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GOVERNMENT OF INDIA

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

BARRACKPORE, WEST BENGAL

INDIA

Annual Report 1965-66

Government of India
Central Inland Fisheries Research Institute
Barrackpore, West Bengal,
INDIA.

C O N T E N T S

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I. G E N E R A L

Satisfactory progress was maintained throughout the year in the field of various research projects undertaken by the Institute. A 284.54 acre piece of land at Panna, Madhya Pradesh, was taken possession of by the Institute for the establishment of the Central Experimental Fish Farm and Sub-Training Centre. The trout and mahseer streams of Himachal Pradesh were surveyed and a consignment of 2,000 fry (37-50 mm) of Tor putitora was transported without mortality for introduction in Bhutan waters.

The following appointments were made during the year:

1) Shri H.P.C. Shetty - Sr. Research Officer
2) " S.D. Tripathi - Research Officer (Jr.)
3) Dr. S.C. Singh - Asstt. Research Officer
4) Shri S. Patnaik - - do -

Sarvashri H.P.C. Shetty, Research Officer (Junior) and S.D. Tripathi, Fisheries Training Superintendent were relieved of their duties to enable them to take up the appointments of Senior Research Officer and Research Officer (Junior) respectively at this Research Institute.

Dr. G.N. Mukherji and Dr. R. George Micheal, Pool Officers of the Council of Scientific and Industrial Research, worked at the Allahabad Sub-Station and Pulicat Unit of this Research Institute respectively.

TRAINING

The 18th session of the Inland Fisheries Training Course commenced on the 1st of June, 1965. A total of 44 candidates consisting of 26 deputees from the States - 1 each from Delhi, Tripura and Himachal Pradesh, 2 each from Madhya Pradesh, Orissa, Rajasthan, Gujarat and Mysore, 3 from Punjab, 4 from Uttar Pradesh and 6 from Bihar; 6 Stipendiaries - 1 each from Nagaland and West Bengal and 4 from Assam, 3 Colombo Plan Scholars-1 from Malaysia and 2 from the Philippines and 9 private candiates - 1 each from Madhya Pradesh, Bihar and Andhra Pradesh; 2 each from Kerala, West Bengal and Madras are undergoing training at this Institute.

Four officers of the Rajasthan Fisheries Department were given a two-week training in induced breeding and weed control methods and a Research Assistant from Tripura was given thorough training in soil and water analysis methodology for a period of one month. An Assistant Director of Fisheries of the Andhra State Fisheries Department was imparted a short training in all aspects of lacustrine fishery. Seminars on various aspects of fish culture practices were arranged for the trainees of the Central Institute of Fisheries Education, Bombay.

MEETINGS

The Director visited New Delhi and Mandapam Camp to attend the Promotion Committee and the Fisheries Research Committee meetings. He also attended the Fourth Five Year Plan Working Group Meeting at New Delhi and the meeting of the Fish Committee of Tungabhadra Board held at Bangalore to discuss pituitary hormone work with Dr.Moudgal of the Indian Institute of Science, Bangalore. He visited Bombay to attend the meeting of the Central Board of Fisheries. Drs. V.G. Jhingran, H. Chaudhuri and A. David, Senior Research Officers, attended the Fisheries Research Committee Meeting at Mandapam Camp as observers.

MISCELLANEOUS

The Director visited Bombay, Hyderabad, Madras and Cochin in connection with the work of the Fish Seed Committee. He visited Tungabhadra Dam to inspect the Lacustrine Sub-Station of this Research Institute located at Tungabhadra Dam. Dr. H. Chaudhuri visited Tripura and Assam on behalf of the Fish Seed Committee.

VISITORS

Mr. H. Lyche of Biological Station, Espegred, Bloomsterdelene, Norway, attached to the Central Institute of Fisheries Education, Bombay, Mrs. Lyche of Zoological Museum, University of Bergen, Norway, Mr. K.H. Alikunhi, Director, Central Institute of Fisheries Education, Bombay, Mr. Narayanrao C. Koli, Member, Central Board of Fisheries, Government of India and Managing Director, Maharashtra Rajya Machhimar Sahakari Sangh, Bombay, Dr. S.M. Ling of the F.A.O. Regional Office, Bangkok, Dr. K.H. Bain, F.A.O. Sub-Regional Office, New Delhi, Mr. P.K. Bhattacharyya, National Chemical Laboratory, Poona, Chin Phuikong, F.A.O., Fellow from Malaysia and Jinda Thiemmeda

