CHAPTER 8

HISTOLOGICAL CHANGES IN THE KIDNEY OF *HILSA ILISHA* AND *HILSA TOLI* DURING DIFFERENT PHASES OF LIFE CYCLE

The migratory fishes have to face severe changes of the environment. When in sea, they have to gain "free" water, prevent loss of water and have to eliminate excess of salts. When they are in freshwater, being in hypotonic media, they have to control flooding out of salts and maintain concentration of body fluids. To overcome all problems a highly elaborate physiological mechanism is necessary.

The kidney function viz. regulation of water, sodium and potassium is known to be controlled by the adrenocortical hormones (Holmes, 1957, cf. Gorbman, 1959; Chester Jones, 1958). Hyperactivity of adrenocortical tissue brings about the degenerative alterations in the kidney and other organs (Robertson *et al.* 1963).

It has been suggested that neurohypophyseal principles like icthyotocin and 8-arginine-vasotocin, the occurrence of which has been well confirmed in the teleost pituitaries, may also be involved in governing water excretion and osmoregulation (Sawyer, 1960, 1963; Carlson and Holmes, 1962; Heller and Bentley, 1964). Maetz (1963) studied the effect of icthyotocin, vasotocin and hypophyseal extracts of fishes *Pollachius* and *Carassius* on the kidney of fish *Carassius auratus*. He found that these cause an increase in renal loss of electrolytes through kidney, whereas stimulation of sodium influx through gills was

observed.

The haemopoeitic tissue is also noticed in the head kidney of the fishes along with the adrenocortical and chromaffin tissues by several workers (Pickford and Atz, 1957; Bern and Nandi, 1964 ; Nandi, 1962).

The kidney and gills are the important organs concerned with the regulation of ions and water in the body. During migration, due to the change in the external medium, the functional activity of the kidney must be playing an important role in maintaining the ionic balance. It was therefore thought interesting to study the histological alterations in the kidney during the various phases of life cycle of the migratory H. ilisha and non-migratory H. toli. The changes in the haemopoeitic tissue were also studied.

Since the changes undergone by the pituitary and the adrenocortical tissue during various phases in the same fishes have also been studied simultaneously by Desai (1967), an attempt is made here to discuss the kidney-pituitary-adrenocortical tissue interactions.

MATERIALS AND METHODS

The live fishes were removed from the net and decapitated immediately. The head kidney was removed and fixed in Bouins fluid. 5-6 μ paraffin sections were cut and stained with Haematoxylin-eosin, Masson's trichrome, Heidenhain azan stain and Aldehyde fuchsin.

OBSERVATIONS

Kidney of fingerling of H. ilisha captured from river:

The glomerulus as well as the Bowman's capsule appeared normal. The tubules were uniform. The cells were solidly packed with each other and were filled with granules. Their nuclei were comparatively large, round and contained little chromatin material. The wall of the arteries showed distinct layers and the lumen were occassionally filled with blood cells. In general the entire kidney tissue was uniform and compact.

Haemopoitic tissue exhibited deeply stained cells with nuclei containing very little chromatin material.

Kidney of immature H. ilisha captured from sea:

In almost all respects, the microscopic structure resembled the kidney of fingerling described above. The glomerulus was normal (Fig. 1), their nuclei were filled with finely granular material, and were comparatively large in size. The cells of the tubule were compactly placed and their big nuclei were with finely granular chromatin (Fig. 2). Many granules were noticed in the cells of the tubules.

The cells of the haemopoeitic tissue were compact. Their nuclei were filled with finely granular chromatin and stained deeply with haematoxylin. Many stages of mitotic divisions were noticed suggesting multiplication of the cells and an increased activity of the haemopoeitic tissue. The cytoplasm was more densely stained than that of tubule cells.

