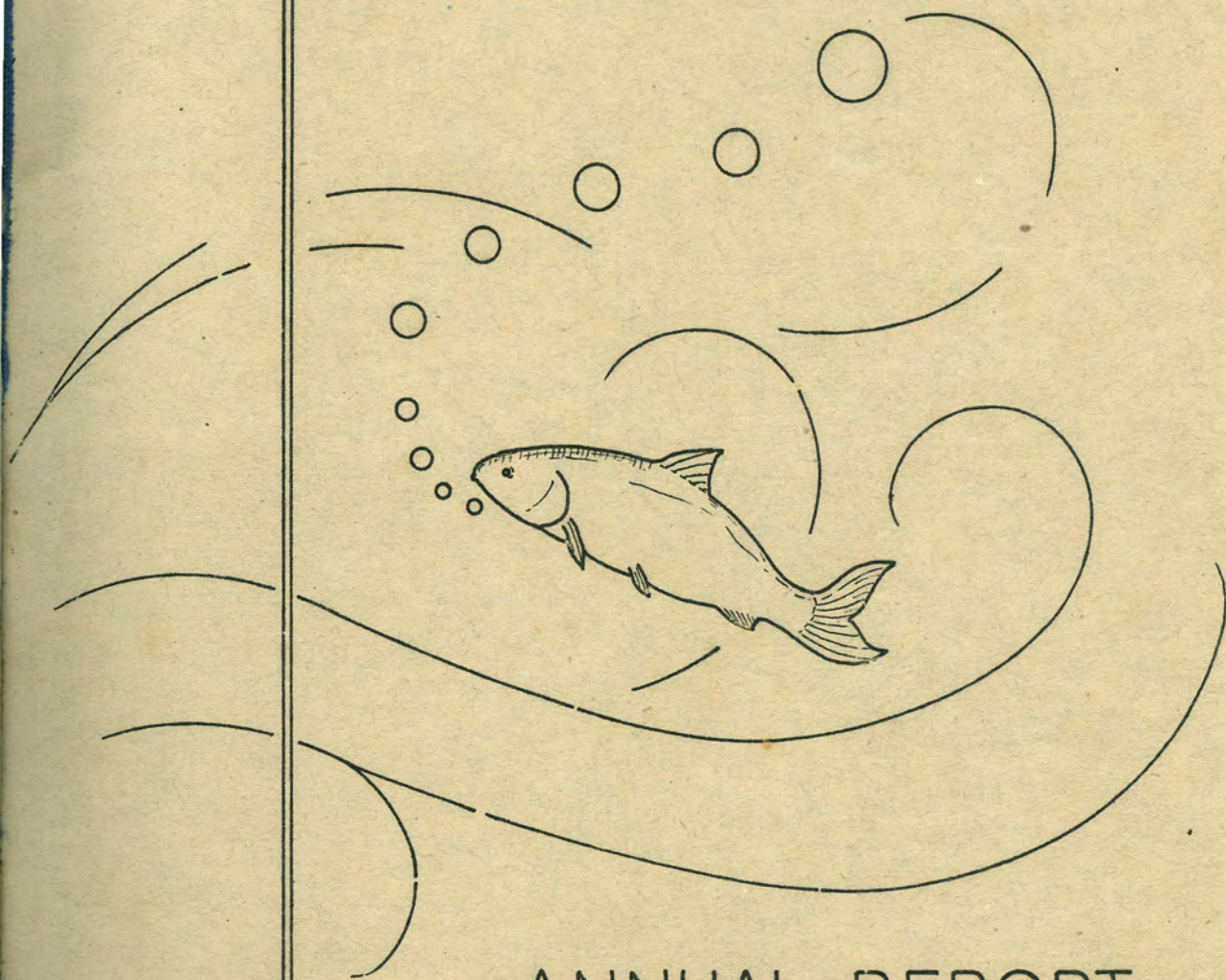


GOVERNMENT OF INDIA

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

BARRACKPORE, WEST BENGAL



ANNUAL REPORT
FOR
1963-1964

SEPTEMBER, 1964

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GOVERNMENT OF INDIA
CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
BARRACKPORE

ANNUAL REPORT FOR THE YEAR ENDING 31ST MARCH 1964.

I. G E N E R A L

Substantial progress was registered in the activities of the Institute during the year, with the continuation of existing programmes and initiation of new programmes of work. New research units established during the year included the Cold Water Fisheries Research Unit at Kangra in the Punjab and the Pulicat Lake Fisheries Research Unit at Ponneri in Madras.

The following appointments were made during the year:

- | | | | |
|-----|---------------------------|---|------------------------------|
| 1) | Dr.A. David | - | Senior Research Officer |
| 2) | Dr.K.C. Jayaramakrishnan | - | -do- |
| 3) | Shri S.J. Karamchandani | - | Research Officer (Jr. Scale) |
| 4) | Shri A.N. Ghosh | - | -do- |
| 5) | Shri S.B. Singh | - | -do- |
| 6) | Shri R.D. Chakrabarty | - | -do- |
| 7) | Shri A. Sengupta | - | -do- |
| 8) | Shri B.N. Saigal | - | Assistant Research Officer |
| 9) | Shri M. Subrahmanyam | - | -do- |
| 10) | Shri R.N. Pal | - | -do- |
| 11) | Shri S.P. Ayyar | - | -do- |
| 12) | Shri K. Raman | - | -do- |
| 13) | Shri K.H. Ibrahim | - | -do- |
| 14) | Shri Y. Rama Rao | - | -do- |
| 15) | Shri Ch. Gopalakrishnayya | - | -do- |
| 16) | Shri Ravish Chandra | - | -do- |
| 17) | Shri Apurba Ghosh | - | -do- |
| 18) | Shri S.D. Tripathi | - | Fisheries Training Supdt. |
| 19) | Shri R.D. Bhattacharjee | - | Accounts Officer |

Dr. B.S. Bhimachar, Director, proceeded on 59 days' earned leave from 26th August 1963 to 23rd October 1963 and Shri K.H. Alikunhi, Deputy Director, was appointed to officiate as Director during the leave period.

Shri K.H. Alikunhi relinquished charge of the office of Deputy Director at this Institute on 20th January 1964 and assumed charge of the post of Director (Under Study) at the Central Institute of Fisheries Education, Bombay.

Dr. G.N. Mukherjee, Pool Officer of the Council of Scientific and Industrial Research, worked at the Allahabad Sub-Station during the year.

TRAINING

The 16th session of the Inland Fisheries Training Course commenced on 1st June 1963. A total of 26 candidates consisting of 14 deutees from the States - 1 each from Nagaland, Mysore, NEFA and Tripura; 2 each from Rajasthan and Madhya Pradesh; 3 each from the Punjab and Uttar Pradesh; 6 stipendiaries - 2 from Tripura and 4 from Assam; 6 Private candidates - 1 each from West Bengal, Madras and Madhya Pradesh and 3 from Kerala are undergoing training at this Institute.

23 trainees from the Central Institute of Fisheries Education, Bombay, were given detailed training for a month on pond cultural practices, including induced fish breeding techniques, weed control methods and other aspects of fish culture. Comprehensive training in the techniques of fish breeding by pituitary hormone injections was imparted to two officers deputed by the Fisheries Directorates of Himachal Pradesh and Mysore State respectively. Techniques of induced breeding of Indian and Chinese carps were also demonstrated successfully to the research staff of Kalyani Research Station of the West Bengal Fisheries Directorate.

MEETINGS

The first meeting of the Technical Committee, set up by the Government of India, to assess the demand for fish fry in the country, was held at the Central Inland Fisheries Research Institute Barrackpore on 8th April 1963 under the Chairmanship of Dr. B.S. Bhimachar, Director, Central Inland Fisheries Research Institute and was attended by all its other members, viz. Shri G.N. Mitra, Director of Fisheries, Orissa, Dr.H.D.R. Iyengar, Deputy Director (Fisheries), Ministry of Community Development Panchayati Raj and Cooperation, New Delhi, Dr.K.C. Saha, Director of Fisheries, West Bengal, Shri C.P. Verma, Fisheries Development Officer, Bihar, Dr. H.L. Chaudhuri, Senior Research Officer, Central Inland Fisheries Research Institute, Dr.G.P. Dubey, Chief Fisheries Officer, Madhya Pradesh and Dr.T.A. Mammen, Assistant Fisheries Extension Officer, Hyderabad. Shri K.H. Alikunhi, Deputy Director, Central Inland Fisheries Research Institute, Shri H.P.C. Shetty, Research Officer, Central Inland Fisheries Research Institute and Shri N.K. Chowdhury, Assistant Fisheries Extension Officer, Calcutta, attended the meeting by invitation. The Director attended the "FOURTH PLAN" meeting in Delhi. He also attended a meeting of the Board of Examinations

of the Central Institute of Fisheries Education, Bombay. Shri K.H. Alikunhi, Deputy Director and Dr.H.L. Chaudhuri, Senior Research Officer, attended the 10th meeting of the Fisheries Research Committee at Simla. Dr.H.L. Chaudhuri and Dr.M.T. Philipose, Senior Research Officers, participated in the Seminar on Inland Fishery Development at Lucknow.

MISCELLANEOUS

The Director visited Himachal Pradesh and the Punjab in order to select a suitable site for locating the Cold Water Fisheries Research Unit. He visited Raipur, Bilaspur and Panna for examining the suitability of proposed sites in those places for the construction of a departmental fish farm. He also visited Tilaya, Konar, Maithon and Panchet in connection with the evaluation of Fisheries of Damodar Valley Corporation reservoirs.

Assistance relating to different aspects of fisheries was rendered to some State Governments during the year. An Officer was sent to Assam to make an on the spot study of water-hyacinth infestations in Marikollong Bheel at Nowgong, and after making some field trials, the most efficient method of eradication of the weed was demonstrated to the State's Fisheries Officers. At the request of the Jammu and Kashmir Government, an officer was deputed there to examine the possibility of providing a suitable fish pass for conducting Mahseer at the Tawi Barrage site. Special lectures were delivered and demonstrations given to the trainees of the Directorate of Fisheries, Orissa. A total of 79.10 and 5.76 lakhs of major carp spawn and fry respectively, 3.92 and 0.58 lakhs of common carp spawn and fry respectively and a little over 1.5 lakhs of fry of both major and common carps was supplied to a few State Governments, Institutions and private pisciculturists.

VISITORS

Dr.G.N. Subba Rao, Assistant Regional Officer of the F.A.O., Shri G.N. Mitra, Fisheries Development Adviser to the Government of India, Dr.S. Jones, Director, Central Marine Fisheries Research Institute, Shri G.V.S. Mani, Director of Fisheries, Andhra Pradesh, Dr. M.L. Roonwal, Director, Zoological Survey of India, Dr.A.N. Bose, Director, Central Institute of Fisheries Technology and four members of the Soviet Zoologists Delegation - Dr.N. Bozhescuius, D. Naymov, Dr.E.V. Zhukov and Dr.A. Yablokov - visited this Institute during the year under report.

II. INVESTIGATIONS ON CULTURE FISHERIES

1. Pond culture techniques

Observations made in connection with experiments for selecting a suitable fish poison as pond clearing agent, showed that

"ENDRINE" applied @ 0.01 ppm could kill major carps, Scale carps and predatory fishes within a period of 2-6 hours, without having any adverse effect on plankton. Powdered seeds and dried leaves of an indigenous plant Millitice piscidia were also found to act as effective fish poisons when applied @ 2 ppm and 10 ppm respectively. A couple of experiments were carried out to ascertain the conditions which would help in the enhanced production and better growth of carps. Three sets of ponds were treated with lime, cow-dung and with a combination of both lime and cow-dung respectively and stocked with identical number of carps fry. Results obtained after six months of rearing clearly indicated that maximum production could be obtained when the ponds are treated with both lime and cow-dung, and the fishes are fed with artificial food. In another experiment, N-P-K was used as a manuring agent and the ponds were stocked with Catla, Rohu and Scale carp. Results after 8 months' rearing indicated a positively better growth and survival in the N-P-K treated ponds than the control ponds. Studies were initiated on the cultural possibilities of Rasbora elanga, Ompok bimaculatus and the freshwater prawn Macrobrachium malcolmsonii. Results obtained indicate that Rasbora elanga could be conveniently cultured with other carps as it does not compete with the food of carps. The fish also showed a fast growth rate, attaining full maturity and size in 10-12 months' time. In the case of Macrobrachium malcolmsonii, a riverine prawn brought from the Godavari, even though it attained maturity and bred in ponds in the course of an year, the rate of survival of the transplanted juveniles and the hatchlings bred in the ponds was poor. Studies on seasonal fluctuations of plankton in a perennial stocking pond showed that a maxima and minima in total plankton were discernible during January and March respectively. Investigations on the life history of Heliodiaptomus alikunhi indicated that the Copepod took 4-5 days to complete six "Nauplius" stages and 11-13 days to complete five Copepodite stages. In 30% cases, the females produced 12 broods, after which they died.

