PART II

SCIENTIFIC AND TECHNICAL

EFFECT OF STARVATION ON THE BIOCHEMICAL COMPOSITION OF *CLARIAS BATRACHUS* (LINN.)

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Marked changes were observed in different chemical constituents of *Clarias batrachus* during starvation. The nitrogen and protein fractions showed a definite pattern of variations. The highest values of these were recorded on 10th day of starvation and thereafter values declined gradually. On the other hand, the acid soluble phosphorus exhibited a reverse trend, increasing gradually from the first to the 30th day of starvation. These changes have been attributed mainly to the energy and metabolic demands of the starving fish.

INTRODUCTION

The chemical composition of fish is greatly influenced by factors such as light, temperature, salinity, food, etc., and these factors vary almost throughout the year. Therefore, when the conditions become adverse and food is scarce, many of the fish species are subjected to natural period of starvation during a part of the year. Many fish species are able to survive without food at low temperature for several months and even years (Love, 1970). Liver and muscle are reported to be the most affected organs during starvation, while brain, heart and gill do not show measurable changes (Love, 1958; Yanni, 1962).

Variations in the lipid and water contents have been reported in many fishes (Black and Schwartz, 1950; Brandes and Dietrich, 1953, 1956, 1958; Idler and Bitners, 1956; Anon, 1966; Coppini 1967). Greene (1919) observed changes in the protein and water content of *Oncorhynchus tschuwytschu* during its upstream migration. An interesting fat-water line has

TABLE

Variations in Nitrogen fractions of the muscle

Date	Length	Weight	Total Nitrogen (Crude protein) g. %			Pure protein Nitrogen g. %		
			Range	Mean	S. E.	Range	Mean	S.E.
24-5-74	22-26 cm.	84-148g.	3.025-3.300	3.175	±.059	2.859-3.012	2.897	±.052
3-6-74			3.475-3.750	3.587	±.068	3.197-3.362	3.316	±.062
13-6-64			3.300-3.450	3.375	±.031	2.500-3.742	2.940	±.277
23-6-74			3.100-3.475	3.244	±.090	2.200-3.132	3.016	±.089

been noted for the skin tissue of many species of fishes during starvation (Takahashi and Shiokava, 1953). Similarly the existence of protein-water line has been reported in several non-fatty fishes (Love, 1970). Arevalo (1948) pointed out the changes in the lipid and protein content at the extremity of starvation of *Trachurus trachurus*. Robertson *et al.* (1967) made an analysis of insoluble protein nitrogen during the fasting of some fish species, while Wilkins (1967) observed changes in the phospholipid content of *Clupea harengus*. However, only few data exist on the effect of starvation in tropical freshwater fishes. In the present study, therefore, an attempt has been made to find out the effect of starvation on different chemical constituents of the muscle of *Clarias batrachus* (Linn.), a common freshwater catfish.

MATERIALS AND METHODS

Fish of a particular size range (22-26 cm.) were released in a large laboratory aquarium and starved for 30 days. Sampling was made after the interval of every ten days. The fish were skinned and muscle was removed and kept in separate glass covered petridishes. Care was taken to ensure that the muscle was free from bones. For the estimation of moisture, a weighed amount of muscle sample was dried to a constant weight at 100°C. The total fat was extracted, using petroleum ether (40-60°C. B. P) as solvent, in a soxhlet assembly for 12 hours. The modified micro Kjeldahl method, as described by Oser (1965) was adopted for the determination of total protein. For the extraction of total water soluble nitrogen the method of Velankar and Govindan (1957) was used. The non-protein nitrogen was estimated by the method of Koch and McMeekin (1924) whereas for the estimation of total phosphorus and its fractions, acid soluble and inorganic phosphorus, the method of Fiske and Subbarow

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of *C. batrachus* during starvation

