INTRODUCTION

The migratory impulses and the migrations of animals have since long attracted the research workers to explore the hidden secrets of them. In modern times, with the help of modern equipments, instruments and with the modern techniques scientists march forward towards their goal, "Explorations of the hidden secrets".

Among the migration of animals, the migration of insects, the migration of fish and the migration of birds are studied considerably; still our knowledge is in fairly elementary stage. Fish migration and bird migration differ considerable from each other, as former involves complex mechanism of osmoregulation in addition to the complex mechanism of direction finding. If the migrations of the anadromous and the catadromous fish are concerned, fish face severe environmental hazzards. Fish like Hilsa ilisha (Ham.) returns safely to the sea quite unlike salmon. To survive in hypotonic medium, to lay eggs facing stress of maturity and starvation and then to return to the sea, suggest that H. ilisha should have developed very efficient, quick, sensitive and complex interconnecting machinary of the endocrine glands. Thanks to the work of Kulkarni (1950, 1951), which has provided us with useful informations about the migration of H. ilisha in River Narbada of Gujarat State

of India. To study the mechanism of complex machinary of the endocrine glands of H. ilisha during migration, the present work was undertaken.

It is well known that two neurosecretory centres of fish play important role in control of the endocrine glands. The discharge of the neurosecretory material (N.S.M) from the nucleus preopticus (NPO), before migration and its role in stimulation of other endocrine glands of Russian and Beluga Sturgeons, is reported by Baranikova (1964). The NPO of H. ilisha prior to migration to sea, starts discharging NSM and filling neurohypophysis with it. As the migration proceeds into the river Narbada, the neurohypophysis shows very considerable quantity of NSM in it when it is about to return to sea, after laying eggs (spent stage) in fresh water, NPO restores the NSM in the pathways and starts filling up the neurohypophysis with NSM. This picture is similar to that of observed in fingerlings of H. ilisha captured from river before migration to sea. It is suggested that on onset of migration, NPO discharge probably for the osmoregulatory adjustments and to trigger the activities of the endocrine glands. This may be considered as "safe adjustments" for the safe migration. The partially destroyed NPO of drifted Hilsa toli may be due to the inability of NPO to cope up with the sudden increased demand of the neurohormones for the quick adjustments in the hypotonic medium, estuary water. The depletion

of NSM from NPO in spent H. toli captured from sea, gives an evidence of consumption of neurohormones during sexual maturity. This finding is similar to that of Sokol (1961). The depletion of NSM from the neurohypophsis of the mature H. toli captured from sea supports the above mentioned observations. The Aldehyde Fuchsin (A.F.) stained, globular protrusions bathing in the cerebrospinal fluid, were suggested as the carrier of hormones. The presence of NS granules in the follicular cells of proadenohypophysis was reported as mediator to the endocrine cells.

The secretory activity of the second group of the neurosecretory cells, Nucleus lateralis tuberis (NLT) was observed in relation with sexual maturity in both, non-migratory, marine H. toli and in migratory (anadromous) H. ilisha.

The multiplication and granulation of basophils in the pituitary of mature H. ilisha and H. toli were correlated with the sexual maturity and the secretory cycle of the NLT. The probable role of proadenohypophysial follicles of pituitary was suggested in osmoregulation in the mature and spent H. ilisha and in the drifted H. toli on basis of the histological observations. The thyrotropes and the gonadotropes of the pituitary of H. ilisha were distinguished on the basis of the study of life history. The period of the growth in H. ilisha and H. toli

was correlated with the secretion cycle of acidophils of pituitary. The following factors were suggested responsible for the degenerative changes observed in pituitary gland of H. ilisha and H. toli, (a) starvation (b) stress due to maturity (c) stress due to aging and (d) stress due to change in media.

The role of the active thyroid follicles of the fingerlings and the H. ilisha captured from sea was reported as stimulator for the central nervous system to discharge NSM from NPO for migration to sea. The increased activity of the thyroid prior to migration in H. ilisha was accompanied by gradual decrease during the migration. The thyroid activity in the non-migratory H. toli was correlated with reproductive cycle. The goiterous thyroid observed in the drifted nonmigratory H. toli was attributed to the iodine poor hypotonic medium - estuarine water.

