STUDIES ON THE BIOCHEMICAL COMPOSITION OF SOME FRESHWATER FISHES
III. OVARY

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Biochemical composition of the spent overies of 23 different species of freshwater fishes showed a much lower value for protein and fat with a much higher moisture content than those of the ripe eggs, suggesting an inverse relationship between fat and moisture. Ovaries during the recovering phase showed fairly high values of phosphorus, but lower than those for the ripe eggs. Higher values of calcium and iron in spent ovaries than those in ripe eggs probably suggest that there is a greater requirement of calcium and iron during the spent phase of the gonads.

INTRODUCTION

A study of the biochemical composition of gonads forms an important pre-requisite in understanding the physiology of pre-spawning and post-spawning fish, for it is well known that the reserves from various tissues are more and more diverted towards gonads as the spawning time approaches. Many studies on the chemical analysis of fish gonads have been undertaken earlier (Milroy, 1908; Greene, 1921; Bruce, 1924; Channon & El Saby, 1932; Wimpenny, 1938; Wilson, 1939; and Idler & Bitners, 1960). On Indian teleosts also an attempt has been made to estimate the changes in the fat and amino-acid contents of the gonads by several earlier authors (Ramaswamy, 1955; Krishnamoorthy, 1958; Durairaj, 1961 & 1962). Recently a detailed physico-chemical analysis of the ripe oocytes of 19 different species has been reported (Hasan and Jafri, 1964). The data pertaining to fully developed unspawned eggs account for the ripe ovaries as during peak maturity ripe ova comprise the major volume of the ovaries. The present paper deals with an analysis of the ovaries a few months after the spawning, when they generally were in a

state of recovery. A comparison, therefore, between the two set of values elucidates the changes which the gonads undergo from the pre-spawning to the post-spawning phases.

Material and methods

Fish which formed the basis of the present study were the same as used for other estimations (parts I & II). Ovaries from each fish were dissected out carefully and their degree of maturity was determined according to the scheme given earlier (Qasim, 1957). Estimations were made after macerating the ovaries of five or more individuals together and taking several readings. The techniques of various estimations were the same as described elsewhere (see part I).

The ovaries of all fishes examined were generally in the recovering spent stage as based on the deduction of Qasim & Qayyum (1961) that in Aligarh the spawning season of almost all freshwater fishes is over by September, or only in a few cases, by October, and that the recovery starts from November onwards after a period of one or two months. All estimations were therefore made during the months of November and December.

Results and discussion

Protein: The values of protein in the recovering ovaries ranged between 10 to 15% on fresh weight basis (Table 1). A comparison of these values with those of ripe eggs recorded earlier (Hasan & Jafri, 1964) will reveal that the percentage of protein is about half to one third of the latter. A higher percentage of protein in the ripe ovary may be because of considerable accumulation of lipo-protein reserves in the egg–yolk. Idler and Bitners (1960) while investigating the biochemical composition of sockeye salmon during spawning migration have noted a four time increase in the total ovarian protein. The freshwater teleosts of India only show an increase of about two to three times during maturation.

In various groups of fishes, average values for carps and cat-fishes were found to be more or less identical (Table 1), while those of murrels were higer than the two. The highest percentages among all the fishes examined were noted in *Labeo rohita, Rita rita, Pseudeutropius garua and Ophicephalus punctatus.* From among the miscellaneous forms, *Mugil corsula* showed a high value (Table 1).

Fat: The total fat percentage in the recovering ovary was found to be low. It ranged between 0.171 and 11.563% on fresh weight basis (Table 1). The values given in Table 1 clearly indicate that the fat content varies widely in the same group of fishes. This may be because of the differences in the breeding time from one species to the other and the length of the breeding season. However, it is well known that the increase and decrease in the fat content of the ovary are connected with the cycle of maturation and depletion of gonads (Wilson, 1939; and Bruce, 1924). It has already been reported that in the red mullet, *Upeneus indicus*, the gonads gain fat steadily until the maximum is attained at peak ripeness (Ramaswamy, 1955). Durairaj (1962) also noted the highest quantity of fat in the ovaries of *Cirrhina reba* just before the spawning began. In sockeye salmon an overall increase of about 200% in the total ovarian fat was noted over the entire period of migration (Idler and Bitners, 1960).