2. Induced breeding of fishes

Experiments conducted during the 1963-'64 breeding season were aimed at further confirmation of the doses standardized for successful spawning in the previous year and also to ascertain various other conditions in connection with induced breeding. In a few preliminary experiments, it was noticed that spawning took place even when the initial dose was lowered to 1.0 and 1.5 mg per kg weight of the breeder in place of the normal dose of 2 mg/kg, followed by the ordinary second dose of 5 mg/kg.

During the year, a total of 111 sets of major carps were injected and the experiments yielded 97.03 lakhs of spawn of Catla, Rohu, Mrigal and Calbasu, out of which 49.1 lakhs were supplied to the Orissa Fisheries Directorate and 23.53 lakhs were stocked in the Killa, Chowdwar, Puri and Lingipur fish farms.

Catla, Rohu and Mrigal were bred in an air-conditioned laboratory successfully and repeatedly with fertilisation of eggs ranging from 30% to 96% resulting in over 8.2 lakhs of spawn. Successful spawning was obtained when the water temperature was maintained at 28°C - 28.5°C and the pH from 8.3 - 7.5. These experiments have demonstrated that major carps could be successfully bred under controlled temperature in air-conditioned breeding rooms, without depending on local weather.

The new mutant strain of golden coloured Catla was successfully induced to breed by administering hormone injections and 4.85 lakhs of spawn were obtained, all of which were coloured like the parents. As such, they seem to be true mutants.

Studies conducted on the storage of fish sperms at low temperature in different diluents have shown that sperms of Scale carp when kept in Holtfreter's solution containing glycerine or glucose, remain motile and viable upto 50 hours at 0°C, while they normally die after 4½ hours at room temperature (33°C). Other diluents like Egg-yolk-citrate (M/15 and M/7), Sodium citrate (M/7) and Phosphate buffer solution were also used, but none were found as effective as Holtfreter's solution containing glycerine or glucose.

The fecundity study pertaining to Rohu was completed during the year. Data were statistically analysed and the relationship of fecundity with body-size and weight of the ovary was established. The average number of eggs per kg body weight of the fish was found to be 3.08 lakhs. Similar study on Mrigal has also been initiated and the observations so far made have shown that number of eggs per gram body-weight of the fish varied between 144-152 only. The study is in progress. The size-weight relationship of the pituitary glands of Rohu and Mrigal was established after studying 529 fishes and glands.

Fish breeding experiments were conducted with considerable success at the Kalyani Experimental Fish Farm in West Bengal in collaboration with the West Bengal Fisheries Directorate. All the species of major carps were induced to spawn and a few lakhs of fry and fingerlings were successfully reared.

Successful hybridization of Catla females with Labeo fimbriatus males was achieved and considerable numbers of the hybrid were obtained. The growth rate of this hybrid was found to be slower than that of Catla.

Histological and histo-chemical studies of the pituitary glands and gonads of major carps and haematological studies of Carps with a view to correlate blood composition with different stages of maturity have been initiated during the year and the studies are in progress.

3. Exotic fish culture

A finding of considerable scientific interest recorded during the year was the attainment of full sexual maturity by the yearlings of induced bred Silver carp, as against 2-3 years in Hong Kong and Japan and a few of them were successfully induced to breed during the year. This is probably the first instance of Silver carp breeding at yearling stage.

Two sets of Grass carp (Ctenopharyngodon idellus) were successfully induced to breed at the Kalyani Experimental Fish Farm in West Bengal. Females were stripped and the eggs were artificial fertilised and it was possible to obtain only about 1000 spawn for rearing.

Attempts made to hybridize Grass carp with Mrigal was only partially successful. About 40,000 eggs of Mrigal were fertilised with Grass carp milt and the fertilisation was over 95%. But the hatchlings produced were abnormal and all died within four days of hatching. A series of experiments were conducted during the year to study the comparative growth rates of Chinese carps with those of Indian carps. Under identical conditions, growth rate of Silver carp was slightly better than that of Catla. Mixed culture of Grass carp, Silver carp, coloured Catla, Rohu, Scale carp and male Tilapia in ponds manured with N-P-K & Cow-dung and fed by the weed Hydrilla and powdered mustard oil-cake gave a maximum yield of 4752 kg per hectare per annum.

In an experiment of about 6½ months' duration where the fishes were fed only on weeds and no manuring was done, the combination of Grass carp, Silver carp and Common carp yielded a much higher production (4327 kg per hectare per annum) than the combination of Grass carp, coloured Catla and Common carp (2433 kg per hectare per annum). While the 40 Silver carps stocked in one pond attained a weight of 27.58 kg, the similar number of Catla with similar initial weight stocked in the adjacent pond attained a weight of only 11.69 kg during the same period.

One pair of Mirror carp produced 1.05 lakhs of spawn, out of which 29,000 fry were obtained and 30% survival was recorded. Experiments on intensive cultivation of Tilapia mossambica along with Chinese carps, Common carp and Catla, in a 0.4 ha pond, which was regularly manured with Cow-dung and N-P-K and the fishes fed with mustard oil-cake, yielded 2268.5 kg of Tilapia and 980.4 kg of other fishes in 18½ months, the initial stocking being 171.4 kg of Tilapia and 261.7 kg of other fishes.

4. Brackish-water fish farming

Exploratory survey with shooting nets and small drag nets. (Hapa nets) for the location of suitable collection centres for the seed of cultivable species of brackishwater fishes was intensified.

in the lower Sunderban areas. Fry and fingerlings of mullets, Mugil parsia, Mugil tade and Mugil corsula were found to occur in Saptamukhi, Muriganga and Baratala rivers from January to October. Fry and fingerlings of Eleutheronema tetradactylum were available throughout the year in all the rivers of the Hooghly estuarine system with August and September constituting the peak period. During March and April, fry of Bhetki (Lates calcarifer) were also encountered in creeks and during the monsoon months in inundated paddy fields. Experimental studies on salinity tolerance of mullet fry showed better survival in salinity below 20‰. Experiments carried out to determine the optimum salinity for the blue green algae Oscillatoria amis and Lyngbya sp have shown that they thrive well and multiply in salinities varying from 5.5 to 12.0‰ and 1.0 to 1.8‰ respectively.

5. Weed control

Results obtained in the trial clearance of small areas of an 85 hectare bheel at Nowgong, Assam, heavily infested with water-hyacinth, by the use of 2-4-D and manual labour showed that 2-4-D treatment was the most economical one and the cost of clearance per hectare worked out to Rs.117/- approximately. Yard experiments with AQUATHOL (Disodium endothol), a new commercial weedicide, have shown that when applied @ 2.3 - 3.4 ppm, it killed and decomposed Hydrilla within a week. The carp fingerlings in aquathol-treated waters died within two days of application. Similar experiments with "KUROSOI-G", another commercial weedicide have been initiated.

Autecological studies on Najas indica and Ceratophyllum demersum were completed. Seeds of N. indica in bottom soil have been found in large numbers in a healthy condition upto a depth of 26 cm. Studies on the autecology of Najas graminea and Wolffia arrhiza have been initiated. Najas graminea has a high aggressive capacity and can withstand competition from the noxious weeds. Wolffia arrhiza was present in the ponds throughout the year, but was more dominant during winter. Studies on Nechamandra alternifolia (Lagarosiphon roxburghii) were continued. The plant showed profuse vegetative reproduction from April to October and flowering and fruiting from August to February.

Field studies on the flowering and fruiting seasons of 35 common aquatic weeds have been completed. The information thus collected would help in fixing the best periods for control of these weeds.

Ecological studies on blue green algae blooms have shown that a direct correlation exists between high values of total alkalinity, chlorides, phosphates, Calcium and Magnesium content of water on the one hand and blooms of Microcystis on the other.

Studies were initiated in connection with utilisation of pond weeds as pond manure, Composts of Eichhornia, Pistia, Najas,

Ottelia and Hydrilla have been prepared and jar-experiments started to ascertain the comparative productivity of plankton when these composts are used as fertilisers.

Experiments on the culture of weeds were initiated partly to meet the increasing demand for suitable Grass carp feed and partly to investigate the causes of non-establishment of certain submerged weeds, particularly Hydrilla, in some nursery ponds in Kausalyganga Fish Farm, Jar experiments with Spirodela have shown that fertilisation with composts of aquatic weeds leads to an enormous increase of the weeds in both number and weight. Field observations indicate that turbidity of the water and the clayey texture and low level of phosphorus in the soil are the likely factors responsible for the non-establishment of submerged weeds in Kausalyganga.

6. Soil chemistry and fish production

An experiment was conducted to study the response of low-nutrient highly unproductive acid soils to different combinations of organic and inorganic fertilisers, and to evolve a suitable manuring practice for carp nurseries, having such soils. The experimental ponds were first treated with chlorinated lime to kill fairy shrimp and then a basal dose of lime @ 200 kg/ha was applied. After that the fertilisers, viz., (a) purely organic (cow-dung + Mustard oil-cake), (b) purely inorganic (N-P-K + Ammonium sulphate) and (c) Organic + inorganic (Mustard oil-cake + N-P-K) on equivalent basis @ 90-40-20 kg of $N-P_2O_5 - K_2O$ per hectare were applied in the ponds. Nine days after fertilisation, the ponds (each of 0.4 hectare water area) were stocked with Rohu spawn @ 50,000/pond. The results obtained showed that maximum percentage of survival (over 65%) was in ponds treated with the purely inorganic combination of fertilisers, and the minimum (about 31%) in those treated with the purely organic combination of fertilisers, which indicated that purely inorganic fertiliser combination @ 90-40-20 kg of $N-P_2O_5 - K_2O$ /ha had a highly satisfactory response for this specific type of unproductive soil.

Studies on the relative efficiency of three different forms of nitrogenous fertilisers, viz. (1) purely nitrate (KNO_3 or $NaNO_3$) (2) purely ammoniacal $(NH_4)_2SO_4$ and (3) ammonium cum nitrate (NH_4NO_3) on soils of pH ranging from 5.4 to 8.5, showed that under laboratory conditions, the maximum loss of added Nitrogen was from Potassium nitrate (88.34%) and minimum from Ammonium sulphate (19.43%) in acidic soils in 60 days. Similar trends were also noticed in soils having slightly alkaline pH. However, in highly alkaline soil (pH-8.5), the trend was just opposite; the highest loss being registered in Ammonium sulphate (62.90%) and lowest in Potassium nitrate (42.75%) in the same period. Thus it was observed that pH of soil played an important role in determining the efficiency of different nitrogenous fertilisers in maintaining higher nitrogen level in pond soils.

A complete ecological study of two fish ponds with special reference to their bottom biota with initiated during the latter part of the year. Each pond was partitioned into two parts with fine meshed wire netting, one part being stocked with fish and the other left as such without any fish. The observations made so far showed that the number of bottom biota per square metre of the pond bottom of the stocked portion was much less than that in the unstocked portion. Further, number per sq metre in both the portion showed an increasing trend from January to March. Aquatic Oligochaetes such as Tubifex sp, Branchiura sp and Dero sp and insect larvae, Pentaneura sp, & Culicoides sp formed the bulk of the bottom biota. Anabaena, Navicula, Euglena, Microcystis, and Ceelosp-harui constituted the main phytoplankters while Brachionus, Keratella, nanplii and Diap-tomus were the dominant zoo-plankters in both the ponds, As regards water quality and soil condition, no marked variation was noticed between the stocked and unstocked portions of the ponds.

III. INVESTIGATIONS ON CAPTURE FISHERIES

1. Fisheries of freshwater rivers

(a) Ganga river system

Landings

The estimated landings at 8 major fish assembly centres from Kanpur to Lalgola Ghat along the Ganga during 1963 totalled 906.3 tonnes as against 628.1 tonnes during the previous year, while those at the two assembly centres, viz. Agra & Saidapur along Jumna were 268.3 tonnes as against 309.1 tonnes of the previous year. Details of group-wise landings are given below:

Species or groups	% in the total landings.	
	G A N G A	J U M N A
<u>Hilsa ilisha</u>	53.0%	7.4%
Catfishes	14.5%	28.7%
Carps	8.7%	46.2%
Miscellaneous	23.8%	17.7%

In the Ganga, Wallago attu, followed by Mustus aor & M. seen-ghala among the catfishes and Mrigal, Rohu and Catla among the carps, dominated the catches. While Hilsa, followed by catfishes dominated the Ganga landings, in the Jumna, the carps dominated the catches, followed by catfishes and Hilsa. Mrigala was the most dominant carp, followed by Rohu & Catla.