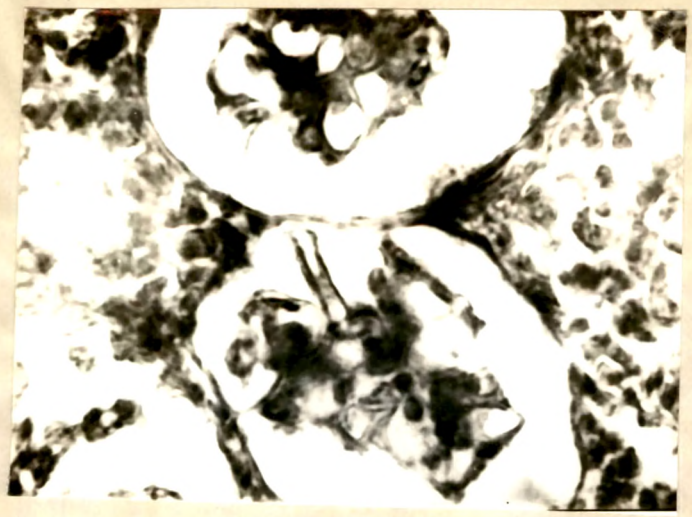

Fig. 1

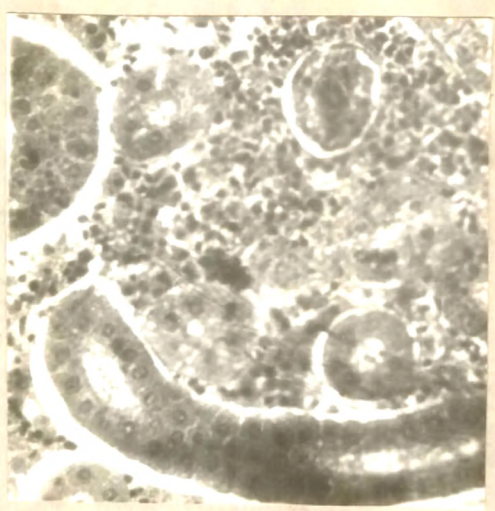

Fig. 2

Fig. 1. Kidney of immature H. ilisha showing normal glomerulii. HE. X 1000

Fig. 2. Kidney of immature H. ilisha showing normal tubule cells full of granules. HE. X 400

The walls of the arteries showed normal layers distinctly.

Kidney of maturing H. ilisha prior to migration:

A begining of degenrative changes in the kidney were noticed in some of the above mentioned fishes examined. These alterations become more pronounced in mature H. ilisha captured from river.

Kidney of mature H. ilisha captured from river:

The entire structure appeared to be somewhat loose with increased intercellular spaces. The glomerulii showed various stages of degeneration. The deposition of collagen was evident by the presence of eosinophilic masses. The presence of blood cells in the glomerulii were also noticed. Some glomerulii were disrupted and a few appeared enlarged completely filling the Bowman's capsule. Their nuclei were enlarged, of irregular shape and were densely filled with chromatin. Degeneration and sclerosis of capillaries of the glomerulus were also noticed in some fishes. A mass of hyaline like material was observed in a few cases which may be the result of progressive degeneration.

Degenerative changes such as loss of cytoplasm of tubule cells, pronounced vacuolization and marked tubular degeneration were noticed in the tubules also. All the cells of the tubule were filled with numerous granules. At several places the loss and disappearance of entire cells were also observed. In some fishes scattered blood cells were observed throughout the entire region.

A tremendous increase in the haemopoeitic tissue was observed. The cells had increased in number and size and the intercellular spaces were prominent. The nuclei were larger with chromatin material. Different stages of mitotic divisions were observed.

A number of arteries in the kidney exhibited the beginning of arteriosclerosis and a few showed advanced stages of arteriosclerosis. When stained with aldehyde fuchsin and Masson's trichrome, the deposition of collagen was clearly noticeable. The tunica intima had increased in size and often showed disruption.