The strong hyperplasia of the chromaffin tissue of the migratory H. ilisha was regarded as the result of stress of starvation, stress due to increase in demand of catecholamines for the mobilization of fat from the liver and adipose tissue. The mild hyperplasia observed in the mature H. toli was attributed to stress due to starvation during spawning, stress due to spawning and due to increase in demand of catecholamines needed for the mobilization of fat from the fat depots. The destructive changes exhibited by the chromaffin tissue of the

drifted H. toli was suggested as the result of inability of chromaffin tissue to cope up with sudden increased demand of catecholamines arose due to sudden change in medium.

The pronounced hyperplasia of the adrenocortical tissue of H. ilisha during migration was compared with the little hyperplasia noted in the non-migratory H. toli of the same stage of maturity and its role in adjustment to the hypotonic medium is discussed. It was interesting to study the degenerative changes noted in the drifted H. toli which were believed to be due to the increased demand of the corticosteroids for the adjustment in the hypotonic medium. Khanolkar et al.(1958) method was a useful tool in demonstration of corticoids in adrenocortico tissue of fish studied. The secretion cycle of adrenocorticosteroids secreting cells were correlated with spawning, and stress caused by change in salinity and starvation during spawning. The zona glomerulosa, zona reticulata like zones of adrenocortical tissue of fish were suggested homologue to the mammalian zona glomerulosa and zona reticulata on basis of histological observations.

The histological studies of the caudal neurosecretory system (CNS) of migratory H. ilisha and drifted H. toli suggested an ionoregulatory role or an osmoregulatory role for CNS. However, the CNS of the marine H. toli suggested its role in sexual maturity and growth. The discharge of Acid-violet

positive granules in the ependymal cells of the spinal cord and in the protoplasmic projections of the central canal of the spinal cord was described. The terminations of NS loaded axon fibres on the walls of the blood vessels were reported.

The histochemical localization of acetyl- and butyryl-cholinesterase in the NS cells of the CNS, NS tracts and in the urophysis of the H. ilisha and H. toli suggested a possible role of the above mentioned enzymes in synthesis, transport and discharge of neurohormones produced by the NS cells of the CNS.

It may be stated that during migration NPO act as trigger for the migration and activates other endocrine glands. The difference in the activities of endocrine glands of migratory and non-migratory fish provides a good deal of information.

CHAPTER I

HABITS HABITATS AND FISHERY OF MIGRATORY(ANADROMOUS) H. ILISHA AND NON-MIGRATORY MARINE HILSA TOLI

The upward migration of migratory (anadromous) Hilsa ilisha (Ham.) in the river like Ganges, Indus, Narbada, Godavari, Kaveri and Ulhas of India is recorded since long (Day, 1873; Chacko and Ganapati,1949; Hora, 1941; Hora and Nair, 1940a, 1940b; Kulkarni, 1950;1951). Our knowledge is definately improved by the contributions made by several workers as their work concentrated on the spawning and breeding grounds of H. ilisha in the rivers of India. Hora(1941) believed that there exist two runs of migration of H. ilisha in rivers of India, one is specially for breeding and another is only for feeding; whereas, Kulkarni (1950,51) sincerely concluded that H. ilisha migrates into the river specially for laying eggs only. It is also recorded that there exist two runs of migration of H. ilisha in river Hooghly, (Hora and Nair, 1940) and in river Narbada of Gujarat State of India (Kulkarni,1950; 1951), however, single run of migration of H. ilisha is reported by Chacko and Ganapati (1949) in the rivers of South India.

So far no worker and no fisherman has reported the availability of dead H. ilisha from the river Narbada; it is presumed that H. ilisha returns safely to the sea after spawning in river Narbada. This safe return to sea will definately ask

for complex, tremendous physiological, biochemical and physiochemical changes in the body of H. ilisha as it has to acclamatize to hypotonic medium during migration for considerable period for spawning and again has to reacclamatize to hypertonic medium - sea water - after safe return from river Narbada.

HILSA FISHERIES IN THE RIVER NARBADA OF GUJARAT STATE OF INDIA:

In spite of several reports about the concentration of shoals and presence of H. ilisha around the mouth of river Narbada in Gulf of Cambay and in river Narbada itself (Moses, 1940; 42; Kulkarni, 1950), only studies contributed by Kulkarni (1950-51) have increased our knowledge about Hilsa-ilisha considerably. For the details about Hilsa-ilisha and Hilsa fishery in river Narbada Kulkarni's contributions should be referred.

