ABSTRACT

Knowledge of the haematology of a particular animal is essential, because it unfolds the metabolic conditions and the physiological changes occurring in the animal body. The blood picture of lower vertebrates, in general and of fishes, in particular, is very much obscure. This thesis emphasizes
(i) the comparative blood values of some freshwater fishes,
(ii) a detailed study on haematology of two important species of major carps namely, *Cirrhina mrigala* and *Labeo rohita* and its variations according to the size, weight, season and maturity of the gonad of the fish. (iii) Seasonal changes in the blood values of these two species of major carps and the influence of various environmental factors e.g., temperature, dissolved oxygen concentration, hydrogen ion concentration and feeding behaviour have been evaluated. (iv) Besides this a few biochemical constituents of some freshwater fishes have also been estimated, (v) Seasonal changes in the biochemical constituents have been related with the feeding intensity and changes occurring in the gonad conditions of *Heteropneustes fossilis*, *Cirrhina mrigala* and *Labeo rohita*.

The paucity of literature and the absence of any authentic record on haematology and biochemistry of fish blood of Indian freshwaters was the main factor responsible for initiating the present work.
Comparative study of the freshwater fishes reveals that maximum packed cell volume is found in *Symbranchus bengalensis*. The haematocrit values in air breathing fishes (*Clarias magur, Heteropneustes fossilis* and *Ophicephalus striatus*) are lower than *S. bengalensis*, but are much higher than the values obtained for carps.

Among the three species of major carps, maximum value of packed cell volume is obtained in *C. catla*, while minimum is found in *L. rohita*.

In all the species investigated, higher values of packed cell volume is found in males than in females.

Both *C. mrigala* and *L. rohita* show significantly high packed cell volume in summer than in winter. Higher values of packed cell volume is also obtained in ripe fishes (4th stage of gonad maturation) than found in immature fishes. Significant differences have been also noticed in packed cell volume, at different lengths and weights of the fishes.

Haemoglobin content in air breathing fishes is much higher, due to the fact that they are more active and require more oxygen to meet their high metabolic activity. Among carps, maximum level of haemoglobin is found in *C. catla* than in the other two species, which have more or less equal amount of haemoglobin content in their blood.
Lowest amount of haemoglobin is found in bottom dweller sluggish fish, *H. attu*. Distribution of haemoglobin content at various lengths and weights of *C. mrigala* and *L. rohita* are significant.

Seasonal variations in haemoglobin content and influence of various ecological factors are very apparent. In both the species maximum level of haemoglobin is found in summer, which appears to be due to high temperature, low dissolved oxygen concentration and abundance of food. A high haemoglobin content in ripe fishes (4th stage of gonad maturation) found in Mrigal and Rohu, has been also reported by other workers for other species.

Again the red blood counts are high in air breathing fishes (*C. striatus, C. magur* and *H. fossilis*). Minimum count of red blood cells is found in *H. attu*. Among carps, erythrocyte counts are higher in *C. catla*, while in *C. mrigala* and *L. rohita* the counts are similar.

Variations in erythrocyte counts at different lengths and weights follow the same pattern as noticed for packed cell volume and haemoglobin in *C. mrigala* and *L. rohita*. Significant differences have been obtained in different seasons of the year. The erythrocyte counts for both the species are higher in summer than in winter. In ripe fishes the erythrocyte counts are higher in both the sexes of both the species.

Leucocyte counts in different species do not vary much and their number is much lower than reported in other freshwater
and marine fishes. The variations are also very much restricted in different seasons and at different lengths and weights of the fish.

Differential counts have been made only on three species of major carps. Thrombocytes, which have been included in the leucocytic series, are found in maximum numbers in C. crigala and lowest in L. rohita. Large lymphocytes are very rare, while small lymphocytes are abundant in Rohu. The ranges of neutrophils in all the three species are almost identical. Eosinophils are maximum in C. catla. Basophil is only noticed in Rohu. All the species of major carps investigated, come under Dawson's II and III group, on the basis of presence of immature erythrocytes in the circulating blood.

Maximum clotting time is obtained in C. catla and C. crigala while in L. rohita, L. sitala and L. magur the clotting time is more or less same. Minimum clotting time is found in C. striatus.

BIOCHEMICAL COMPOSITION OF SOME FRESHWATER FISHES

The following biochemical constituents of the blood serum of some freshwater fishes have been estimated. Seasonal variations in alkaline phosphatase level, phosphorus, calcium, cholesterol, protein and iron content have been observed in the blood serum of Heteropneustes fossilis and in two species of major carps namely, Cirrhina crigala and Labeo rohita. The
results thus obtained have been correlated with the two most important aspects of the biology i.e., feeding intensity of the fish and affect of spawning and maturation of gonads in various months.

Alkaline phosphatase activity

High level of alkaline phosphatase is found in the carnivorous fishes (H. fossilis and W. attu). While among carps, alkaline phosphatase level gradually decreases from bottom feeder C. grigala to surface feeder C. catla, the difference seems to be due to different dietary habits of the three species of major carps. The males, in all the species investigated, are found to have higher level of alkaline phosphatase than the females.

In H. fossilis, maximum level of alkaline phosphatase is found in November, when the dietary condition of the habitat is excellent. Lowest value in summer coincides with the adverse environmental conditions, as the habitat usually gets dired and the food becomes scare. In carps minimum level of alkaline phosphatase is found in monsoon. The level of alkaline phosphatase then gradually increases reaching maximum in early winter. When the spawning season approaches the values fall down.

Phosphorus

Phosphorus contents in the blood serum of H. fossilis, L. rohita and C. catla are more or less similar. Maximum phosphorus content is found in W. attu and minimum in C. grigala.
In *H. fossilis*, again the level of phosphorus is high in winter and low in summer. Variations in phosphorus contents in both Mrigal and Rohu are found to be greatly influenced by spawning and feeding habits of the fish.

**Calcium**

Maximum calcium content is found in *H. fossilis*, while minimum in *N. attu*. The three species of major carps do not show much variation in their serum calcium contents.

*H. fossilis* accumulates a large quantity of calcium just prior to the spawning and shows low values after spawning. The values increase when the fish is in active phase of feeding. Similar variations as noted for *H. fossilis* are also noticed in two species of major carps.

**Total serum protein**

In both the carnivorous species investigated, the protein contents are much higher and similar. In major carps protein content gradually decreases from surface feeder, *C. catla* to bottom feeder *C. mrigala*. The males of all the species are showed higher protein content than the females.

Serum protein in *H. fossilis* is high in winter, which is utilized during summer when the dietary and environmental conditions are unfavourable. In major carps, high protein content in first transitory period and winter indicates that the fish soon recovers after spawning, due to intensive feeding.
Protein values in males are higher throughout the year except in spawning season when the values in females are higher.

**Cholesterol**

As found in protein, the cholesterol content is higher in carnivorous fishes (*H. fossilis* and *W. attu*). The cholesterol contents in *C. catla* and *L. rohita* are almost the same while the values are higher in *C. mrigala*. Except in *C. mrigala* higher values are noticed in males than in females.

Seasonal variations in cholesterol contents of all the species follow similar pattern. High values are obtained during intensive feeding period, while low values are found when the fishes are spent.

**Iron**

Iron levels in the blood of *W. attu, C. mrigala* and *L. rohita* are comparable. Maximum iron content is found in *H. fossilis*, while among carps the iron is maximum in *C. catla*.

The lowest value of iron just after spawning indicates the anaemic condition of *H. fossilis, C. mrigala* and *L. rohita*, while maximum value of iron in all the three species is found in their respective intensive feeding periods.