SUMMARY

CHAPTER 1

A brief account of the habits, habitats and fishery of H. ilisha and H. toli is given. H. ilisha is an anadromous migratory fish. Their migration up the River Narbada commences in July and continues till the middle of September. The upstream limit of the migration is about 100 miles. H. toli, which is a non-migratory marine fish were found to be drifted into River Narbada at the highest high tide time of the year.

CHAPTER 2

Histological studies revealed degenerative changes in the red and white muscles of H. ilisha. In the red muscle region the connective tissue infiltrates into the fasciculi with the result that isolated groups of muscle fibres cut away from the main fasciculi and surrounded by fat cells were seen. In these groups of fibres much variation existed with regard to the number of fibres, diameter of the fibres and the fibril loss. Abnormal characteristics such as necrosis, shifting of nuclei to the central position and fibres with single or multiple vacuoles filled with fat were also observed. In the region of the white muscle, degenerative changes like necrosis and fragmentation of the sarcoplasm of the fibres were observed, but in a very less marked degree when compared to that seen in the region

of red muscle. The above mentioned changes were found to start while the fishes were in the sea, progressed as they migrated up the river so that the maximum changes were noted in the spent fishes from the freshwater zone.

In some of the maturing and all the spent H. toli collected from the sea and all H. toli collected from river, degenerative changes as in maturing H. ilisha from sea were observed, but in a less marked degree. In those obtained from the river, it was found to be more than the ones from the sea.

The probable role of different factors like starvation, aging, hyperactivity of endocrine glands which accompany migratory ascent in bringing about the degenerative changes are discussed. It is concluded that reproductive stress initiate the changes by the stimulation of the endicrine glands, the catabolic effects of which in turn are influenced by factors like aging, starvation, stress from migration and physiological adjustments required in the transition from salt to freshwater. In mature and spent H. ilisha more of such factors come into play and hence greater degenerative changes occur, whereas the less marked degenerative changes in H. toli may be attributed to the fewer factors involved.

CHAPTER 3

Fat and water contents were estimated in the red and white muscles of the migratory and non-migratory species

of Hilsa during different stages of maturity. Regional differences in the fat and water contents were noted. Fat was found to be predominant in the red muscle.

In H. ilisha of IVth stage of maturity, enormous storage of fat was observed in the myocommata, connective tissue between red and white muscle regions, lateral line septum and the intermuscular connective tissue. The red fibres unlike the white ones also showed the storage of considerable amount of intracellular fat in the form of globules.

On migration and spawning, H. ilisha of both sexes showed a considerable amount reduction in fat, which was nearly twice that was seen in H. toli upon maturation and spawning. In both species compared to males, females showed more reduction in fat level. The water content was found to be inversely related to the concentration of fat.

The changes observed have been correlated with migration or growth. The probable role of hormones in the storage and mobilization of fat is discussed.

CHAPTER 4

The distribution of iron in the red and white muscles of migratory and non-migratory species of Hilsa and its changes during different stages of maturity were investigated. A higher concentration of iron was observed in the red than in the white muscle of both species, and the former muscle of H. ilisha was found to be richer in

iron than that of H. toli. A regional difference in its distribution was noted in both species, wherein, the red muscle from the middle region contained more iron than the same muscle from the tail region. The white muscle however, exhibited the reverse condition. During the migratory ascent an initial increase and followed by a gradual reduction in its content took place from both muscles, and it was more marked in the red muscle. Thus the minimal values were obtained for spent fishes from the freshwater zone. In H. toli upon maturation the changes in its content were not much significant.

The alterations in the level of iron observed in H. ilisha have been correlated with the probable changes in respiratory metabolism, which in turn may have been brought about by changes in the activity of thyroid, transition from salt to freshwater and also the degeneration of the muscle during migration.