(A) MIGRATION OF HILSA ILISHA IN THE RIVER NARBADA OF GUJARAT STATE:

Hilsa-ilisha migrates twice a year in the river Narbada. First run, can be called as major run, which, commences in July alongwith the setting of monsoon season and ends in September. Second run - minor run or a small run - starts in March and continues upto middle of April. It is not yet confirmed, whether the minor run develops into a major run

in July as fishermen do not fish in between April and July. In the major run comparatively large number of H. ilisha are captured. These fish are of much commercial importance, as sea fishery is completely at standstill, due to monsoon. H. ilisha is sent to various consuming centres like Bombay, Baroda and Ahmedabad in iced boxes.

In minor run there is no fish being exported to the above mentioned centres. Hilsa migration in river Narbada is restricted upto 100 miles limit unlike long comfortable migration in river Ganges, because of rocky bottom of the river Narbada off about 100 miles off sea coast.

(B) HILSA FISHERY OF NARBADA AND ITS RELATION WITH LUNAR PERIODICITY:

The fishermen of Bhadbhoot, Nikora, Zadeswar, Maktampur, Broach, Koral etc. places (as shown in the map 2) capture mature and spent male and female of H. ilisha using 4.5" to 5.5" meshsized cotton or nylon surface drift nets, in the 20 to 30 feet flat bottom non-mechanized wooden boats used by them for fishing, is worthnoting point from the fishery point of view. The fingerlings of 4" to 6" size of H. ilisha result of the major run are also captured in the month of January by fishermen using bagnets. Kulkarni (1951) has already mentioned in his exhaustive studies that Hilsa ilisha is captured in maximum number on the full moon day. He also has established

a close relation between catch of H. ilisha and lunar periodicity. His observations were confirmed by the author during the collection of samples for the present thesis. The length of gravid female varied from 37.5 cm to 45.8 cm. (Average 37.7 cm.) and weight varied from 660 gm. to 1070 gm. (Average 836 gm.) Male of H. ilisha exhibited length from 33.5 cm. to 42.2 cm. (Average 37.7 cm.). The spent fishes were captured very few. It is also interesting to note that all of the stomachs of H. ilisha (mature and spent) examined were found empty, suggesting that H. ilisha do not feed during migration.