STUDIES ON FISHERIES BIOLOGY AND POPULATION DYNAMICS

Species and size selectivity of commercial gear

As a pre-requisite for the study of population dynamics, the commercial gears of the Ganga river system were classified, on the basis of gear design and mode of operation, into seven gear types, viz. drag, gill, purse, scoop and cast nets, hook and line and traps. The season of operation of each commercial gear, its species and size selectivity and the contribution of each to the catches at selected centres at Sadiapur, Mehendorighat, Buxar, Ballia & Bhagalpur were also studied. Further, to design a suitable sampling technique to assess accurately the landings of each species of fish in relation to effort, a small section of the Ganga river system which supplies the Allahabad fish market was selected for through study. In this connection a fresh inventory of fishermen, craft and tackle was made and patterns of fish trade determined.

Fish tagging experiments

7,813 fingerlings of Catla catla, Labeo rohita and Cirrhina mrigala were tagged with plastic streamer type tags and released in the rivers Ganga and Jumna from selected centres in order to study their migration, growth and exploitation rates. 66 recoveries have been made so far. The longest time lag between tagging and recovery and the longest distance travelled were 60 days and 24 km respectively during the period under report.

Observations on spawning success

The programme initiated during 1962 in the river Gomti at Jaunpur was continued through the season of 1963. There were four floods in the river as in the previous year and the catch per net, hour was 61.5 as against 2171 during 1962. The carp hatchlings were available only in the fourth flood and the percentage of various species was Cirrhina mrigala (37.8%), Labeo calbasu (30.1%), L.ro (15%) and Catla catla (5.6%).

Fishery biological investigations

CARPS

Cirrhina mrigala: 33.1 and 62.4 tonnes of Mrigal were landed from the various centres along the rivers Ganga and Jumna respectively during 1963 as against 32.8 and 85.2 tonnes respectively in the previous year. The species accounted for 41.9% and 50.3% of the major carp landings from the two rivers respectively.

The size-age-group composition of C.mrigala landings from the Ganga river system revealed that between the ages I-VI, the

percentage distribution by weight was 5.9, 22.4, 30.5, 16.6, 10.7 & 13.9 respectively. The length frequency data in respect of Mrigal from the river Jumna were critically analysed using probability paper to dissect polymodal frequency distributions following the techniques of Hanring (1949) & Cassie (1950). The results obtained showed that the size at ages I-VII work out to 260, 470, 600, 740, 840, 890 & 920 mm respectively. This age and growth pattern generally agreed with earlier investigations conducted in respect of Mrigal of the Ganga.

Catla catla: Estimated total landings of Catla catla from Ganga and Jumna were 21.0 and 20.0 tonnes respectively in 1963, as against 22.5 and 17.2 tonnes during 1962. The species contributed to 28.5% and 16.2% of major carp landings from the Ganga and the Jumna respectively. A thorough analysis of 9 years data (1955-63) on length frequency of Jumna Catla using cumulative percentage frequency plot on probability paper to dissect the overlapping modes, showed that at about the breeding time of fish, the observed flexions were at 330, 510, 680, 790, 870, 930 & 975 mm at ages I-VII. Size frequency data of Ganga Catla from Buxar for 8 years (1955-63), analysed using the same technique as in the case of C. mrigala revealed that with reference to biological year, the flexions were at 340, 500, 660, 780, 880, 920, 8970 mm and these were in fair agreement with those described in the case of Catla in Jumna.

Labeo rohita: The estimated productions of Rohu at eight centres on Ganga and two on Jumna in 1963 were 21.2 and 24.8 tonnes respectively as against 20.5 and 24.1 tonnes in 1962. The contribution of the species in the total annual landings of major carps from Ganga and Jumna was 26.9% and 20.0% respectively. The length frequency data of 3136 specimens ranging between 55 mm and 1005 mm were collected from the commercial landings for age and growth studies, the length frequency distribution of the species being polymodal, cumulative percentage on probability paper were used for splitting up the overlapping modes into their components with a 5 mm class interval, and 19 flexion values ranging from 65-975 mm were tentatively observed.

Gut content study of the juveniles of the species measuring between 93-187 mm showed sand particles (79%), rotifers (13.3%), copepods (1.2%), other animal matter (0.9%), diatoms (5.3%), green algae (0.1%) and blue green algae (0.2%). The gut contents of the adult specimens ranging from 300 mm - 875 mm were observed to consist of sand particles (75.1%), plant debris (15.4%), mucous (1%), diatoms (4.5%), green algae (2.2%), blue green algae (1.2%), rotifer (0.2%), copepods (0.1%) and other animal matter (3.0%). Gastro-somatic index of the fish was found to be low with the start of maturation, but soon after the spawning period the feeding intensity became high with the gastro-somatic index varying from 3.5 to 4.2.

151 specimens of Labeo rohita were studied for sexual dimorphism and it was observed that the anal fin in females was longer than the pectoral fin in the males. 't' - test was applied and the value

of 't' in females was 13.379 as against 15.131 in the males, the showing a highly significant difference. It was also observed that in the females, the anal fin extended beyond the origin of caudal fin, while in the males it either touched or remained short of the origin of the caudal fin.

The gonado-somatic index of the females ranged from 0.24 to 17.23, the maximum being observed during June and July, when fishes were in full mature condition. But the index value was reduced to a great extent varying from only 0.37 to 0.93 during the period September to November when most of the females were in spawning condition.

Labeo calbasu: Estimated total annual landings of the species from Ganga and Jumna were 3.5 and 16.6 tonnes respectively in the year 1963, as against 2.7 and 14.2 tonnes respectively during the previous year. The species formed 4.4% and 13.4% of the total catch landings from the Ganga and the Jumna respectively in 1963.

For age and growth studies, the length frequency data were analysed using Petersens' method and Cassie's and Hardings' method of dissecting polymodal frequency distribution on an arithmetical probability paper and the respective sizes at ages I to VIII were found to be 155, 290, 390, 460, 545, 615, 680 and 740 mm. These lengths when compared with the ages back calculated from scale studies showed close correspondence.

In the Ganga, the size groups II and III dominated the landings both by weight (76.53%) and number, while in the Jumna, size groups III & II dominated the catches by weight (41.36%) and number respectively.

A length-weight relationship in male and female Calbasu has been worked out and can be described by the following equations:

$$\sigma \sigma \text{ Log } w = 5.43687 + 3.32881 \text{ Log } L$$

$$\varnothing \varnothing \text{ Log } w = 6.22502 + 3.51212 \text{ Log } L$$

Fecundity of the species, ranging between 472 and 820 mm total length, was calculated to be from 2,30,831 to 24,32,390. Gut content studies of Labeo calbasu indicated that the fish mainly subsisted on phytoplankton and decayed organic matter, followed by crustacea and insect larvae.

CATFISHES

Rita rita: The total annual landings of Rita rita from the rivers Ganga and Jumna were estimated at 9.8 and 7.6 tonnes respectively in 1963. The length frequency data of 1736 specimens of Rita rita, ranging from 51 mm to 610 mm, were analysed for growth studies and the sizes at ages I-VI worked out to be 163, 288, 388, 443, 493

538 mm respectively. The food of Rita rita consisted mainly of molluscs (32.6%), macro-vegetations (27.2%), insects (17.2%) fishes (4.7%), crustacea (2.5%), and other miscellaneous items (10%). The dominant occurrence of molluscs and organic detritus mingled with sand and clay in the stomach indicated the bottom feeding nature of the fish. Out of 100 specimens examined for gonad study, 50% of the individuals were found to be mature at 295 mm. Fecundity of two pairs of ovaries of Rita rita measuring 535 and 572 mm, was found to be 14,687 and 54,465 respectively. The number of ova per gram weight of ovary worked only to 396-413.

Wallago attu: 49.5 and 22.6 tonnes of Wallago attu were estimated to have been landed at the eight centres on the Ganga and 2 centres on the Jumna in 1963. For age and growth studies, length frequency data of 4078 individuals were analysed by using probability plot method. The sizes attained by the species at first five years of its life have been estimated to be 370.5, 530.5, 678.5, 750.5 and 830.5 mm. Gut content study of 56 specimens showed the food of the fish to be composed of about 70% fish remains (Hilsa sp, Gadusia sp and Eutropichthys sp), 20.5% crustacea (mainly prawn and crabs) and 9.3% insects. Fecundity, as revealed by examination of 52 ovaries of individuals, ranging between 691 to 1208 mm in total length, ranged from 44925 to 7,46,496.

Ecological studies

A full range of physico-chemical characters was continued to be studied fortnightly at fixed hours at three selected centres one each on Ganga above and below confluence and one in Jumna.

(b) Godavari river system

Landings

The total estimated landings of fish including prawns from a stretch of 130 miles (208 km) of the freshwater area of the river Godavari were 315.433 tonnes during the year 1963-64. Groupwise and zone-wise estimated landings are tabulated below :

Fish groups or species	Zone-I	Zone-II	Zone-III	Total	Percentage in Total
	tonnes	tonnes	tonnes	tonnes	
Carp	33.378	15.441	17.186	66.005	20.92%
Catfishes	17.949	4.605	17.959	40.573	12.84%
<u>Hilsa ilisha</u>	13.059	0.702	0.536	14.297	4.53%
Prawn (<u>Macrobrachium malcolmsonii</u>)	89.049	2.054	9.951	101.054	32.03%
Miscellaneous fishes	67.631	6.673	19.260	93.564	29.65%
Zonal total	221.066	29.475	64.892	315.433	
Zonal percentage	70.08%	9.34%	20.57%		

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As in the previous year, Zone I was the most productive area followed by Zones III & II. As a group, the prawns represented by a single species Macrobrachium malcolmsonii record the highest landings constituting 32.03% in the total annual landings. Landings of Hilsa ilisha showed a steep fall forming only 4.53% of the total as against over 24% last year. Carps were mainly represented in commercial catches by Labeo fimbriatus, L. calbasu, L. rohita, Cirrhilabrus mrigala, C. horai and Catla catla. Mystus seenghala, Bagarius bagarius, Wallago attu, Pangasius pangasius and Silonia silonia were the predominant catfishes in the landings. Eight main types of gears were recorded from the three zones of the river stretch under investigation. Of these, Cast net, Nylon gill net, Alivi & Jaruguvalas (Seine nets), Kante-vala (drag net), Rekha-vala (Scare line) and long lines were common all along the river stretch. Rangoon net (gill net) and Bendu-vala (Seine net) were however, confined to only Zones I & II respectively. Jaruguvala recorded the highest landings (136.6 tonnes), followed by cast net (90.2 tonnes) and these two nets were responsible for catching of only '0' year group and juvenile fish and adult prawns. Nylon gill net came third with a catch of 37.9 tonnes, followed by Rangoon net with 4.9 tonnes. The total catch for each gear and the number of man hour expended are given in the table below:

<u>Type of gear</u>	<u>Total catch</u>	<u>Man power</u>	<u>Catch/Man/Hour</u> <u>(in kg)</u>
Cast-net	2816	22,363	0.126
Konte-vala	727	3,504	0.208
Nylon-net	3328	25,667	0.129
Jaruguvala	6432	13,996	0.459
Bendu-vala	119	660	0.180
Alivi-vala	2027	10,614	0.191
Long lines	749	66,857	0.109
Rangoon net	300	4,744	0.063
Rekha-vala	47	166	0.405
Miscellaneous gear	692	2,203	0.314

Fishery biological investigations

Fishery biological studies especially on age and growth of ten commercially important species of fish of the river stretch were continued. The length frequency data were analysed by "Peterson" probability methods. Scale markings were also studied to check-up the results obtained by the other methods.

Analysis of the length frequency data revealed growth increments of 50-73 mm between I & II years, 50-60 mm between II & III years, 79.3 mm between III & IV years and 67.67 mm between IV & V years in Labeo fimbriatus and 108.5 mm between I & II years, 89.4 mm between II & III years, 85.3 mm between III & IV years, 72.25 mm between IV & V years, 84.75 mm between V & VI years and 48.56 mm between VI & VII years in the case of Cirrhina mrigala.

Studies on primary organic production

Studies on primary production were taken up in January 1964 as part of the investigations of lacustrine conditions of river Godavari and deep pools in non-monsoon season. The light and dark bottle technique of Gaarder and Gran with slight modification was adopted for study. Studies made so far revealed that the gross primary organic production of the surface water upto 32 km stretch of the river above Dowlesswaram anicut ranged in time and space from 674Mg/M³/day to 2322 Mg/M³/day in terms of carbon assimilated. The productivity at the confluence of the effluents of the paper mills was nil, but the highest production occurred in the regenerated water just immediately after the periphery of the septic Zone V. The average production values computed for the period was 1753 Mg/M³/day carbon assimilated in fertile water and 881 Mg/M³/day for unpolluted water. It thus clearly brought out that pollution after complete trophyllysis affected primary production in a very beneficial way by practically doubling the productivity in the area. Assuming that the average depth of the water spread in the area to be 1.5 m, the organic production ranged from 15.675 kg/hect/day to 26.295 kg/hect/day and the computed average for the area was found to be 22.316 kg/hect/day for the season.