CHAPTER 5

Changes in the sodium and potassium contents of red and white muscles of the migratory and non-migratory species of Hilsa during different stages of their maturity were studied. In both muscle types the potassium content was greater than that of sodium. The white muscle showed much higher values for potassium and slightly higher values for sodium as compared to the red muscle. Among marine immature H. ilisha, disturbance in the ionic balance as

indicated by lowered sodium and increased potassium content was noticed in fishes of IVth stage of maturity. During the migratory ascent a gradual increase in sodium and decrease in potassium took place. Thus mature and spent fishes from the freshwater zone showed a marked drop in potassium and increase in sodium content in both the muscles. The increase in sodium was more significant in the red muscle, while the decrease in potassium was found to be marked in the white muscle. However, the drop in potassium exceeded the rise in sodium in both the muscles and hence the total sodium and potassium concentration was less than that found in marine immature fishes. In H. toli the changes observed upon maturation and spawning were not much significant. In those specimens which were collected from the river, the values obtained for both ions were lesser than in those of same maturity from the sea.

The observed ionic changes in the muscles of H. ilisha have been correlated with factors such as starvation, degeneration of muscle fibres and the hormonal changes accompanying migration and spawning.

CHAPTER 6

The calcium and phosphorus contents of red and white muscles of the migratory H. ilisha and non-migratory H. toli in different stages of life cycle were studied. Since lipid phosphorus content is an index of the phospholipid level, the fat extracted tissue as well as the extr-

acted fat were analysed separately for phosphorus. The tissue phosphorus and calcium content were found to be more in the white muscle, whereas the red muscle showed a higher concentration of lipid phosphorus.

In H. ilisha, a reduction in calcium and lipid phosphorus in red and white muscles as well as tissue phosphorus from the white muscle took place upon completion of migration and spawning. In the marine H. toli no marked difference was noticed in the values obtained for calcium and tissue phosphorus among immature, mature and spent fishes, while lipid phosphorus showed a reduction on maturation. River H. toli showed much inconsistency in the values.

The tissue phosphorus level in the red muscle of H. ilisha showed an initial drop and then an increase during the migratory ascent. Thus its level was found to be higher in mature and spent forms from the river than in marine immature fishes of IVth stage of maturity, but lower than in those of the IIIrd stage.

The probable factors which may be responsible for the observed changes have been discussed. The difference shown by the red and white muscles of H. ilisha with respect to changes in tissue phosphorus has been attributed to the different metabolic adaptations.

CHAPTER 7

The histochemical localization of cholinesterases in three representative types of fishes, a marine migratory

fish, H. ilisha, a non-migratory marine fish, H. toli and a freshwater fish, Barbus stigma was investigated.

In all the fishes studied, the innervation of red muscle was found to be similar, i.e. the fibres showed myotendinous junctions at both their ends and regularly distributed neuromuscular junctions of 'en grappe' type along their length. In the white muscle region of both species of Hilsa, while a few superficial fibres revealed myotendinous and irregularly placed 'en grappe' neuromuscular junctions; the rest of the fibres from the deeper region possessed myotendinous junctions alone. In Barbus, unlike in the other two species all the white fibres showed both types of junctions as in red muscle. Urea-silver nitrate staining revealed the presence of nerves at both myotendinous and neuromuscular junctions. AChE and BuChE, were both observed at the neuromuscular and myotendinous junctions of H. ilisha, while in the other two fishes BuChE was absent.

The innervation of red and white muscle fibres of the above mentioned fishes have been compared with similar fibres of other fishes, frog, birds and mammals pointing out the similarities and dissimilarities between them. Based on the density of nervous innervation and electrophysiological properties, three types of muscle fibres (fast, slow, intermediate) have been characterized.

CHAPTER 8

The changes in the cholinesterase activity in the

red and white muscles of the migratory and non-migratory species of Hilsa during different stages of maturity and the effects of different concentrations of added monovalent cations (Na^+ & K^+) on their activity were investigated histochemically.

The highest AChE activity was found in the juveniles of H. ilisha. Upon maturation and spawning, in both the species a decrease in concentration of esterases took place, the reduction being more pronounced in the migratory species. The changes observed have been correlated with factors such as growth, muscular activity, and the transition from salt- to freshwater which occur during migration.

The incorporation of monovalent cations (Na^+ & K^+) in low doses (0.05M) revealed a slight activation of AChE in all the stages of maturity. The AChE was more resistant to the effects of ions than BuChE in all stages. The enzymes were destroyed faster at the neuromuscular than at the myotendinous junctions. To bring about a total inhibition of AChE in mature and spent H. ilisha, a higher concentration of ions than in other stages was found to be necessary. The role of ions in altering the ratio of substrate concentration versus enzyme activity has been discussed.