Kidney of spent H. ilisha captured from river:

The degenerative changes noticed in the mature migrating H. ilisha were more pronounced in spent H. ilisha. The entire kidney tissue showed pronounced disruption showing disintegrated cell masses with or without nuclei and a large number of empty spaces. More affinity for eosin staining was noticed. Many blood vessels and wandering blood cells were noticed throughout the kidney.

Glomerulii exhibited more pronounced degenerative changes than those noticed in mature migrating H. ilisha. At several places disintegration of glomerulii, shrinkage of the glomerulii (Fig. 3) and enormous proliferation of capillaries of glomerulus were noticed.

The degeneration of the tubules was also prominent. Necrosis of tubule cells exposing the cytoplasm to lumen and to parenchyma of the kidney was discernible (Fig. 4). The intact

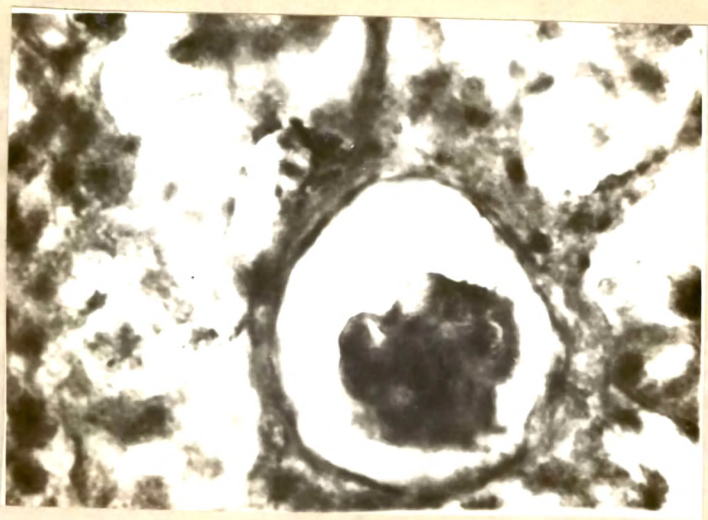

Fig. 3

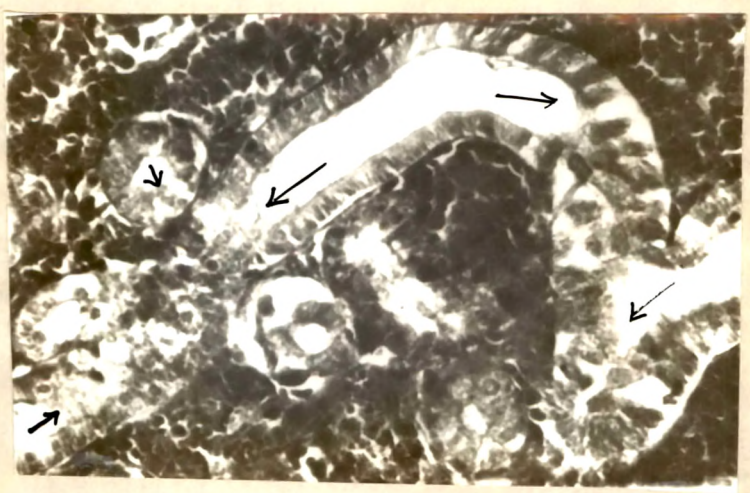

Fig. 4

Fig. 3. Kidney of spent H. ilisha showing shrunk glomerulus with thickened Bowman's capsule. HE. X 1000

Fig. 4. Kidney of spent H. ilisha showing tubular necrosis (arrows). HE. X 400

cells were not compactly placed and the nuclei were densely filled with chromatin material.

The arteries showed an advanced stage of arteriosclerosis. Some arteries were found to be broken also.

The cells of the haemopoeitic tissue were loosely packed and shrunken. Some cells were destroyed or broken. The cells were less eosinophilic than the tubule cells. The nuclei exhibited varied conditions, some were shrunk, some distorted and some pycnotic.