(c) Narbada and Tapti rivers

Landings:

Observations on the fish landings were continued during the year in a 48 km stretch of Narbada river near Hoshangabad, by covering fisheries of two important fish landing centres at Hoshangabad and Shahganj and 56.4 tonnes of fish were estimated to have landed. The percentage species composition of the commercial catches at Hoshangabad and Shahganj individually and group-wise are shown in the table below :

<u>Species</u>	<u>Hoshangabad</u>	<u>Shahganj</u>	<u>Both centres</u>
<u>Barbus tor</u>	24.1 %	21.2 %	22.65 %
<u>Labeo fimbriatus</u>	18.6	28.5	23.55
<u>Labeo calbasu</u>	5.1	3.6	4.35
<u>Cirrhina mrigala</u>	3.4	1.7	2.55
<u>Labeo bata</u>	1.6	1.3	1.45
<u>Catla catla</u>	0.5	0.9	0.70
* <u>Other carps</u>	5.4	1.7	3.55
<u>CARPS</u>	<u>58.7</u>	<u>58.9</u>	<u>58.80</u>

<u>Species</u>	<u>Hoshangabad</u>	<u>Shahganj</u>	<u>Both centres</u>
<u>Rita pavementata</u>	7.1	22.6	14.85
<u>Mystus seenghala</u>	11.6	4.4	8.00
<u>Wallago attu</u>	8.2	5.5	6.85
<u>Mystus aor</u>	4.4	3.1	3.75
<u>Clupisoma garua</u>	1.6	1.5	1.55
** <u>Other cat-fishes</u>	<u>0.6</u>	<u>0.3</u>	<u>0.45</u>
<u>CAT FISHES</u>	<u>33.5</u>	<u>37.4</u>	<u>35.45</u>
<u>Ophicephalus marulius</u>	4.6	1.8	3.20
<u>Notopterus notopterus</u>	0.5	0.5	0.50
<u>Mastacembelus armatus</u>	1.2	1.4	1.30
*** <u>Miscellaneous</u>	<u>1.5</u>	<u>-</u>	<u>0.75</u>
<u>OTHER FISHES</u>	<u>7.8</u>	<u>3.7</u>	<u>5.75</u>

* Labeo dyocheilus, Labeo gonius, Cirrhina reba and Barbus saray

** Ompok bimaculatus and Mystus cavasius.

*** Small fish and prawns.

In the annual fish landings, Labeo fimbriatus, Barbus tor, Rita pavementata, Mystus seenghala, Wallago attu, Labeo calbasu, Mystus aor, Ophicephalus marulius and Cirrhina mrigala, together made up 89.75% of the total. Among carps, the fishery of Barbus tor was almost equally important at both the centres, whereas Labeo fimbriatus was predominant at Shahganj centre. Among the catfishes Rita pavementata was far more important at Shahganj and Mystus seenghala, Wallago attu and Mystus aor, comparatively to a lesser degree at Hoshangabad.

Observations on age/size composition of important fisheries of the stretch of the river under investigation were continued. The percentage composition by weight and estimated number of fish of various age-groups were determined in respect of Barbus tor, Labeo fimbriatus and Rita pavementata, while in the case of Wallago attu, Mystus seenghala, Mystus aor and Labeo calbasu, the entire size range was arbitrarily divided into four size groups and the percentage composition by weight and estimated number of fish of various size groups were determined. The estimates are tabulated below:

Age composition

<u>Important fisheries</u>	<u>Age group</u>	<u>Length range mm</u>	<u>Percentage by weight</u>	<u>Estimated number</u>
<u>Barbus tor</u>	0-I	100-280	8.7	3,536
	II-III	281-400	30.5	5,143
	IV-V	401-505	39.2	3,694
	VI & above	506 & above	21.6	964

<u>Important fisheries</u>	<u>Age group</u>	<u>Length range mm</u>	<u>Percentage by weight</u>	<u>Estimated number</u>
<u>Labeo fimbriatus</u>	0-I	82-208	0.9	421
	II-III	209-309	11.1	2,598
	IV-V	310-411	39.4	4,925
	VI-VII	412-520	41.0	2,872
	VIII & above	521 & above	7.6	436
<u>Rita pavementata</u>	0-I	75-123	3.8	8,029
	II-III	124-163	17.5	13,360
	IV-V	164-203	30.7	9,946
	VI & above	204 & above	48.0	4,567

Size composition

<u>Wallago attu</u>	I	Upto 265	0.1	88
	II	266-470	5.8	327
	III	471-650	33.9	705
	IV	651 & above	60.2	606
<u>Mustus seenghala</u>	I	Upto 265	0.9	450
	II	266-470	19.9	745
	III	471-650	30.1	754
	IV	651 & above	49.1	577
<u>Mystur aor</u>	I	Upto 265	5.1	1,198
	II	266-470	31.7	926
	III	471-650	30.4	386
	IV	651 & above	32.8	174
<u>Labeo calbasu</u>	I	Upto 165	0.1	33
	II	166-320	19.7	706
	III	321-470	69.8	2,094
	IV	471 & above	10.4	77

Catch per unit of fishing effort

Observations on the catch per unit of effort mainly in respect of cast net and long line operations were continued at Hoshangabad and Shahganj centres to determine the fluctuations in the relative abundance of fish. The estimates are presented in the following table :

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CAST NETHoshangabad area (9 months)

	<u>Total gear</u>	<u>No. of hours</u>	<u>Catch per gear per hour</u>
April - June, 1963	202	800	0.511 kg
October - December, 1963	225	1,076	0.534 kg
January - March, 1964	152	690	0.530 kg
Dominating species: <u>Labeo fimbriatus</u> , 31.5%, <u>Barbus tor</u> , 30.3%			
<u>Labeo calbasu</u> , 9.6%, <u>Wallago attu</u> , 5.3%.			

Shahganj area (12 months)

April - June, 1963	140	484	0.381 kg
July - September, 1963	30	170	0.391 kg
October - December, 1963	107	542	0.647 kg
January - March, 1964	57	283	0.415 kg
Dominating species: <u>Labeo fimbriatus</u> , 28.2%, <u>Burbus tor</u> , 27.8%			
<u>Wallago attu</u> , 9.3%, <u>Mystus seenghala</u> , 7.4%			

LONG LINEHoshangabad area (9 months)

April - June, 1963	27	181	0.533 kg
October - December, 1963	140	1,556	0.289 kg
January - March, 1964	39	344	0.179 kg
Dominating species: <u>Rita pavimentata</u> , 23.5%, <u>Barbus tor</u> , 21.6%			
<u>Clupisoma garua</u> , 7.9%, <u>Labeo fimbriatus</u> , 7.			

Shahganj area (12 months)

April - June, 1963	13	135	0.451 kg
July - September, 1963	136	1,396	0.279 kg
October - December, 1963	123	1,166	0.281 kg
January - March, 1964	23	226	0.232 kg
Dominating species: <u>Rita pavimentata</u> , 45.6%, <u>Barbus tor</u> , 20.8%			
<u>Mystus aor</u> , 9.9%, <u>Labeo fimbriatus</u> , 7.4%.			

Fishery biological investigations

Labeo fimbriatus: Studies on the biology of this important species were initiated in April, 1963 and continued during the year under report. In all 331 specimens of this species measuring from 177 mm to 645 mm were examined. The observations on feeding intensity were based on gastro-somatic index (G.S.I.) and 'condition' of gut. The feeding activities were found to be poor from July to September (G.S.I. : 1.6- 2.1) and this period of poor feeding coincided with its peak breeding season (July and August). The feeding activities increased progressively from October (G.S.I. : 4.2) to March (G.S.I. : 8.1) and thereafter declined upto July. The highest feeding was observed from January to March (G.S.I. : 7.9 to 8.1).

The fish was found to subsist mainly on Bacillariaceae (20.82%), Chlorophyceae (12.38%), Myxophyceae (1.37%) and miscellaneous matter (4.57%). The fish was also found to take large quantities of decayed organic matter (24.31%), sand and mud (36.50%), which indicates its bottom-feeding habit.

The maturity studies based on gross examination of the Gonads, gonado-somatic index and ova diameter measurements indicated that the fish has a breeding season extending from May - June to September - October, with peak breeding during July and August. The gonado-somatic index has been found to bear an inverse relationship with gastro-somatic index, indicating thereby that feeding intensity declines considerably during the breeding season. Based on 13 ripe ovaries, collected from specimens measuring 464-582 mm, the fecundity of this species was found to range between 1,00,000 and 5,00,000.

The length-weight relationship of Labeo fimbriatus (male) was calculated to be:

$$\text{Log } W = - 5.4949 + 3.2089 \text{ Log } L.$$

Where W = Weight of the fish in grams and

L = total length in mm

Burbus (tor) tor: The scales of 228 specimens of this species were studied and the lengths of various age groups were determined. The length frequency data of 4,680 specimens were also analysed. The lengths of various age groups upto seventh year, as determined from the analysis of scales and length frequency data are tabulated below for comparison of results obtained by the two methods.

Age groups	Length in mm (from analysis of L/F distribution)	Length in mm (from analysis of scales).
I	225	250
II	297	325
III	368	390
IV	428	445
V	483	490
VI	532	535
VII	570	590

The relationship of scale length(S) with fish length(L) showed a high degree of correlation, the value of coefficient of correlation being 0.92. The relationship is expressed in the following formula:

$$S = 0.0306L + 1.2412$$

The formulæ correlating total length (L) with weight (W) of males and females of Barbus (tor) tor have also been calculated. These relationships showed high degree of correlation both in males (r = 0.96) and females (r = 0.99). The formulae expressing these relationships are as follows:

$$\text{Male} - \text{Log } W = 2.9851 \text{ Log } L - 4.9647$$

$$\text{Female} - \text{Log } W = 3.0522 \text{ Log } L - 5.1263$$

The gut contents of 57 juveniles measuring 95 mm to 200 mm in total lengths were analysed with a view to compare their diet habits with those of adult fish. The juveniles were found to subsist on insects (53.8%), molluscs (21.9%), macro-vegetation (4.7%) and algae (2.8%). May fly larvae, chironomus larvae, caddisworms and caddisfly pupae mostly formed the insect diet. Molluscs consisted mainly of Corbicula striatolla among bivalves and Melanoides lineatus among gastropods. The macrovegetation was made up of digested plant matter and aquatic grasses. Spirogyra and Zygnema were the common forms of filamentous algae in the diet. These observations on the diet composition of juveniles have indicated that the juveniles and the adult fish subsist on almost the same food organisms, but in varying degrees.

The analysis of data on maturity and spawning season of Barbus (tor) tor were continued during the year under report. The length frequency data comprising 12,243 post-larvae and fry (size range : 6-60 mm) were analysed and the results obtained have shown that the breeding of this fish commences in July and extends upto March, with peak breeding in August and September. The fish belonging to various size groups were observed to breed, in succession during different periods, exhibiting prolonged spawning season.

Rita pavementata: Length-weight relationships of Rita pavementata (both male and female) are expressed in the following formulae:

Males - $\text{Log } W = 3.0033 \text{ Log } L - 4.8803$

Females - $\text{Log } W = 3.2258 \text{ Log } L - 5.3827$

The coefficient of correlation (r) was found to be as high as 0.98 and 0.99 in males and females respectively.

On the basis of gonado-somatic index, three ovaries were selected and 600 ova from each of these selected ovaries were measured for maturity study, which has indicated that this species has only one spawning season, extending from June to September, with July-August being the peak period.

2. Fisheries of estuaries

(a) Hooghly-Matlah Estuarine System

Landings

The total fish including prawns landed from different zones during the year 1963-64 amounted to nearly 6412 tonnes as against 5091 tonnes during the previous year. This increase was due mainly to better catches made in the lower zone (Zone III) of the estuary, which accounted for over 83% of the total landings. Other zones, except zone V which registered a slight increase over last year's figures, showed a decline as compared to previous year's landings. Hilsa ilisha, Harpodon nehereus, and prawns contributed to 22.3%, 20.2% and 14.5% respectively of the year's landings. The most widely employed gears were bagnets, tangle nets, seines and set-barriers and these respectively accounted for 49.5%, 24.2%, 7.8% and 5.1% of the total fish caught during the year.

Fish landings from seasonal winter fishing camps in the Sunderbans showed an increase of 682.40 tonnes over that of the corresponding period of the previous year.

