Ancylus fluviatilis Müll. and crustaceans Gammarus pulex L. may constitute a large share of the food of young salmon. In late winter the activity of salmon increases and, consequently, the larvae of Plecoptera, which complete metamorphosis in early spring, become more available constituting in February and March 70-80% of the weight of the whole stomach content. Beginning from spring two-summer-olds (1+) start feeding on Ephemeroptera and Trichoptera larvae, their share increasing towards autumn.

The food items in the stomachs of young salmon older than two years (from 2 to 3 +) are identical with the food composition of two-summer-old salmon (1+).

The size of food species depends on the size of young salmon. Two-summer-olds (1+) and older salmon eat larger larvae of older generations, whereas fry and fingerlings (0+) choose smaller organisms belonging mainly to the generations of the year (Table 1)

The conditions of the spring season when the adult insects start to fly out and their new offspring is born may have a great influence on the abundance of food for the young.

A high spring run-off creates favourable conditions for the nutrition and growth of the larvae of new generations serving as food, primarily, for the fry and fingerlings (0+) of salmon.

Since the larval period of life of the majority of food organisms lasts a year or more, the conditions of the given spring may also affect the availability of salmon food the following year.

2. The Effect of Feeding on the Growth of Young Salmon and the Strength of Year-classes

In the papers cited above the interrelation between the growth pattern of young salmon and the abundance of salmon year-classes has been indicated :-strong year-classes are characterized by a high rate of growth of the young in the rivers, poor year-classes by a low growth rate.

The research has shown that the intensity of feeding of young salmon[1]) and their growth rate are interrelated. Thus, the comparison of the June-September averages of the general indices of stomach fullness with the mean length and weight of fingerlings (0+) in September 1961 and 1963 (the years when most representative data on the feeding of the young for all months were available) has indicated that the greater indices correspond to a faster growth rate (Table 2). The materials for other years show a similar picture. This regularity is also true in respect to older juveniles. For example, in June 1962 the weight increment of two-summer-olds (1+) and the general indices of stomach fullness were:- in the Salatsa River 49 mm and 329 o/ooo respectively, and in the Daugava River - 6o mm and 225 o/ooo.

Naturally, the relation between feeding and growth is of a more complicated nature; the water temperature also affects the growth rate by influencing the level of metabolism in the fish organism.

In the Daugava River fingerlings (0+) with similar indices of stomach fullness grew better in 1961 than in 1963, as the summer of 1963 was warmer, the mean daily temperature rising in separate periods to + 22-24°C, which is unfavourable for salmon - a representative of an Arctic freshwater faunistic complex. Thus, indices of stomach fullness may be used to characterize the conditions of life, growth and abundance of young salmon and, apparently, to make preliminary forecasts of the strength of the year-classes.

On the basis of the analysis of the growth of young salmon in the first year of their life an attempt was made to evaluate the strength of the salmon generations of the Daugava River.

Two methods of population estimation are compared in Table 3:-

a) by the deviations of length and weight of fingerlings (0+) from the mean values (our data);
b) by the age-composition of the spawning population (data by B.K. Evtyukhova).

The results of the two methods agree rather well except the assessment of the 1961 year-class, only insufficient data are available, since its spawning migration will take place only in 1964-1966.

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1) The general index of the fullness of the digestive tract was used as an index of the intensity of feeding:

$$\text{a o/ooo} = \frac{\text{Weight of food}}{\text{Weight of fish}} \cdot \text{lo,ooo}$$

Consequently, making use of the characteristics of young salmon (length, weight and general index of stomach fullness) it is possible to make relatively precise qualitative predictions of the strength of salmon year-classes and of the eventual catch 3-5 years later.

References

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Table 1. The mean weight of insect larvae found in the stomachs of young salmon from the Daugava River, 1961.

Month	Young salmon			Mean weight of larvae, mg	
	Age	Average length, mm	Mean weight g	Baetis sp.	Hydropsyche sp.
July	0+	71	5.2	1.2	4.2
	1+	119	24.3	2.3	6.8
August	0+	83	9.3	1.8	11.5
	1+	135	34.8	2.4	13.4

Table 2. Degree of fullness, temperature conditions and growth rate of young salmon (0+)

Year	River	Average index of stomach fullness, from June till September, o/ooo	Mean monthly t° of water from June till September	Length and weight of fingerlings in September (mm) : (g)	
1961	Daugava	19o	16.5°	96	9.9
	Salatsa	177	16.5°	89	9.3
1963	Daugava	189	17.5°	84	7.1
	Salatsa	13o	17.6°	66	3.3

Table 3. Growth of fingerlings (0+) and one-year-old salmon in the Daugava River, and population estimation

Year-class	T_1 till 1+[1]		Length and weight of fingerlings in September				Deviations from mean values	Population estimation[3]	
	mm	%	L cm		P			by growth of young salmon	by the age of spawning population[2]
			mm	%	g	%			
1957	67	112					+	+	+
1958	62	1o4					+	av.+	av.+
1959	56	94	8o	94	7.1	89	-	-	-
196o	57	96	82	96	7.8	98	-	-	-
1961	67	113	96	112	9.9	124	+	+	-
1962	48	81	85	99	8.8	11o	-	-	
1963			84	98	7.2	9o	-	-av.	
average	59.5	1oo	85.5	1oo	8.o	1oo			

1) The first annual increment calculated by the method of E. Lea.

2) Data by B.K. Evtyukhova

3) - = poor year-class
av. = average year-class
+ = strong year-class