Kidney of immature H. toli captured from sea:

The structure was normal and was similar to that of immature H. ilisha captured from sea.

Kidney of mature H. toli captured from sea:

The degree of degenerative changes such as tubular necrosis, glomerulosclerosis, arteriosclerosis, degeneration and shrinkage were of very mild type when compared with those observed in migrating mature H. ilisha and drifted mature H. toli. The haemopoeitic tissue did not show any remarkable difference from that of drifted H. toli. It was more compactly arranged than mature migrating H. ilisha.

Kidney of spent H. toli collected from sea:

The entire mass appeared somewhat loose. The degenerative changes noted in the spent migratory H. ilisha were observed here, but they were at a very low level. Glomerulosclerosis and tubular degeneration were noticed frequently and in more intensity than in mature H. toli captured from sea.

Kidney of immature H. toli drifted into river:

A marked glomerular and tubular degeneration was quite evident in the kidney of immature drifted H. toli. The glomerulii were found to be shrunk (Fig. 5), degenerated or destroyed. The tubules showed abnormal, abrupt changes. Mostly the cells were devoid of cytoplasm. Nuclei of some tubule cells were shrunk and of irregular shape. In some cells they were extremely enlarged almost filling the entire tubule cells. In a few intact tubule cells the nuclei were pycnotic. Some tubules were completely broken (Figs. 6,7)

The haemopoeitic tissue was intact and showed no remarkable changes.

Kidney of mature H. toli drifted into river:

The structure was very similar to that of the drifted immature H. toli described above. The intensity of degenerative changes remained the same but in addition arteriosclerosis was noticed in some of the major arteries.

The haemopoeitic tissue had increased considerably in size occupying the major part of the head kidney. The cells were loosely arranged giving rise to intercellular spaces.

DISCUSSION

In the maturing fish prior to migration, beginning of degenerative changes in the kidney was evident. In the mature and spawning H. ilisha the degenerative changes in glomerulii and tubules like glomerulosclerosis, thickening of Bowman's capsule,

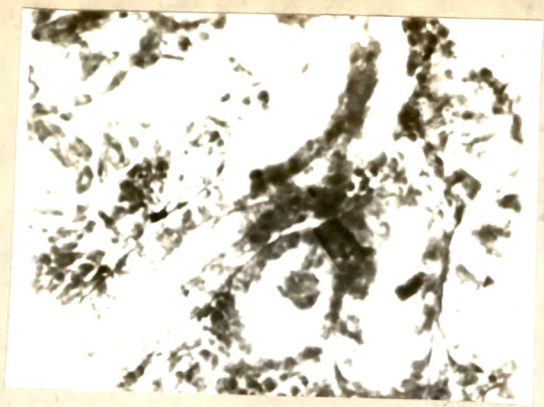

Fig. 5

Fig. 6

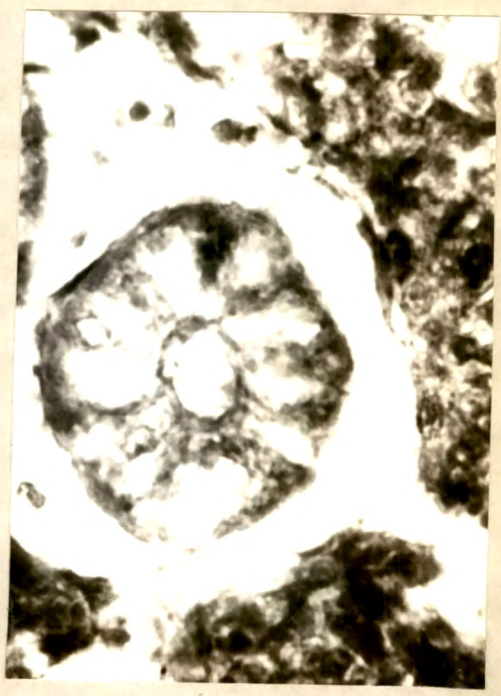

Fig. 7

Fig. 5. Kidney of drifted immature H. toli showing shrunk glomerulus and tubular necrosis. HE. X 400