Estimated catches, species-wise, zone-wise and gear-wise and the catch per unit of effort are furnished in the following tables:

ZONE-WISE AND GEAR-WISE CATCH (IN KG) AND C.U.E. (IN KG)
IN THE HOOGHLY-MATLAH ESTUARY DURING
1963-1964

G E A R	Zone I		Zone II		Zone III		Zone IV		Zone V		Total catch
	Catch	C.U.E.	Catch	C.U.E.	Catch	C.U.E.	Catch	C.U.E.	Catch	C.U.E.	
Trawl net	1,21,628	4.02	-	-	-	-	-	-	-	-	-
Seine net	57,927	8.30	-	-	4,37,012	-	1,024	8.75	3,560	6.52	-
Purse net	15,089	0.46	54	0.14	260	-	-	-	-	-	-
Drift net	54,448	1.95	10,324	0.73	24,480	-	5,785	2.05	-	-	-
Lift net	74,376	3.10	949	0.24	141	-	-	-	-	-	-
Cast net	22,232	3.65	-	-	7,676	-	-	-	-	-	-
Bag net	1,96,552	5.19	1,60,530	2.57	25,46,294	114.79	1,61,276	5.92	1,12,883	15.41	-
Tangle net	-	-	-	-	15,50,787	-	-	-	-	-	-
Set-gill net	3,041	3.56	-	-	2,17,998	-	-	-	-	-	-
Set-barrier net	287	2.99	-	-	3,24,586	-	-	-	-1,739	4.05	-
Traps	12,290	0.16	-	-	-	-	-	-	-	-	-
Hooks & lines	51,879	2.29	-	-	1,31,489	-	-	-	-	-	-
Unknown	-	-	-	-	1,00,445	-	-	-	2,620	5.12	-

* Based on catch at winter fishing centres only

SPECIES-WISE CATCHES (IN KG) HOOGHLY-MATLAH ESTUARY: 1963-64

<u>Name of fish</u>	<u>Annual catch in Kg</u>	<u>Percentage in Total</u>
1. <u>M.tade</u>	12,309	0.2
2. <u>M.parsia</u>	38,874	0.6
3. <u>L.calcarifer</u>	43,871	0.7
4. <u>S.panijus</u>	46,055	0.7
5. <u>P.paradiseus</u>	61,969	1.0
6. <u>P.indicus</u>	134,485	2.1
7. <u>E.teradactylum</u>	23,069	0.4
8. <u>S.biauritus</u>	136,797	2.1
9. <u>S.miles</u>	11,594	0.2
10. <u>P.pama</u>	143,235	2.2
11. <u>H.ilisha</u>	1,432,264	22.3
12. <u>H.toli</u>	18,378	0.3
13. <u>I.elongata</u>	113,053	1.8
14. <u>C.ramcarati</u>	54,680	0.9
15. <u>C.borneensis</u>	1,807	Below 0.1%
16. <u>S.phasa</u>	252,493	3.9
17. <u>S.taty</u>	65,102	1.0
18. <u>P.pangasius</u>	59,611	0.9
19. <u>T.jella</u>	147,409	2.3
20. <u>O.militaris</u>	32,792	0.5
21. <u>P.canis</u>	9,093	0.1
22. <u>T.savala</u>	29,793	0.5
23. <u>T.haumela</u>	207,521	3.2
24. <u>H.nehereus</u>	1,293,197	20.2
25. Prawns	926,975	14.5
26. Miscellaneous	1,115,235	17.4
Total:	6,411,661	100.0

Analysis of commercial catches

Clupeoids, as in previous years, were the single largest group of fishes contributing to nearly 30% of the total catch during 1963-64. Hilsa ilisha, the most dominant species in the group, alone accounted for over 22% of the total landings. Other species of clupeoids that contributed to the catches in order of abundance, were Setipinna phasa, Ilisha elongata, Setipinna taty, Coilia ramcarati and Hilsa toli.

The Bombay duck, Harpodon nehereus, comprised the second largest group and accounted for 20.2% of the total commercial landings. It was available in the Hooghly upto the middle zone and was represented in the catches by the I, II & III year groups, having modal lengths of 65.5, 145.5 & 215.5 mm respectively. Females having modal lengths of 215.5 and in the IV & V stage of gonadal maturity were encountered in the lower zone of the Hooghly during January.

Sciaenids ranked fourth in order of abundance in the total annual landings and three species Pama pama, Sciaenoides biauritus and Sciaena miles chiefly contributed to the landings. Pama pama the dominant species in the group and was represented in the catches by the '0' - IV year groups. '0' year group was available only in the upper and middle zones of the Hooghly, while the bigger ones (I-IV) were encountered in the tidal and marine zones. The bulk of the catches was made during winter months. S.biauritus was fished in the river Ichamati and lower zone of the Hooghly, chiefly during the winter months and individuals ranging from 31-1270 mm were represented in the catches. Females of the species, encountered in the lower zone of the Hooghly, were in the I/II stage of gonadal maturity, S.miles contributed to the catches from Ichamati, Matlah and lower zone of the Hooghly and was represented in the catches in the size group having a modal length of 37 mm.

Catfishes, which contributed to 3.8% of the total commercial landings of the year were represented by four species: Pangasius pangasius, Tachysurus jella, Osteogobius militaris and Plotosus canius. Although T.jella dominated the cat-fish catches, its fishery had declined considerably as compared to previous year's landings. P.pangasius came next and was represented in the catches by the '0' - V year groups mainly from the middle and lower zones of the estuary.

Polydactylids, represented by Polydactylus indicus, Polydactylus paradiseus and Eleutheronema tetradactylum, formed 3.5% of the total landings, an improvement over the previous year by 1%. The increase was largely due to better catches of the first two species, the remaining almost the same as in the previous year. Catches of P.indicus comprised of individuals ranging from 90-490 mm and were landed from the Matlah, Ichamati, Saptanukhi and the Hooghly. Individual fish measuring upto 200 mm were found to be immature. E.tetradactylum was fished throughout the year from the Matlah, Ichamati and the Hooghly and was represented in the commercial

catches by five size groups having modal lengths of 45, 235, 285, 345, and 405 mm respectively.

Trichiurids represented by Trichiurus savala and T. haumela were more abundant than during the previous year. The increase was due to heavier landings of T. haumela, which yielded more than twice the landings of the species during the preceding year. Three size groups having modal lengths of 62, 110 and 212 mm respectively formed the fishery. Two modal sizes (72 & 112 mm) of T. savala contributed to the commercial catches from the lower zone of the Hooghly, Icha-mati and the Matlah. The species was available practically throughout the year.

Sillago panijus was represented in the catches by four year classes (I-IV), with the 'IV' year class present in the catches made during the colder months of the year only. Mulletts by two species, viz. Mugil parsia and M. tade were represented in the commercial landings of which the former was more abundant.

Hydrological studies

There was a general rise of salinity over the previous year in all the three rivers, viz. Hooghly, Matlah and Rupnarayan. While the increase in the first two rivers was slight, the increase in Rupnarayan was 3.5% more than what was recorded during the previous year. Salinity in the upper zone was traces throughout the year. Surface temperature also showed a slight increasing trend during the year. In the Hooghly, the temperature varied from 19°C to 33°C, while in the Matlah and Rupnarayan, it ranged from 19.8°C - 31.5°C and 17.8°C to 33.5°C respectively.

Plankton

The general downward trend in plankton production observed in the preceding years continued during the current year also. Diatoms among phytoplankters and Copepods and Cladocerans among zooplankters were the most important forms, both in number and variety. Rotifers, which were also encountered in considerable numbers were observed mainly in the freshwater zone. Larval forms like Nauplius, Veliger, Cyphonautes and Trochophore were fairly abundant in the Matlah and Rupnarayan rivers. In the upper and middle zones of the Hooghly and in the Rupnarayan, predominant diatoms encountered were Melosira, Coscinodiscus, Synedra, Nitzschia, Surirella and Biddulphia. Algal forms encountered in the same area were Spirogyra, Microcystis, Oscillatoria and Pediastrum. In the lower zone of the Hooghly and in the Matlah near Port Canning, brackishwater and marine forms of diatoms such as Chaetoceros, Skeletonema, Biddulphia, Lithodesmium and Coscinodiscus were present. Besides these, Trichodesmium & Oscillatoria (Algae) and Peridinium & Ceratium (Dinoflagellates) were also present in small numbers. The upper zone of the Hooghly and the Matlah at Port Canning were highly productive both in number and variety of forms.

Studies on the abundance and distribution of fish larvae

Larvae and pro-larvae of Setipinna phasa were available in the upper zone of the Hooghly from March to August, with March being the peak period. Post larvae and yolked larvae were available in the Rupnarayan from September to November and October to November respectively. Larvae and post-larvae of Pama pama were found mainly during March to May in the upper and middle zones of the Hooghly while in the Rupnarayan they were available till August. Yolked larvae of Polynemus paradiseus were encountered in the upper and middle zones of the Hooghly and Rupnarayan during the latter half of June, thus indicating the commencement of spawning. Although larvae were noticed in the Hooghly during the period July to August they were present in the Rupnarayan. Post-larvae and juveniles of Eleutheronema tetradactylum were available in the Rupnarayan during the months June to August only and those of Coilia sp in June only. Larvae and post-larvae of Mugil sp were available in tow net catches throughout the year, both in the Hooghly, as well as in the Rupnarayan.

(b) Mahanadi Estuarine System

The total marketable surplus of fish and prawns landed from the Mahanadi estuary for the year 1963-64 was estimated to be 564.415 tonnes as against 668.995 tonnes of the previous year. There might have been some decline in the fishing effort during the year because fishermen and fish merchants found it more profitable to work as labourers or as contractors in the Paradip Port construction project and also due to the outbreak of a devastating cholera epidemic which very badly affected a number of important fishing villages. Species-wise landings from the estuary during 1963-64 are shown in the table on page No. 27.

As in previous years, the mullets were in greatest abundance in the estuary, contributing to 44% of the total landings of the year as against 37.3% of the previous year. Three species, viz. Mugil cephalus, M. parsia and M. cunnesius mainly formed the fishery. M. cephalus accounted for 14.5% of the annual total landings and was available almost throughout the year with a peak period during December. It was represented in the commercial catches by individuals ranging from 95.5 to 844 mm, with the size groups varying from 200 to 315.5 mm dominating the fishery. M. parsia which formed 8.8% of total landings, was abundant in catches made during December and almost absent from March to September. Individuals varying from 55.5 to 255.5 mm formed the fishery and those with the modal length of 135.5 mm dominated the catches, possibly due to selectivity of gear employed. 7.9% of the total landings were of M. cunnesius. Like the other two species, it was also widely abundant in December, but as the catches were very scanty during March to August. Various size groups ranging from 45.5 to 415.5 mm were represented in the catches, but the most dominated group was the one having a modal length of 165.5 mm. Among the others that contributed to the annual

Species-wise market disposals and exports (in Kg).Mahanadi Estuary : 1963-64.

Name of fish	Dry fish market disposals (in terms of fresh fish)	Fresh fish exports	Total	%
1. Mullet (unclassified)	36,170	13,432	49,602	8.8
2. <u>Mugil cephalus</u>	74,778	7,263	82,041	14.5
3. <u>M. cunnesius</u>	40,665	3,886	44,551	7.9
4. <u>M. parsia</u>	44,842	5,067	49,909	8.8
5. <u>M. tade</u>	205	-	205	-
6. <u>M. trochelli</u>	17,398	5,207	22,605	4.0
7. Prawns	49,043	5,971	55,014	9.8
8. <u>P. indicus</u>	1,998	99	2,097	0.4
9. <u>E. tetradactylum</u>	18,955	1,570	20,525	3.6
10. Sciaenids	23,833	1,580	25,413	4.5
11. <u>L. calcarifer</u>	10,305	4,260	14,565	2.6
12. <u>Thrissocles</u> sp	8,992	2,958	11,950	2.1
13. <u>Namatolosa</u> sp	7,170	15	7,185	1.3
14. <u>Ilisha</u> sp	2,927	1,935	4,862	0.9
15. <u>Anchoviella</u> sp	135	-	135	Below 0.1%
16. <u>Sardinella</u> sp	44,430	-	44,430	7.9
17. <u>H. ilisha</u>	8,715	4,994	13,709	2.4
18. <u>Mystus</u> spp	523	-	523	0.1
19. <u>Arius</u> spp	1,367	170	1,537	0.3
20. <u>O. militaris</u>	-	-	-	-
21. <u>P. pangasius</u>	397	80	477	0.1
22. Miscellaneous	98,892	14,188	113,080	20.0
TOTAL:	491,740	72,675	564,415	100.0

landings, may be mentioned Sardinella sp (7.9%), sciaenids (4.5%), E.tetradactylum (3.6%), Lates calcarifer (2.6%), H.ilisha (2.4%), Thrissocles sp (2.1%) and prawns (9.8%). E.tetradactylum, ranging in size from 110-770 mm, was abundant during November to June. Almost the entire catch of L.calcarifer was landed during December and January and the size groups represented in the catches varied from 104.5 to 984.5 mm.