PN/TN	Non-protein Nitrogen g. %			Total water soluble Nitrogen g. %			Water soluble Nitrogen g. %		
	Range	Mean	S. E.	Range	Mean	S. E.	Range	Mean	S. E.
1.216	253.5–291.00	278.25	±8.037	775.0–900.00	837.499	+26.942	521.500–612.00	559.250	+21.763
0.924	246.00–288.00	271.5	±8.979	891.666–1016.666	960.777	+36.748	614.166–742.166	695.112	+40.482
0.871	266.5–288.00	262.125	±17.172	600.0–800.00	685.416	+44.406	325.500–588.50	423.291	+60.585
0.930	168.0–274.50	227.625	±27.934	583.333–741.66	660.416	±32.520	375.500–473.166	432.791	±23.092

(1925) as described by Oser (1965) was followed.

Results And Discussion

Marked changes were observed in the chemical composition of *C.batrachus* during starvation. The nitrogen and protein fractions showed different patterns of variation (Table I and II). Total nitrogen (crude protein) was found to be elevated (3.587 g.) on the 10th day, but thereafter decreased gradually upto 30th day of starvation. Similar trend was observed for the protein nitrogen content. The ratios of PN/TN were found to vary from 0.871 to 1.216 during the whole starvation period. However, the ratio was high (1.216) on the first day. The maximum value of non-protein nitrogen was recorded on the first day (278.25mg.), thereafter it gradually declined upto 30th day of starvation. The trends of total water soluble nitrogen differed markedly from that of non-protein nitrogen. The highest value of total water soluble nitrogen was observed on the 10th day of starvation. Afterwards the value showed a reduction, whereas the water soluble nitrogen fraction registered a slight increase on the 30th day of starvation.

The starvation also brought about changes in the concentration of various protein fractions. The highest value of crude protein, pure protein and albumin were recorded on the 10th day of fasting (22.42g., 20.72g., 4.34g., respectively). Between 10th and 30th day, the values excepting those of albumin declined gradually (Table II).

The effect of starvation on the blood constituents of *C. batrachus* has earlier been observed by siddiqui (1972), who reported that the levels of protein fractions (total protein, albumin, globulin, fibrinogen) and that of non-protein nitrogen registered an initial rise on the second day of fasting,

TABLE — II

Variations in Protein fractions of the muscle of *C. batrachus* during starvation

Date	Length	Weight	Crude Protein g. %			Pure Protein g. %			Albumin g. %		
			Range	Mean	S. E.	Range	Mean	S. E.	Range	Mean	S. E.
14-5-74	22–26 cm.	84–148 g.	18.906–20.625	19.843	±0.366	17.319–18.825	18.105	±0.327	3.259–3.825	3.495	±0.136
3-6-74			21.719–23.437	22.422	±0.425	19.981–21.719	20.723	±0.4	3.838–4.638	4.344	±0.235
13-6-74			20.625–21.562	21.094	±0.193	15.625–23.387	18.373	±1.73	2.034–2.711	2.645	±0.374
23-6-74			19.375–21.719	20.273	±0.565	18.162–20.000	18.848	±0.558	2.347–2.957	2.705	±0.456

TABLE

Variations in the chemical constituents of the

Date	Length	Weight	Fat g. %			Moisture g.%			Total phosphorus mg. %		
			Range	Mean	S. E.	Range	Mean	S. E.	Range	Mean	S. E.
24-5-74	22-26cm.	84-148g.	0.675-1.023	0.861	±0.074	77.29-78.98	78.055	±0.348	275.2-308.8	288.4	±95.934
3-6-74			0.724-1.362	0.947	±0.147	77.916-77.610	77.276	±0.164	292.8-320.80	308.60	± 6.131
13-6-74			0.372-1.061	0.697	±0.170	77.01-79.190	78.151	±0.336	286.4-300.8	295.200	±3.487
23-6-74			0.350-	0.461	±0.050	78.235-	78.925	±0.210	286.4-	292.800	±2.355

followed by a gradual fall during the later phase of starvation. These changes in the blood chemistry of fish were in agreement with the variations observed presently in the muscle tissue. Lovern (1939) has reported that eel during starvation lost considerable body weight, more as a result of the loss of protein than the lipid.

