CCLVI. FAT METABOLISM IN FISHES.

V. THE FAT OF THE SALMON IN ITS YOUNG FRESHWATER STAGES.

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It was pointed out in a previous communication [Lovern, 1932] that the fats from the species of freshwater fish examined up to that date formed a class distinct from the majority of marine species. The principal differences were increased proportions of C_{16} and C_{18} acids and decreased proportions of C_{20} and C_{22} acids in the freshwater fishes. Only four species had been examined, however, and it was possible that the observed differences were due to species peculiarities. Owing to the rather unusual life history of the salmon (*Salmo salar*), experiments on this fish should provide conclusive evidence. The eggs hatch out in freshwater, and for the first 1-4 years of their life the young salmon live like any other freshwater fish. During this stage they are known as salmon parr. Each year, at an average age of 2 or 3 years, some of these fish change colour and become silvery like the adult salmon. Now called smolts, they swim downstream and right out to sea, becoming a marine species. Hence, if the observed differences between freshwater and marine fish fats are due to environment, the fat from young salmon should be of the freshwater type, and that from adult salmon of the marine type.

EXPERIMENTAL.

The fish were minced (after removal of the viscera in the case of the smolts, but not with the parr, which were so soft that much fat would have been lost in the process of evisceration), and the mince was desiccated with sodium sulphate and extracted with ether. The particulars of the fats are given in Table I, and the compositions of the mixed fatty acids as weight and molar percentages in Table II.

Table I. *Particulars of salmon parr and smolt fats.*

Fish	Fat content %	Sap. equivalent	Iodine value	Unsaponifiable %
Parr	3.9	294.3	148.5	5.0
Smolts	1.2	334.1	166.0	18.0

Table II. *Fatty acid compositions.*

Fish	Saturated				Unsaturated				
	C ₁₂	C ₁₄	C ₁₆	C ₁₈	C ₁₄	C ₁₆	C ₁₈	C ₂₀	C ₂₂
	Wt. %								
Parr	0.7	2.7	17.7	3.3	3.1 (> -2.0 H)	21.7 (-2.3 H)	30.0 (-3.8 H)	12.9 (-8.3 H)	9.9 (-10.2 H)
Smolts	—	2.7	14.3	5.0	0.7 (-2.0 H)	7.9 (-2.0 H)	32.2 (-3.2 H)	19.4 (-6.7 H)	17.8 (-9.4 H)
	Mols. %								
Parr	0.9	3.2	18.4	3.1	3.7	22.8	28.6	11.3	8.0
Smolts	—	3.4	15.9	5.0	0.9	8.8	32.5	18.1	15.4

DISCUSSION.

These figures reveal several features of interest. In the relative proportions of the various acids, the fat from the parr is typically of the freshwater fish class, although the C₁₈ acid percentage is somewhat low. That from the smolts is not typical, and suggests a freshwater fish fat with the species peculiarities of the salmon [Lovern, 1934] superimposed on it. The adult salmon evidently only tolerates a relatively low proportion of palmitoleic acid and prefers a high content of C₂₂ acids. When the parr becomes a smolt, it becomes indistinguishable from an adult salmon except in point of size, and it proceeds to take up the normal marine life of the adult fish. Evidently its whole metabolism undergoes a change at this period. The fat which it has stored in its freshwater life is suitable no longer, and the smolt fat examined appears to be at a transitional stage from a typical freshwater fat to the special fat of the adult salmon. The lower fat content of the smolts compared with the parr suggests a partial withdrawal of fat to effect this change of type. No significance can be attached to the figures, however, in view of the different habitat of the two batches of fish. Different food and growth rates might well affect the fat content.

The fat from salmon eggs [Lovern, 1934] is particularly interesting in that it has a composition very like that of the smolts—in other words, like that of a freshwater fish with the peculiarities of the salmon. The significance of this is not clear.

The high degree of unsaturation of these fats should be noted. All are very markedly more unsaturated than the fats from the adult fish [Lovern, 1934]. The parr has the highest group unsaturation, and the egg and smolt fats about the same. Here again, the smolt fat shows signs of a change in type from the parr type to the adult type. Incidentally, these figures afford a good example of the futility of relying only on the general iodine value of a fat as a guide to unsaturation. The smolt fat has a much higher iodine value than the parr fat, which in fact is indistinguishable from the adult salmon fats in this particular.

The occurrence of a small quantity of lauric acid in the parr fat is interesting, and there was a suggestion that a trace of lauroleic acid was also present.

It is evident that the results confirm the previous suggestion of a different class of fat for freshwater fishes from that for marine.

SUMMARY.

The fats from salmon parr and salmon smolts have been examined. The composition of the former is typically that of a freshwater fish, whilst the smolt fat suggests a freshwater fish with the species peculiarities of the salmon. Both the fats are very highly unsaturated.

It is suggested that when the salmon changes from the parr stage to the smolt stage, its metabolic requirements become those of the adult fish, and thus the composition of its depôt fat takes on the peculiarities characterising the salmon fats as a whole.

The distinction between different classes of fat for freshwater and marine fishes is confirmed.

The unauthorised taking of immature salmon in our rivers is subject to heavy penalties. The sanction of the Dee District Salmon Fishery Board was requested for the taking of the quantity of smolts required. This having been granted, the Aberdeen Harbour Commissioners netted some 400–500 smolts in the tidal part of the Dee for this experiment. In the case of the parr special arrangements were made through the Fishery Board for Scotland for the Selkirk Angling Association to take the required number from the Ettrick Water.

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REFERENCES.

- Lovern (1932). *Biochem. J.* **26**, 1978.
— (1934). *Biochem. J.* **28**, 1955.