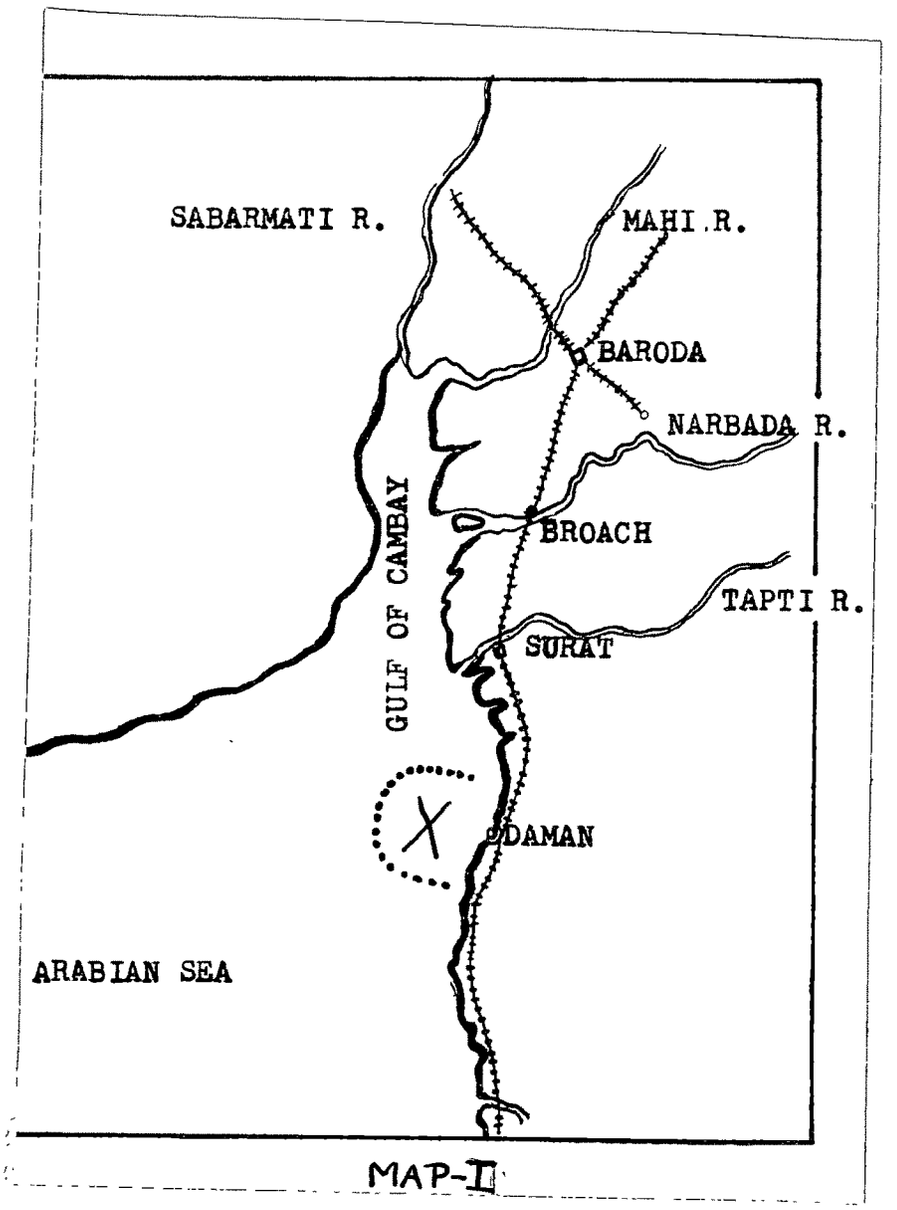
The live samples of H. ilisha were collected directly from the nets of used by fishermen, fish were sacrificed on the boats within few minutes and the tissues and organs were fixed within few seconds after removal. The places of collection are shown in the map-1 by 'CROSS' and by 'dotted lines' in map-2. Enough care was taken to discard wriggled fish to obtain correct results and to avoid 'Stress'.

(C) FISH AND FISHERY OF HILSA TOLI(Cuv. & Val.):

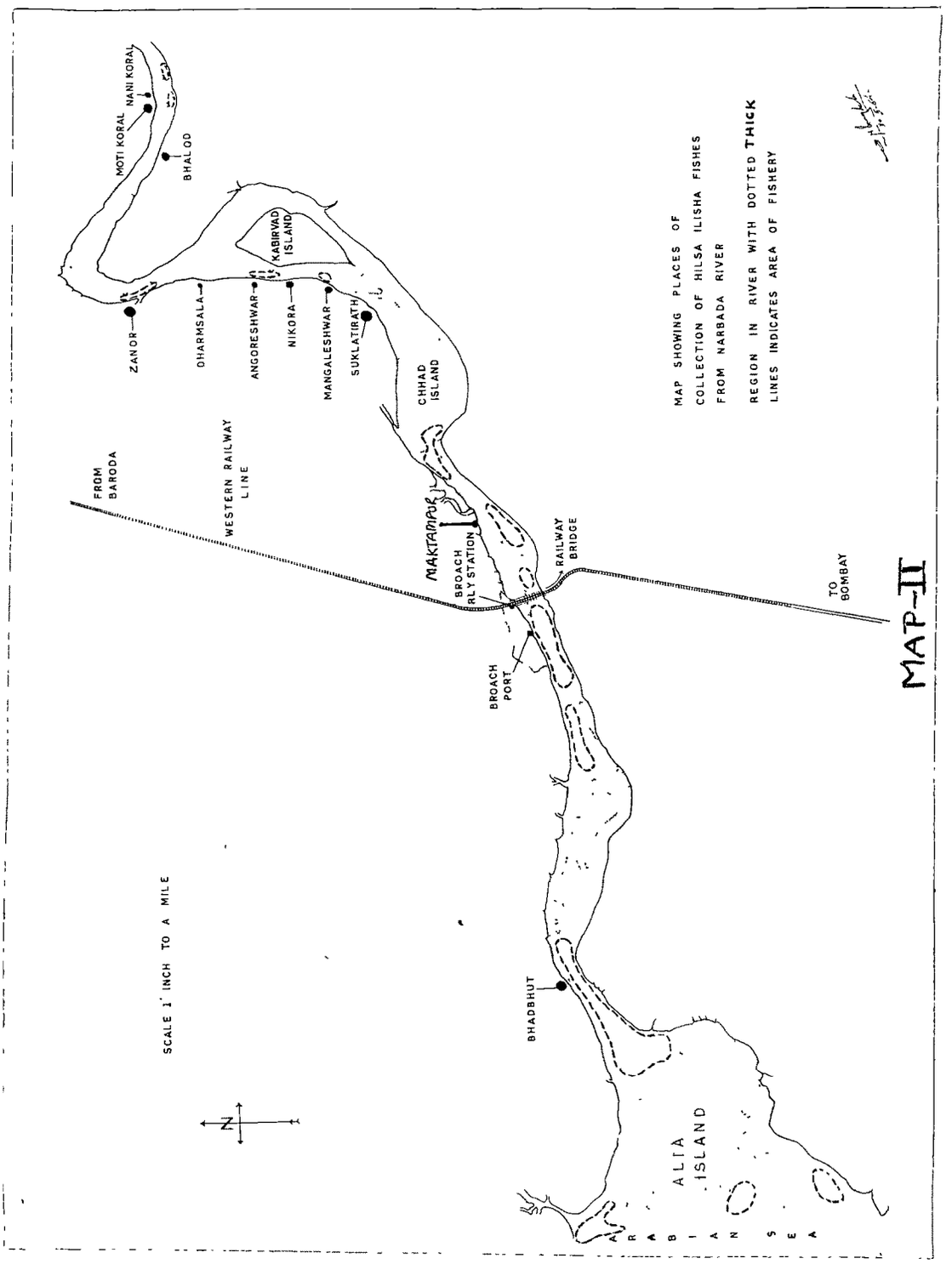
Hilsa toli is captured by surface drift nets, and bottom set drift nets by the fishermen of India throughout the year 8 to 15 miles off sea coast of India, except monsoon as fishing ceases in monsoon season. Hilsa toli fishery is of significant importance to India as it contributes to food fishes of India.