The pattern of variations in the fat content of starving *C. batrachus* were similar to that of protein. The highest value of fat was noted on the 10th day of starvation but, thereafter, the values showed a gradual decrease till the lowest was obtained on the 30th day (Table III). The precentage of moisture was found to be maximum at the end of starvation (78.92%) & minimum (77.27%) on the 10th day thus showing an inverse relationship with the fat (Table III). The observed decline in fat level indicates that the fish during its starvation utilizes this source of food for energy and this fall in the fat content is compensated by a parallel increase in the tissue moisture percentage. This is in agreement to the observations of Brandes and Dietrich (1953, 1956, 1958). More or less similar type of conclusions have also been drawn by Love (1970). His findings reveal that during starvation the rise in the tissue water runs parallel to a fall in tissue protein and lipid levels. An inverse relationship between lipid and water has also been reported in *Scomber scombrus* (Anon, 1966). Black and Schwartz (1950) pointed out that during starvation the sum of lipid and water remains constant in *Sardinella ocellata* and *Scomber scombrus*, while in *Oncorhynchus nerka* the water content, during spawning migration, changes from 60 % to 77%, but the sum of lipid plus water remains 80% (Idler and Bitners, 1959). An increase in the moisture percentage,

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muscle of *C. batrachus* during starvation.

Inorganic phosphorus g. %			Acid Soluble Phosphorus mg. %			Ash g. %		
Range	Mean	S. E.	Range	Mean	S. E.	Range	Mean	S. E.
127.5–145.5	138.0	±3.208	305.00–402.0	350.00	±40.718	1.028–1.208	1.137	±0.140
172.5–187.5	178.875	±3.793	336.0–372.0	349.50	±24.949	1.252–1.320	1.273	±0.016
119.25–149.25	133.312	±6.801	354.0–372.0	360.75	± 3.944	1.053–1.266	1.181	±0.049
123.0–133.5	122.625	±2.617	378.0–432.0	402.75	±11.513	1.03–1.12	1.105	±0.026

with the decreased value of protein, was reported in *Oncorhynchus tschuwytscha* during spawning migration (Greene, 1919). Further, low values of protein and lipid with higher percentage of moisture were found in *Oncorhynchus gorbuscha* where the higher percentages of moisture were found to maintain the body weight of the fish (Parker and Vanstone, 1960). Except for a slight decrease in the ash content from 1.27 to 1.10 mg. no definite pattern of variations could be observed in the ash content of starving *C. batrachus* (Table III). A fall in the ash content has also been reported in other fish species during starvation (Tilik, 1932; Love, 1958, 1968).

Remarkable changes were also observed during starvation in the total phosphorus and its fractions, the acid soluble phosphorus and inorganic phosphorus(Table III). The total phosphorus and inorganic phosphorus showed the same pattern of variations as exhibited by protein, and fat contents. The highest values for these constituents were recorded on the 10th day of starvation(308.60mg. for total phosphorus and 178.875mg. for inorganic phosphorus). Thereafter, a gradual decline in their concentrations was noted. The acid soluble phosphorus, however, showed an opposite pattern of variation and consequently, the entire period of starvation was marked with an increase in the value of this fraction from 350 mg. to 402.75 mg. It is interesting to note that the total blood phosphorus in this species also showed a gradual decline after an initial rise on the second day of starvation (Siddiqui, 1972).

It is well known that during starvation the metabolic activity of the fish, like other animals, slows down considerably. The

fish during this period of fasting utilizes its reserved food materials for their basal metabolism and this explains the fall in the concentration of most of the chemical constituents of fish muscle during starvation.

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