(c) Godavari estuary

A programme of survey and sampling of the estuarine stretch of the Godavari was initiated during the year 1963-64. The entire region was arbitrarily divided into two zones and designated as Goutami zone and Vasishta-Vainatheyam zone and 10 sampling centres were selected for procuring catch statistics. The total estimated landings of fish and prawns including inshore marine species during 1963-64 from Goutami zone amounted to 2299 tonnes, out of which prawns and crabs contributed to nearly 57.8% of the total landings. Percentages of other important fisheries were sharks and rays (Stromateus spp (6.6), Mackerels (4.75), Mugil spp (3.14), Clupea (3.5), Ribbon fish (3.3) and the Perches (1.7). Out of various types of gears employed, bag net was found to be most efficient, followed by nylon gill net and seines. In the second zone, the estimated total landings amounted to 1617.0 tonnes. The percentage of important fisheries were sharks and rays (35.0), clupeoids (14.0), Mackerels and catfishes (8.0 each), Perches (6.0), Sciaenids (5.0) and Ribbon fish (2.0). Among the gears, nylon nets yielded the highest landings, followed by bagnets, seines and gill nets. Observations made on the seasonal fluctuations of fisheries indicate that in both the zones, prawns and Hilsa dominated the monsoon months from July to November. Rest of the groups contributed mainly to winter fishery from December to March. The fisheries were in their least magnitude during the summer months of April to June and contributed to only about 1% of the total annual landings.

3. Fisheries of fresh water lakes

(a) Tungabhadra reservoir

A total of nearly 86.50 tonnes of fish were estimated to have been landed during the year under report. Catfishes dominated the landings having contributed slightly over 50% of the total landings, followed by carps which contributed to about 44%. Among the carps, Puntius kolus, Puntius dobsoni and Labeo fimbriatus respectively contributed to 24.1%, 10.8% and 7.5% of the total landings. Other species of carps in the order of their abundance were Puntius sarana, Labeo calbasu, Osteobrama vigorsii. Tor spp, Puntius pulchellus and Catla catla. Mystus seenghala among catfishes contributed to 23.4%, while Mystus aor & Silanopangasius childrenii contributed to 13.9%, & 4.9% respectively of the total landings. Other species landed were Wallago attu, Mystus cavasius & Ompok bimaculatus.

Experimental fishing in the reservoir was conducted for a total of 123 days during the year and 409.100 kg of fish were caught in 582 nets, with the catch per net working out to 0.704 kg. On an average, Rangoon net of $1\frac{1}{2}$ " mesh was found to be the most effective gear, followed by $1\frac{3}{4}$ ", 2" & $2\frac{1}{2}$ " mesh nets. Among the bottom set gill nets (Uduvalai), $1\frac{1}{2}$ " mesh net was found to be efficient and to some extent comparable to $1\frac{1}{2}$ " Rangoon net.

Carps formed 80% of the catches in experimental fishing operations. Puntius kolus was the most dominating species contributing to 49.41% followed by P.dobsonii (20.85%). Other species of carps caught included P.sarana, C.catla, L.fimbriatus, L.calbasu and Thynnichthys sandkhol.

The water of the reservoir was found to be slightly alkaline (50-100 ppm) with almost a constant pH of 8.0. The dissolved oxygen content varied from 4.9 - 9.6 ppm while the temperature ranged from 24°C - 26°C. Hardness varied from 48 to 72 while SiO₂ from 8 to 12 ppm. Littoral and bottom fauna were studied from seven selected regions of the reservoir. Tambrahalli region was found to be the richest of all having a fauna represented by prawns, dragon fly, damsel fly and may fly nymphs; Tendipedid larvae, bivalves and gastropod molluscs like Lymnea sp & Vivipera sp. The other regions in order of relative richness were Sovinahalli, Vyasankere, Karkihalli, Hampasagar, Nowli and Katharki.

Studies on the plankton of the reservoir indicated the highest richness at Katharki region followed by Karkihalli, Tambrahalli, Hampasagar, Vyasankere, Sovinahalli & Nowli. Zooplankton was found to uniformly predominant over phytoplankton in all the regions and the ratio of phytoplankton to zooplankton was 1:2.88. Except in Vyasankere and Hampasagar where phytoplankton was higher in density in surface water, zooplankton was dominant in surface waters at Nowli. While maximum concentration of phytoplankton was noticed at Karkihalli the minimum density was noticed at Hampasagar. Among phytoplankton, diatoms were predominant forming nearly 50% followed by blue green algae (31%) and green algae (18%). The order of abundance in general among zooplankton was copepoda (38%), rotifera (29.62%), protozoa (23.93%) and cladocera (8.45%).

As a part of population studies and also to study the extent of growth and migration of the Gangetic major carps, 1615 carp fingerlings were tagged and released into the reservoir. One of the tagged fishes recovered showed a growth of 97 mm in 53 days.

Food studies on some of the important species of fishes were continued. Gastropods, ostracoda, & bivalves formed the main food items of P.kolus while aquatic submerged weeds like Chara, Hydrilla & Vallisneria spp constituted major portions of the food of P.dobsonii. L.fimbriatus guts revealed a predominance of bacillariophyceae in its food. Fish remains were found in Osteobrama vigorsii, Notopterus notopterus, Mystus seenghala and Mystus aor.

(b) Vanivilassagar reservoir

Hydrobiological observations on the reservoir were continued. The water in the reservoir was fairly alkaline (194 to 288 ppm), with a high pH (8.4-8.6) while the dissolved oxygen content of water varied between 6.5 and 8.0 ppm. The reservoir was found to be unusually rich in plankton. Common forms like Microcystis, Clathrocystis, Cyclotella, Ceratium, Brachionus, Keratella, Difflugia, Nanplii and Cyclops were encountered in plankton samples.

The monthly landings of Catla catla, the only prominent fishery of the reservoir, ranged between 4300 and 4550 kg. Individuals having modal lengths varying from 611-625 mm were represented in the catches.

Experimental culture of a commercially important prawn Macrobrachium malcolmsonii in the Vanivilassagar reservoir was initiated and fry of the same brought from Kadiam fish farm of Andhra Pradesh have been transplanted into the reservoir.

Exploratory spawn catching operations were carried out in the river Vedabathi (Mysore State) near Kelloodu during the 1st week of June 1963. The eggs collected during exploratory netting, on rearing found to consist of 95% of Cirrhina reba and 5% of Catla catla. Similar operations were also carried out in Krishna river below its confluence with the Bhima river near Raichur. Except a few advance fry of Labeo fimbriatus eggs, fry and juveniles caught were mostly of Labeo bata, L. porcellus, Bagarius bagarius and Clupea sp, Barilius barna and Rohitee sp respectively.

4. Fisheries of brackishwater lakes(a) Chilka lake

The total landings of fish from the lake during the year 1963 were estimated at 3925 tonnes which when compared to the previous year showed a decline of about 5%.

Mulletts as a group contributed to 918.92 tonnes (23.42% of the total annual landings). Mugil cephalus provided the richest fishery (over 68% of the total mullet catches) and was represented in the commercial landings by I-III year age groups, with the I year group predominating. Liza troschelli, which contributed to over 10% of the total mullet landings, registered a substantial increase over last year's catches and this fishery was also dominated by the I year group, their share being 76.25%.

Among the perches, which contributed to 670.30 tonnes (17.08%) of the total landings, Lates calcarifer provided the most important fishery (66% of total perches caught). The sizes ranging from 375-550 mm formed more than half of the catches. Among the important perches may be mentioned Sparus sarba, Gerres setifer

Etroplus suratensis & Crenidens crenidens which contributed to 85.26, 17.75, 92.83 & 2.72 tonnes respectively.

Catfishes contributed to 572.80 tonnes (14.60%) of the total landings and were represented in the catches by Mystus gulio and Poltossus canius. While M.gulio constituted 9.78% of the total landings, P.canius contributed to only 1.52% of the total landings. The catches of the M.gulio were dominated by size groups ranging from 135-225 mm.

The clupeoids contributed to 427.86 tonnes (10.90%) of the total annual landings. Hilsa ilisha, which formed 5.13% (201.32 tonnes) of the total, was the most prominent. Nematolosa nasus contributed to 105.86 tonnes (2.70%) and was represented in the catches by individuals belonging to three (I-III) year groups.

Psuedosciaena coibor constituted the bulk of the sciaenid catches and contributed to 350.94 tonnes (8.94%) in the total landings. The size group upto 325 mm dominated the catches. There was no significant contribution of other sciaenids, which together accounted for only 0.84% of the total landings.

The thread-fins contributed to 189.94 tonnes (4.84%) of the total landings. The fishery was provided by Eleutheronema tetradactylum which was represented in the catches by three year groups (I-III), with the I year group dominating the catches.

Beloniformes was represented by Hemiramphus gaimardi & Tylosurus strongylurus and contributed to 36.23 tonnes (0.79%) of the total landings of the year.

BIOLOGICAL STUDIES

Three size groups, viz. 110-160 mm, 130-175 mm & 135-195 mm dominated the fishery of Triacanthus brevirostris, during the periods April to September, October to December and January to March respectively. The food comprised mostly of organic matter detritus, along with Modiola spp, prosobranchs, isopods, crustaceans algae and other vegetative matters. Gonads were in IV, V, VI, & VII stages of maturity during April to August.

Gut content studies of Thrissocles purava showed that mysids were the most important item of food followed by isopods, fish, prawns, insects, green algae, crab remains, amphipods and Potamogeton. Gonad studies indicated that gonads were in immature stages from September to February and reached the full maturity stage in June. The size frequency analysis of Etroplus suratensis gave an indication that the fish grow to 75 mm in 6 months time and to 165 mm in 1½ year. Weeds, gastropods, lamellibranchs and organic matter formed the food of this species. Gonadial studies showed two distinct peaks of breeding, one in July and the other in December.

Studies on fish eggs, larvae and juveniles

Larvae of Anchoviella sp were available in tow net collections from July to March in the Northern sector of the lake while eggs were available in Central sector, Southern sector and the Outer channel during the period January to March, October to December and January to March respectively. Abundance of larvae in the Northern sector was observed during the months July to September. Larvae of Hemiramphus gaimardi were available in all the sectors of the lake in the Outer channel in profuse numbers from July to March and those of Gobids were abundant in Southern sector of the lake during January to March. Larvae and post larvae of E.tetradactylum were present in the Northern sector during the months January to March. Eggs and larvae of Thrissoeles sp were available in all the sectors of the lake, except Southern sector. Juveniles of Panchax panchax, Gobids and Barbus ticto were abundant in the Northern and Central sectors. Juveniles of M.cephalus were noticed in the Southern sectors. In the outer channel, juveniles of Gerres setifer, Sillago sihama, Mystus gulio, mullets, Sparus sarba, Thrissoeles spp and Leiognathus spp occurred in large numbers.

Hydrobiological studies

Both minimum (21.5°C) and maximum (31.5°C) temperatures of the lake were registered in the same area, viz. the Outer channel in December and in June respectively. pH of the lake water varied from 7.6 to 8.9, free CO₂ from 0-4.48 ppm, alkalinity 50.00-128.6 D.O from 4.2-11.0 ppm, salinity from 0-309-29.843‰, phosphate from .033-.095 ppm, nitrates from .025-0.90 ppm, silica from 2.37-3.91 and iron from 0.0016 to 0.005 ppm.

The average plankton biomass for the lake was 11.76 cc/k. Important plankters encountered during the year were Copepods, nauplii, rotifers and gastropod larvae. Phytoplankters were represented mostly by blue green and green algae.

Detailed studies on the bottom biota of the lake was carried out and the average biomass of the entire lake was calculated at 13.582 gm/sqm. The maximum biomass (18.279 gm/sqm) was obtained in the Central sector and the minimum (11.02 gm/sqm) in the Northern sector. The most widely available bottom forms were Foraminifera, nematodes, polychaetes, Ostracoda, Copepods, Isopods, nauplii, lamellibranchs, algae and diatoms.

Of the dominant weed of the lake, Potamogeton pectinatus was found in all the sectors of the lake, and it exhibited maximum growth (1334 gm/sqm) in the Southern sector. Najas faveolata was abundant in the Central sector of the lake than in other sectors. Halophila ovata was observed in the Southern sector, while it was very poor in the Central sector and absent in the Northern sector. Gracillaria was mostly abundant in the Southern sector.

(b) Fulicat lake

(b) Pulicat lake

The Pulicat Lake Research Unit started functioning from the third week of January 1964. During the period under report a detailed inventory of fishermen population, craft and tackle was initiated. Samples of fishes, prawn and crabs from the lake were collected and 45 species have so far been identified. The channels of trade and disposal of catches at various centres were examined for working out a suitable sampling system for estimating the catches.