Day (1873) reported the concentration of shoals of H. toli in monsoon in the mouths of rivers of west coast of India. During the collection programme for the present study, the author has also noticed a regular H. toli fishery in the mouth of river Narbada in monsoon only. Pillay (1953) has recorded the presence of Hilsa toli in river Hooghly river mouth, which, is not supposed to be migration, but is considered as drifting of H. toli into the river Hooghly by the strong force of sea. Somewhat similar drifted of H. toli within 8-10 miles upward strata of river Narbada is noticed at peak on the highest high tide day of the year. It is quite obvious that the strong current of sea felt on the highest high tide day of the year might have forced some of H. toli concentrated in the river mouth into the 8-10 miles strata of river Narbada. H. toli is never captured by fishermen of Bhadbhoot (see map-2) on other days when H. ilisha is captured. H. toli were also collected from the sea from the area marked with 'CROSS' in map-1 and from the area marked with 'dotted lines' near Bhadbhoot in map-2.

H. ilisha and H. toli were procured from the nylon surface drift nets of meshsize 5.5" to 6.5" by the demonstration mechanized boats operating in the area marked with CROSS-X- in map-1. Enough precautions were taken in discarding wriggled fish, in removing the required organs from the body and fixing them in different fixatives to obtain correct results.


SABARMATI R.
MAHI R.
BARODA
NARBADA R.
BROACH
TAPTI R.
SURAT
GULF OF CAMBAY
X
DAMAN
ARABIAN SEA

MAP-II


MOTI KORAL
NANI KORAL
BHALOD
KABIRVAD ISLAND
ZANOR
DHARMSALA
ANGORESHWAR
NIKORA
MANGALESHWAR
SUKLATIRATH
CHHAD ISLAND
FROM BARODA
WESTERN RAILWAY LINE
MAKTAMPUR
BROACH RLY STATION
RAILWAY BRIDGE
TO BOMBAY
BROACH PORT
BHADBHUT
ALIA ISLAND
ARABIAN SEA
SCALE 1 INCH TO A MILE
N
MAP SHOWING PLACES OF COLLECTION OF HILSA ILISHA FISHES FROM NARBADA RIVER
REGION IN RIVER WITH DOTTED THICK LINES INDICATES AREA OF FISHERY
MAP-II