A comparison of the figures of fat given in Table 1 with those of the ripe eggs reported earlier (Hasan and Jafri, '64) will indicate that the increase in fat in the ovaries during maturation is considerable.

In some cases it may be as large as 17 to 19 times.

In carps the recovering spent gonads of *Barbus stigma* and *B.sarana* showed relatively higher values. Amongst the cat-fishes higher percentages were noted in *Clarias magur, Callichrous pabda* and *C. bimaculatus.* Murrels in general possessed high fat content in the ovary (average 4.537%), but the highest percentage (11.563) was recorded in *Notopterus notopterus.* A higher fat content in these species probably suggests a quick recovery of gonads after the spawning, as the ovaries were advancing faster towards maturation than those which had less fat.

Moisture: The percentage of moisture in the recovering ovary was found to be very high, ranging between 73 to 83%. A comparison of these with the moisture figures reported earlier for ripe eggs will reveal that in the recovering spent ovaries the moisture content is higher. This may be because of a lower fat content present in the spent ovaries. The inverse relationship between fat and moisture as has been found in other tissues (see part II) seems to be true for the spent ovaries also. This gives a further support of the view that the fat increases at the expense of moisture. The above relationship between fat and water contents (FW) has been found to be generally applicable to the fatty tissues (see muscle, liver and ripe eggs). The recovering spent ovaries with their very low fat content do not show a well marked relationship between the two fractions.

Dry matter and ash: The dry matter percentage in the ovaries varied from 16.230 to 26.620 (Table 1). Relatively high values of ash were recorded in the recovering ovaries as compared to the ripe eggs. The average ash content in the spent ovaries of all the fishes examined was about 1.9%. In general the values were found to be higher than those reported for muscle and liver (part I & II).

MINERAL CONTENTS

Phosphorus: As compared to muscle and liver the phosphorus content of the spent ovaries is relatively higher (see parts I & II). This may be because of a heavy demand of phosphorus by the ovaries towards maturation (Milroy, 1908; and Bruce, 1924). The values were, however, lower than those of ripe eggs suggesting that more and more phosphorus is mobilised in gonads as they advance towards higher stages of maturity. Change *et al.*, (1960) have noted a very significant increase in the lipid phosphorus in the ovaries of sockeye salmon during the spawning migration. A comparison of the values of phosphorus and fat obtained in the recovering spent ovaries with those of the ripe eggs shows that in the eggs higher fat values are also accompanied with a relatively high phosphorus content whereas in the ovaries during the recovering spent phase values for both fat and phosphorus contents were comparatively low. This probably indicates that a portion of phosphorus is associated with the lipid as phospholipids.

In various species analysed the quantity of phosphorus varied considerably. It showed a range of 0.435 to 1.350% on fresh weight basis (Table 1). The highest percentages were recorded in *B. sarana* and *Mastacembelus armatus.*

Calcium: The amount of calcium in the spent ovaries varied between 20.00 and 80.00 mg per 100 gm of fresh tissue (Table 1). These were much higher than the amount recorded for the ripe eggs. This suggests that probably calcium requirement is more during the recovering phase of the gonad than when they attain full ripeness.

The spent ovaries of *O. punctatus*, *R. rita* and *M. armatus* recorded the highest values of calcium while the lowest values were obtained in *L. rohita* and *M. corsula*. On an average, the murrels had a higher calcium content (55.00 mg) than other fishes.

Iron: The values of total iron (ic) ranged from 15.00 to 55.00 mg per 100 gm of fresh tissues (Table 1). The iron content of spent ovaries was significantly higher than the ripe eggs and it seems that like calcium, the iron requirement of gonads is greater in the post-spawning phase than in the pre-spawning period.

The average values for carps, cat-fishes and murrels did not differ much. The highest value (55.00 mg.) was recorded in the spiny-eel, *M. armatus*. The same species recorded the highest percentage of iron in its muscle (see part 1).