5. Exploratory fishing in Sunderbans

During the year under report, nine exploratory fishing cruises were made in the Sunderbans estuarine waters. The operations were mainly confined to Saptamukhi, Thakuran and Matlah rivers. The gear operated was mostly trawl net of cotton yarn. A nylon net of different specifications was also tried. Gill nets of cotton and Terylene yarn of 127 mm (5") & 153 mm (6") mesh sizes were also used. Hooks of sizes 4 to 6 with different baits and set in different positions were also tried. A total of 2345.3 kg of fish including prawns were landed by trawl nets and the average catch per haul was highest during January and February, viz. 20.5 & 27.6 kg respectively. The important groups that made up the landings were Cat-fishes (17.6%), Clupeoids (16.6%), Sciaenids (15.9%), Bombay duck (14.8%), Sharks & rays (10.9%) and Prawns (4%).

Gill nets were operated on 11 occasions of which seven were made in Saptamukhi - Muriganga zone and four in Thakuran - Matlah zone. Average catches per hour were 0.831 kg & 1.735 kg respectively in the two zones. Carcharias laticaudus accounted for more than 61% of the catches followed by Arius gogora, Polydactylus indicus, Pristis cuspidatus and Osteogenosus militaris.

Long lines, operated six times during the year landed on an average 0.436 kg of fish per hour of operation. Main species components were Arius sona, Dasyatis uarnak, Carcharias laticaudus, Muraenesox telabonoides, Osteogenosus militaris & Arius jella.

Biological studies on Coilia ramcarati indicated that the species inhabiting Sunderbans waters belonged to the same stock. Similar observations were also recorded with regard to Coilia dussumieri. While the former species appeared to have two spawning seasons one during the winter months from December to February and the other during monsoon in August, the latter showed year round spawning habit. Observations made on the breeding habits of Setipinna taty and S. phas showed that they breed during the months March to July in Sunderbans.

6. Hilsa fisheries

Hooghly estuary

The total landings of Hilsa ilisha from the Hooghly estuary during the year amounted to 1432.264 tonnes (22.3% of the annual total landings), as against 1506.728 tonnes (25% of the total landings) during the previous year, thereby registering a reduction in the catches by about 74 tonnes.

Two modes, one at 46.0 mm and the other at 152.0 mm were discernible amongst fish of the '0' year class. Other modes observed were at 237.5, 355.5, 421.5 & 472.0 mm, corresponding to year classes I to IV respectively.

Yolked and post larvae of Hilsa ilisha were available in the upper zone of the Hooghly during the period March to November. The unusually heavy winter breeding of 1962-63 continued upto June. During June, the larvae were abundant at Medgachi, but during subsequent months these were available in the whole stretch of the estuary between Konnagar & Medgachi. In the Rupnarayan, the larvae and juveniles were observed only during October - December.

In order to produce sufficient number of fry and fingerlings of Hilsa ilisha for the purpose of stocking in ponds, trial experiments were conducted in the river Hooghly near Nabadwip on the induced spawning of the fish by administering homoplastic pituitary hormone injections. Non-availability of male and female breeders simultaneously was a great handicap and consequently no fruitful result could be achieved. The experiments will be repeated in the ensuing Hilsa season.

Hilsa toli contributed to 18.378 tonnes or 0.3% in the landings from the Hooghly estuary. Individuals belonging to year classes '0' - V, having modal lengths at 108.5, 132.0, 170.0, 232.0, 320.0, 358.5 & 398.5 mm respectively, were represented in the official landings.

Mahanadi estuary

Total landings of Hilsa ilisha from the Mahanadi estuary amounted to 18.378 tonnes forming 2.4% of the total landings. The fish was mostly caught during January 1964 and the size-group in the landings were observed to range from 134.5 mm to 494.5 mm. Bulk of the catches was contributed by individuals ranging from 274.5 mm to 374.5 mm with mode at 314.5 mm.

Ganga river system

The total estimated landings at selected center of the river system comprising Jumna, Ganga and Padma amounted to 480.30 tonnes.

during the period under report. The maximum quantity (353.39 tonnes) of Hilsa was landed at a single centre on river Padma while six centres on river Ganga and one on Jumna produced 107.00 & 19.91 tonnes respectively. Bulk of the landings from all these rivers comprised of individuals belonging to the II (229-381 mm) & III (382-500 mm) size groups. Observations on the pattern of distribution of the fishery in the three rivers have showed that while the fishery in Ganga and Padma is supported by the monsoon runs with a low magnitude of winter fishery, the mainstay of the fishery in the Jumna is the winter run with a very negligible monsoon run. Similar studies in connection with Ganga river alone have shown that the winter fishery is the main fishery in the upper zone of the river extending from Daraganj to above Buxar, with maximum production at Varanasi; while in the lower zone, from Buxar to Bhagalpur, the bulk of the landings are made during the monsoon months with the maximum production at Ballia.

Investigations to locate the spawning grounds of Hilsa ilisha indicated the presence of one ground on river Ganga at Allahabad about 8 miles upstream from its confluence with river Jumna and another one in the Jumna, about 2 miles above the confluence.

Studies on seven morphometric characters of Hilsa stocks of the Ganga and Jumna indicated that the two stocks were significantly different. The D^2 was found to be 17.8083 yielding a variance ratio test criterion as 45.8094 and 7 and 84 degrees of freedom which was highly significant.

Six modal groups, viz. 65.5, 215.5, 315.5, 365.5, 415.5 & 465.5 mm arrived at by analysing the length frequency data were discernible in the commercial landings of the species.

Scales, otoliths and opercular bones of Hilsa ilisha were studied for the purpose of age determination. The observations made so far have shown the presence of markings on them.

Observations made on sex-ratio showed that during the major part of the year, the male Hilsa was dominant in the commercial catches. Only in the month of September, the sex-ratio was observed to be 1:1.

Feeding intensity of Hilsa ilisha was found to be high in the month of May in both the upper and lower zones of river Ganga. This condition continued till September in the upper zone while in other months, it varied from moderate to low. In the lower zone, in addition to the month of May, the feeding intensity was found to be high in the month of December and in other months it varied from moderate to poor. Studies on the food of the fish indicated that the fish has equal preference for phyto-and-zoo-plankton. The main items of food as revealed by the gut contents study are algae, diatoms, protozon, rotifera, Crustacea and young bivalves, besides organic debris and sand particles.

Godavari

14.3 tonnes of Hilsa were landed in the 208 km long freshwater section of River Godavari from below Dowleishwaram to Durgam Anicuts during the period April, 1963 to March, 1964. Of 13.1 tonnes come from Zone I and 0.7 and 0.54 from Zones II and III respectively. The former constituted 92.8% and the latter two 7.2% of the Godavari Hilsa landings. The length range of Hilsa in the landings of zones I and II was from 85 to 165 mm of the '0' year class during the period April-June, 1963 and January-April 1964. These were captured in Alivivala (Seine) nets. Specimens of the size-range 310-565 mm forming III-V age groups were mainly captured by gill nets of Rangoon type from July-October, 1963.

The Goutami and Vasishta estuaries of the Godavari contributed 8.6 and 6.6 tonnes of Hilsa catches forming 60% and 30% of estuarine Hilsa landings of Godavari. The landings were confined to the months December-April. In December and January, size-groups of the length range 408-520 mm were available and in April, the size range discernible was from 458-490 mm.

Narbada & Tapti

Observations relating to location of spawning grounds of Hilsa were continued in the monsoon of 1963 at Rundh and Narkhe. Over 2,500 Hilsa eggs were collected at these two centres. Back calculations based on age estimation of developing Hilsa eggs indicated that the eggs collected at the centres cited above had drifted down from spawning grounds located at a distance of about 32.0 - 38.4 km upstream possibly near Gora and Indravarna.

Chilka Lake

Hilsa ilisha contributed to 201.32 tonnes or 5.13% in the total annual landings of the lake. In April two modes (175 and 225 mm) were noticed in the commercial landings. The first mode progressed to 225 mm in September, 275 mm in December and 325 mm in March/April. The '0' year class having a modal length of 75 mm was observed in the catches in December.

7. Tank Fisheries

Collection of information on available tank resources in the States of Mysore and Andhra Pradesh were continued during the year. Out of a total of about 37,300 tanks, both major and minor, depending upon the extent of land irrigated, detailed information pertaining to their location, water-spread area, fish stocking, nature (Perennial or seasonal), etc. of 7593 tanks were collected from sources like P.W.D., Irrigation, Revenue and State Fisheries Departments. These tanks, however, do not include the larger reservoirs numbering 800 situated in the various districts of the State.

Tank survey in Andhra Pradesh revealed that there were approximately 1434 perennial tanks, with a water-spread area of 97,984 hectares and 17,327 seasonal tanks having a water-spread area of 1,90,345¹ hectares.

A detailed survey of tanks in three districts of Mysore, viz. Bijapur, Bekgaum & Gulbarga and in the Krishna district of Andhra Pradesh was initiated and data collected so far are furnished below:

Name of the State	Name of the district.	Total No. of tanks surveyed	Percentage of perennial ponds	Percentage of ponds with good plankton production	Percentage of stocked ponds.
Mysore	Bijapur	52	35%	50%	23%
	Belgaum	754	2.9%	34%	66%
	Gulbarga	213	12.6%	43%	-
Andhra Pradesh	Krishna	60	65%	-	-

Studies on the productive potential and hydro-biological conditions of two perennial tanks (Bellandur & Hessarghatta tanks) and four seasonal tanks, (Bellary Fort tank, Daroji tank, Koppal tank & Ginigera tank) all located in the State of Mysore was initiated.

Observations made, so far, with regard to the sewage-fed Bellandur tank, have indicated it to be a productive tank. The tank maintained high water qualities and a good plankton population throughout the year. Phytoplankton constituted nearly 80% of the population and are represented mainly by Microcystis, Anabaena, Clathrocystis, Scenedesmus, Spirulina, Pediastrum & Synedra. The Zoo-plankton consisted mainly of rotifers (Keratella, Brachionus and Triarthra), Cladocerans (Daphnia, Diaphanosoma & Ceriodaphnia) Copepods (Diaptomus & Cyclops) & Nauplii. The tank yielded a daily average of 30-40 kg of fish which declined to a considerable extent at the end of December. The fishery comprised of Catla catla, Cirrhina mrigala, Labeo rohita, Scale carp, Mirror carp, Barbus spp & Cat-fishes.

Rainfed Hessaraghatta tank, on the other hand showed characteristics of a most ordinary tank without much of fluctuations in its water qualities and with poor plankton production. Zoo-plankton dominated the plankton and was represented by rotifers (Keratella, Noteus & Polyarthra), cladocerans (Daphnia, Diaphanosoma & Chydorus), copepods (Cyclops & Diaptomus), Nauplii and protozoans (Arcella & Difflugia). Phytoplankton comprised about 15% of the population and represented by Synedra, Pediastrum, Spirogyra, Phromidium & Chlorella. A total of 5022 kg of fishes comprising Scale and Mirror carps,

Catla catla, Labeo rohita, Ophicephalus striatus & Etroplus spp. landed during the year.

Studies made on the hydrology of the four seasonal tanks showed that Ginigra tank was having the most satisfactory water quality followed by Daroji, Kopoal & Bellary tanks. Plankton population in all these ponds was fairly good and both phyto- and Zoo-plankters were almost equally represented. The fish fauna of four tanks comprised of Major carps, Common carps. (Bellary for tank only), Barbus sp, Chela sp, Rasbora sp, Mystus cavasius, Puntius sarana & Ompok bimaculatus.

8. Water pollution

Studies to ascertain the nature, quantity, etc. of industrial effluents discharged into the Hooghly, their effect on fish and other biota and to evolve suitable methods of treatment to eliminate or minimise the toxic effects of pollutants were continued during the year. Considerable data were collected in connection with pollution load contribution in respect of C.O.D. alkalinity and solids and these are being processed to ascertain the pollution picture of the river. Further studies on the treatment of pulp (Sulphate) mill effluents by electricity were carried out and it was observed that the D.O. values of the effluents after treatment by electricity could be raised to about 2.5 - 3.8 mg/litre by adding forced aeration, using porcelain diffuser. Further studies in this respect are in progress. The coagulant ferric chloride gave very satisfactory results when tried on a mixed waste from a hydrogenated vegetable oil (including soapunit) factory in doses vary from 0.2% - 0.5%. C.O.D. suspended solids, turbidity and colour removed to a considerable extent by this method.

Experiments to study the effects of various industrial effluents on the acclimatised carp fry used as test animals were initiated. Results obtained so far showed that these animals could tolerate additions of paper pulp effluents upto 40% and textile and vegetable wastes upto 5%, but distillery wastes were found to be highly toxic to the fry within the range of 1.5% - 4.5%.

Investigations of the pollutional effect of the effluent of paper mills at Rajahmundry, Andhra Pradesh were initiated. Observations so far made indicated that the maximum tolerance limit for carps was 65%. The pollutant generated a very rich crop of plankton in aquaria after standing for 3 days. It was also observed that the anoxic zone extended for 2.4 km when the dissolved oxygen was reduced to 21 ppm at bottom to 4.2 ppm at surface. The productivity of water immediately below the anoxic zone was $2\frac{1}{2}$ times to the productivity elsewhere.