Fig. 6. Kidney of drifted mature H. toli showing tubular and glomerular degeneration. Note that some tubule cells are normal (arrow). HE. X 400

Fig. 7. Kidney of drifted immature H. toli showing tubular degeneration. HE. X 1000

vacuolization and loss of cytoplasm of tubule cells were noticed. In spent H. ilisha, the changes were pronounced. Similar changes, though of a very mild degree and less frequent, were observed in non-migratory mature H. toli also. The general deterioration would seem to be due to the effects of hyperadrenocorticism and aging. Hyperadrenocorticism is more pronounced in migratory H. ilisha than non-migratory H. toli (Desai, 1967). From this it may be presumed that high concentration of corticosteroids prevail in the blood of H. ilisha, bringing about characteristic pronounced histological changes than in H. toli. Robertson et al. (1963) administered corticosteroid hormone in immature trout, Salmo gairdneri, and found the deteriorative changes in the kidney from first week onwards after administration of hormone, They concluded that histological changes are due to high concentration of cortisone and hydrocortisone in blood. The mild and less frequent degenerative changes observed in mature H. toli might be due to mild hyperadrenocorticism and aging. Robertson and Wexler (1962) observed that the degenerative changes in senile castrated kokanee salmon were closely similar to spawning salmon and suggested that the degenerative alterations might be accelerated due to spawning process. Thus aging associated with hyperadrenocorticism must be bringing about alterations in kidney of H. ilisha and H. toli.

Drifted non-migratory H. toli captured from river showed much pronounced degenerative changes. Such alterations were equally evident in mature as well as immature drifted H. toli. Normal

immature H. toli never showed any alterations. However, the drifted immature H. toli showed abrupt and marked deteriorative alterations. The deteriorative changes observed in drifted mature H. toli were also more marked than one normally finds in mature H. toli. Thus it would seem that the alterations are independent of the maturity and aging. The abrupt marked deteriorative changes must be due to sudden change of external media for which the fish is not prepared. Chester Jones et al (1958)have suggested the role of hydrocortisone and cortisone in electrolyte metabolism. In H. ilisha the hyperplasia of adrenocortical tissue prior to migration prepares the fish for tolerance of changes in media. Corticosteroids also helps to withstand against stress as shown by Bonta (1965) in the case of rat. Thus the absence or excess of corticosteroids will bring about deteriorative alterations in tissues and organs. The alterations observed in kidney of drifted H. toli must be due to failure of adrenocortical tissue to secrete the required amount of corticosteroids. The adrenocortical tissue showed complete destruction in drifted H. toli of both stages, i.e. immature and mature (Desai, 1967). The adrenocortical tissue must have been exerted to its maximum to cope up with the functional demands to supply corticosteroids to withstand stress due to drifting and also to maintain balance of various ions in the body. The inability of the adrenocortical tissue to meet the functional demands must have brought about an exhaustion and an eventual disruption of the tissue.

Heller and Bentley (1963) reviewing the work of several

authors suggested that the neurohypophyseal hormones control the electrolyte balance within the body through the kidney. The discharge of neurosecretory material from neurosecretory cells in the neurohypophysis in fingerling of H. ilisha returning to sea, in mature H. ilisha prior to migration from sea to river and in spent H. ilisha returning to sea (Desai, 1967) must be enabling these fishes to maintain electrolyte balance in media altogether different in salinity. Absence of such neurohypophyseal secretion in drifted H. toli (Desai, 1967) must be bringing about the extensive alterations observed in the kidney.

The increase in haemopoeitic tissue in mature H. ilisha and H. toli may be correlated with the increase in demand for blood cells with higher metabolic activities which accompany maturation and migration.