Summary

Biochemical analysis of spent ovaries of 23 different species showed that the protein and fat contents were much lower than what these occur in the ripe eggs. The moisture content, on the other hand, is much higher suggesting an inverse relationship between fat and moisture fractions. Fairly high values of phosphorus were recorded in the ovaries during the recovering phase. These were, however, lower than the values noted for the ripe eggs. Spent ovaries showed higher values of calcium and iron than those found for the ripe eggs. This probably suggests that there is a greater requirement of calcium and iron during the spent phase of the gonads.

Acknowledgement

We are extremely grateful to the Indian Council of Agricultural Research for financially supporting this investigation.

We also wish to thank Prof. M. A. Basir, Head, Department of Zoology, Aligarh Muslim University, Aligarh, for his hospitality and encouragement.

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TABLE I COMPARATIVE CHEMICAL COMPOSITION OF THE OVARY DURING ITS RECOVERY IN VARIOUS FRESHWATER FISHES

SPECIES	Protein %	Fat %	Moisture %	Dry Matter %	Ash %	Phosphorus %	Calcium mg per 100 gm	Iron mg per 100 gm
CARPS								
1. *Cirrhina mrigala* (Ham.)	13.120	1.769	80.936	19.064	2.240	0.747	36.00	40.00
2. *Catla catla* (Ham.)	10.310	0.461	80.607	19.393	2.053	0.762	26.00	30.00
3. *Labeo rohita* (Ham.)	15.000	0.171	82.236	17.764	2.032	0.830	20.00	22.50
4. *Labeo calbasu* (Ham.	10.937	0.213	80.570	19.430	2.200	0.830	60.00	15.00
5. *Labeo gonius* (Ham.)	10.620	0.505	83.770	16.230	2.690	0.740	45.00	25.00
6. *Barbus stigma* (Cuv. & Val.)	14.375	9.086	73.470	26.530	2.250	0.845	40.00	18.00
7. *Barbus sarana* (Ham.)	11.250	5.332	75.892	24.108	2.480	1.350	40.00	38.00
8. *Barbus (Tor.) putitora* (Ham.)	12.810	1.524	80.830	19.170	1.930	0.702	40.00	18.00
CAT-FISHES								
9. *Mystus seenghala* (Sykes)	12.500	1.188	83.850	16.150	1.965	0.875	30.00	25.00
10. *Mystus aor* (Ham.)	12.180	0.639	83.590	16.410	1.960	0.740	40.00	33.00
11. *Bagarius bagarius* (Ham.)	11.250	0.950	81.330	16.670	2.120	0.435	40.00	30.00
12. *Rita rita* (Ham.)	15.310	0.866	82.384	17.616	2.114	0.695	80.00	47.50
13. *Pseudeutropius garua* (Ham.)	14.680	0.392	80.784	19.216	2.124	0.890	24.00	20.00
14. *Wallagonia attu* (Bloch)	10.310	0.680	83.000	17.000	2.010	0.770	60.00	18.50
15. *Clarias magur* (L)	12.810	8.071	75.820	24.180	1.990	0.747	30.00	25.00
16. *Callichrous pabda* (Ham.)	10.310	3.727	76.220	23.780	1.980	0.807	60.00	22.50
17. *Callichrous bimaculatus* (Bloch)	11.600	5.682	78.530	21.470	2.330	0.875	60.00	27.50
MURRELS:								
18. *Ophicephalus punctatus* Bloch	15.940	5.941	76.080	23.920	1.320	0.575	80.00	22.50
19. *Ophicephalus striatus* Bloch	12.500	1.961	80.800	19.200	1.710	0.560	40.00	38.00
20. *Ophicephalus marulius* Ham.	11.870	5.711	77.688	22.312	1.630	0.657	45.00	20.00
MISCELLANEOUS:								
21. *Notopterus notopterus* (Pallas)	11.870	11.563	73.380	26.620	1.200	0.390	45.00	37.50
22. *Mugil corsula* (Ham.)	15.310	1.886	81.060	18.940	1.916	0.710	20.00	32.50
23. *Mastacembelus armatus* (Lacep)	11.250	5.060	78.870	21.130	1.460	1.120	80.00	55.00

N. B. All percentages are on fresh weight basis.