9. Cold Water fisheries

The Cold Water Fisheries Research Unit was established at Kangra in the Punjab during the middle of November 1963. A preliminary survey of the Punjab regarding its trout and Mahseer resources was initiated and that part of it pertaining to Mahseer fisheries in the rivers Beas, Chakki and Ravi and their tributaries Baner, Guj, Baharal, Dehri, Bathu, Jabbar and Jogal in the Kangra Valley and its adjacent districts in the Punjab was completed. In the course of the survey a few seed collection centres for Mahseer were located in the tributaries Baner, Jogal, Bathu and Jabbar. So far only one species of Mahseer, Barbus (Tor) putitora, was recorded from the above rivers. Other fishes recorded during the survey were Barillus spp., Crossocheilus sp., Nemachilus sp., Labeo dyocheilus, Barbus spp., Cirrhina mrigala, Rita rita, Wallago attu, Oreinus sp., Ophicephalus spp., Chela spp., Xenentodon cancila, Danio sp., Botia sp., and Eutropiichthys vacha.

Work on the stripping and hatching of trout ova was initiated in some State Fisheries hatcheries, near Katrain in Kulu Valley. The improved technique of hatching adopted resulted in doubling the survival rate in those hatcheries. Experiments on the artificial feeding of trout were also initiated and a food prepared out of a mixture of minced meat and barley powder gave encouraging results.

Work on the commercial production of common carp seed was initiated and the first breeding took place during the last week of March 1963. The rate of fertilisation ranged from 60% to 80% and the percentage of hatching varied from 70-78.

10. Prawn Fisheries

Hooghly estuary

The total landings of prawns from the Hooghly estuary during the period under report amounted to 926.975 tonnes, accounting for 14.5% of the total landings from the estuary, as against 797.577 tonnes (15.5% of the total landings) during the previous year. Eleven species of prawns, listed below in the order of their abundance, contributed to the commercial catches of the estuary: Metapenaeus brevicornis, Leander styliferus, Parapenaeopsis sculptillia, Palaemon malcolmsonii, Palaemon villosimanus, Penaeus indicus, Metapenaeus monoceros, Palaemon rudis & Penaeus carinatus.

M. brevicornis was represented in the fishery of the middle and lower zones of the Hooghly, Rupnarayan and Matlah estuaries. Two year groups of males and females (0 and I) were observed to constitute the fishery. The '0' year group was dominant in the fishery from March to September, while 0 and I year groups were abundant during the period from November to February. Presence of mature individuals (over 90 mm) in the tidal zone during February and March indicates the period as being the breeding season of the species. L. styliferus

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was represented in the commercial catches by three year groups (0 to II), of which the I year group of both males and females dominated the fishery. Berried females were observed in zone III from September to February. P. sculptilis occurred in the middle and lower zones of the Hooghly, Rupnarayan and Matlah estuaries and was represented in the commercial catches by two year groups (0 & I) of males and three year groups (0 & II) of females, during the period from March to December. '0' year group of both males and females contributed to the bulk of the landings. P. mirabilis occurred in all the zones of the Hooghly and Rupnarayan estuaries, represented by '0' year group of males and '0' & 'I' year groups of females. Presence of berried females over 40 mm throughout the year in the middle and lower zones of the Hooghly indicated prolonged year-round breeding. P. carinatus was encountered in the upper and middle zones of the Hooghly estuary from April to November dominated by the II year group of males and the I and II year groups of females. Mature individuals and those in early stages of berried condition were noticed during March - April and the spawning occurred during May - July. Peak period of the fishery was from May - November. P. malcolmsonii was available in the upper and middle zones of the Hooghly and the Rupnarayan estuaries. Males having modal lengths of 44, 60 and 74 mm and females with modal lengths of 29, 56, 77 & 98 mm were represented in the commercial catches. P. villosimanus was encountered in the upper and middle zones of the Hooghly and Rupnarayan estuaries. Males and females were represented in the commercial catches by three (modal lengths at 44, 60 and 74 mm) and four year groups (modal lengths at 29, 56, 77, and 98 mm) respectively. Females over 85 mm were in advanced stages of maturity or in berried condition and occurred in zones I & II of the Hooghly estuary from May to July indicating the period as being the breeding season. M. monoceros and P. rudis were available mostly in the upper and middle zones of the Hooghly, Rupnarayan and Matlah estuaries. Presence of young ones of P. rudis in zone I suggested upward migration of the larvae. P. carinatus was fished in the Rupnarayan estuary during the winter months and was represented by two dominant groups having modal lengths at 90 and 116 mm.

Induced breeding of prawns

Successful experiments were conducted in the laboratory on the induced breeding of the giant fresh water prawn Palaemon carinatus. The breeding experiments indicated that this prawn could be induced to breed in water ranging from fresh tap water to 7% saline water with the temperature varying from 24.3° - 29.5°C, pH from 8.3-8.4 and dissolved oxygen from 3.76 - 5.89 ppm.

Mahanadi estuary

During the period under report, 55.014 tonnes of prawns were landed, constituting 9.8% of the total annual landings from the estuary. The fishery showed a decline when compared to the previous year, when the prawns contributed to 17.0% of the total landings.

Observations made on the landings indicated that the months September to November constituted the peak period for prawn fishery.

Chilka lake

Prawns ranked third in order of abundance and contributed to 663.19 tonnes (16.90%) in the total annual landings from the lake. Penaeus indicus was the dominant species contributing to 8.61% in the total annual yield and to half of the prawn catches. Individuals ranging from 80-120 mm in length formed nearly 93% of the fishery. Other species represented in the commercial fishery in the order of their abundance were Penaeus carinatus (4.99%), Metapenaeus monoceros (1.89%) and Metapenaeus dobsoni (1.20%).

Godavari river

From a 208 km freshwater stretch of river Godavari extending from 8 km below Dowleishwaram Anicut to Dummugudem Anicut, 101.054 tonnes of prawns were landed which constituted 32.03% of the total commercial catches of the area. Only one species, Macrobrachium malcolmsonii formed the entire prawn fishery. The crustacean fishery of the estuarine section of the river amounted to 1585.832 tonnes constituting over 40% of the total annual yield of the estuary.

Large number of juvenile prawns (15-25 mm) were successfully transported to Tungabhadra Dam under Oxygen packing and the mortality during transport was very negligible.

IV. Ancillary projects

1. Investigations on Fish Pathology

Detailed investigations were made on the diseases prevalent in three trout hatcheries of the Government of Jammu and Kashmir, located at Harwan, Laribal and Achabal in order to study the relationship between environmental factors and different trout diseases. The most common disease observed was fungus infection caused by Saprolegnia parasitica. Other forms of diseases noticed were sac-disease of alevins, similar to blue-sac disease, "White sopt" disease of advanced fry and fingerlings, "Whirling disease" of adult brown trouts and "Dropsy" in adult Rainbow trouts. Some control measures against these diseases have already been suggested. Detailed study on the fungus S. parasitica and on the sac-disease, were initiated. In the case of the former, it was observed that the fungus which appeared as tufts of greyish white threads or mycelia, had penetrated deep under the skin of the fish. In the latter case, the serous fluid of the infected fish did not show any colouration, but white and opaque spots were - visible on the yolk.

Acanthogyrus acanthogyrus was found to be the cause of a common infection in major carp culture fisheries in several parts of West Bengal. Generally, fishes below 250 mm in length were not attacked by this parasite. From one Catla, measuring 650 mm in length, as many as 188 parasites were recorded. Its rates of infection in Catla catla, Labeo rohita and Cirrhina mrigala were recorded as 95.3%, 76.74% and 7% respectively on the basis of results obtained from an examination of 120 fishes. The parasite was recorded for the first time in C. mrigala. Studies on the incidence of Pallisentis nagpurensis in Ophicephalus striatus and O. punctatus were initiated and the rates of infections were found to be 60% and 20% respectively in the two fishes during the period under report. Studies on the parasites of Hilsa were continued and 30 specimens were examined. Pellodistomes and cestode larvae were present in all the fish studied. Lecithaster spp. were recorded from Hilsa obtained from the freshwater zone of the river Hooghly.

A series of experiments conducted to determine the lethal dose of Potassium permanganate, Potassium dichromate, Methylene blue and Acriflavine, using fry and fingerlings of major carp as test animals, have indicated that at 30°C, the lethal doses of chemicals stated above are 1:20,000, 1:10,000, 1:80,000 & 1:40,000 respectively.

Investigations on fish mortality in 12 tanks during the period under report showed that the causes of death were due to unusual abundance of phytoplankton (Oscillatoria, Anabaena, Microcystis and Euglena), deficiency of dissolved oxygen, concentration of lethal gases, and infection by Ichthyophthirius, Gyrodactylus, Argulus, Myxosporidian parasites and attack of Dropsy. Suitable control measures adopted in the tanks gave satisfactory results.

2. Research training scheme

Under the Research training scheme of the Union Ministry of Education, necessary facilities and guidance were afforded to five Research Scholars working at this Institute. Two of the Scholars completed their assignments during the year, while the other three maintained very satisfactory progress. Salient features of the investigations carried out are stated below.

(1) Investigation on the seasonal variations of plankton, correlated with seasonal fluctuations of physico-chemical variables in the environment, diurnal variation of plankton, bottom fauna and their seasonal abundance, interrelationship between various factors and their bearing on fish production (work completed).

Observations made for a period of two years in a typical fresh water fish pond showed that water level had a close relationship with the amount of rainfall, factors such as silt and plankton abundance were found to cause temporary variation in turbidity. Dissolved oxygen content did not show any definite seasonal trend. The total alkalinity values were correlated with the monsoons.

of the physico-chemical factors showed clear pattern of variations during the day. Rotifers were found to exhibit different types of variations. Number of Crustacea were more during the nocturnal hours as also the total volume of plankton. Two different zones with variations in species composition were observed in the case of bottom fauna. Most of the organisms occurred in maximum densities during January to April. Variations in standing crop of bottom fauna were found to be affected by densities of a single species of bivalve Lamellidens corniamus.

(2) Morphological, histological and histochemical studies of the pituitary gland and cytological study of the ovary of Cirrhina mrigala (Ham) in different maturity stages and to correlate the changes in the ovary. (Work completed).

The morphological observations revealed that the pituitary gland of G. mrigala (Ham) is spherical in shape in smaller individuals, becoming approximately pear-shaped in adults. Histological observations revealed remarkable change that take place mainly in the meso-adenohypophysis of the pituitary gland during different maturity stages and in the early maturity stages, the pituitary is characterised by a relatively small meso-adenohypophysis with a predominance of acidophil cells; but by the time the gonad enters the final stages of sexual maturity, the meso-adenohypophysis increases much in size and the basophils outnumber the acidophils. Cytological study on the different maturity stages revealed six distinct stages till the ova attain the ultimate size prior to being shed. Results of histo-chemical test showed that glyco-proteins were present in the basophil cells of meso-adenohypophysis.

(3) Investigations on the seasonal abundance, life histories and biology of aquatic insects and their bearing on fish culture.

Observations so far made on the life history and biology of Anisops waltirensis showed that a period of 29.09 (average) days is required to attain the imago stage from the egg. Life histories of Ranatra filiformis, Ranalia sp. and Plea sp., were completed. Observations on the feeding habits of Laccotrephes sp. and Ranatra sp. indicated that both the species feed on mosquito larvae, chironomid larvae, notonectids, corixids and may fly nymphs. Study on the biology of Anisops bowvieri has been completed. Similar studies on other species of aquatic insects are in progress.

(4) Studies on quantitative and qualitative estimation of plankton found in the Ganga river system in the vicinity of Allahabad and other limnological studies.

Investigations on fluctuations of plankton so far made indicated that plankton population was at its minimum during the months of July to September. A progressive decline in the plankton population, was observed in both the Ganga and Jumna during the

above mentioned period, reaching a minima during September. Ninety species of Copepods collected from the plankton samples of the above rivers were indentified during the year. Further investigations are in progress.

3. Documentation

The Documentation Unit continued to compile and publish "Quarterly Bibliography of Current Indian References on Fisheries and Allied Subjects" and ~~altogether~~ from numbers (June, September and December 1963 and March 1964) were brought out during the year. Besides, the Unit processed, edited and brought out departmental 3 Bulletins and 2 Miscellaneous Contributions. Work on the subject wise indexing of publications received in the library was continued. Taxonomic indexing of publications has also been initiated. Editing and preparation of various scientific reports of the Institute continued. Substantial and valuable additions were made to the Institute's library by acquiring publications from various research Institutes, scientific bodies, Universities, etc. both in India and abroad either gratis or on exchange basis. Bibliographic details of all research papers contributed from the Institute during the year were periodically furnished to the F.A.O. for incorporation in "Current Bibliography for Aquatic Sciences and Fisheries".


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