of the College of Fisheries, Bangkok, Thailand, Mr. S.C. Dey, Zoology Department, Gauhati University, Assam, Dr. S.B. Setna, New India Fisheries, Bombay, Shri Joginder Singh, Under Secretary to the Government of India, Ministry of Food & Agriculture, New Delhi, Dr. M. Banhawy of Ain Shams University, Cairo, U.A.R., Dr. A.C. Majumdar and Mr. I.N. Sengupta, Indian Institute of Experimental Medicine, Calcutta, Dr. Tadashi Yamamoto, F.A.O. Regional Office, Bangkok and the members of Mekong Committee, Bangkok, visited this Institute during the year under report.

II. INVESTIGATIONS ON CULTURE FISHERIES

1. Pond culture techniques

Laboratory experiments, using a wide variety of items such as the pulses, grams, oil-cakes, brans, fish by-products and secondary pond products (shrimps and notonectids), were conducted to evolve a more satisfactory artificial feed for carp fry than the conventional mixture of mustard-oil cake and rice-bran. A mixture of powdered notonectids, prawns and cow-peas in the ratio of 5:3:2 was found to give the best results showing an increase of 10% in survival rate and 6 mm in growth over that of mustard-oil cake and rice-bran.

To determine the optimum rate of stocking, field experiments in six ponds, each having an area of 0.08 ha, were carried out with a view to raising a crop of fingerlings, 130-150 mm in size, in 2-3 months' time. The ponds were manured with organic and inorganic fertilizers and the fry fed regularly on a mixture of mustard-oil cake and rice-bran. Three rates of stocking i.e., 62,500, 93,750 and 125,000/ha were tried (with 2 replicates for each), the stocking ratio for catla, rohu, mrigal and Cyprinus carpio being 3:4:1:2. At the end of three months' rearing, desired growth was exhibited only by rohu and mrigal and to some extent by catla. Cyprinus carpio not only did not show a good growth but recorded a low survival too. A general tendency towards a fall in growth with increased stocking density was noticed but the difference being not significant, possibility of increasing the stocking rate further with good results is indicated. The net production for the three stocking rates being 2,024, 2,403 and 3,079 kg/ha respectively appeared to be satisfactory for a three-month rearing period.

Experiments on mixed farming of indigenous and exotic fishes in manured ponds gave (i) a gross production of 2,112 kg/ha when stocked with 95 kg of fingerlings. Major carps, silver carp, grass carp,

common carp and gourami attained a weight of 632-750, 975, 450, 333 & 233 gm respectively in one year; and, (ii) in a duplicate pond, a gross production of 1300 kg/ha was obtained in five months. In similar experiments in two other ponds where, besides manuring, feeding was also done and Etroplus added to the combination, the fishes attained a marketable size in five months and a remarkable production of 1807-2070 kg/ha was estimated.

Experiments aimed at enhancing growth and production of fish in Assam waters by lime treatment, fertilization and artificial feeding were concluded at Jaysagar after an year's study and the data are being processed. A study of the hydrology of twenty ancient temple tanks, 0.4 to 32 ha in area, in Sibsagar district (Assam), has indicated that the level of essential nutrient salts present in the waters in sufficiently high and that these can be profitably used for fish culture, if suitably limed, to raise the pH and the total alkalinity levels.

Studies on the effectiveness of various plant parts as fish poisons were continued. Powdered bark of Albizzia procera and fruits of Entada pursaetha, Diospyros montana and Pongamia pinnata proved effective but only at high concentrations. A field experiment confirmed the usefulness of powdered bark of Barringtonia acutangula at 20 ppm in clearing unwanted fishes. Jar experiments with bleaching powder indicated that chlorine at 8-10 ppm could kill Tilapia within 2-3 hours. Bleaching powder (calcium hypochlorite) was tried with partial success for benumbing and killing 'weed' fishes. In a small circular pond, about 2' deep, 80% of E.danricus and R.daniconius were killed within half an hour on an application of 1.9 gm of bleaching powder per gallon. In another pond, 1.1 gm/gallon did not give satisfactory results in that the fishes were partially affected but recovered later.

Studies on the seasonal succession and vertical distribution of periphyton organisms were continued and a clear picture of changes taking place during different seasons obtained. Common and constant forms encountered were some filamentous green algae, diatoms, blue-greens, ciliates, suctoria, heliozoa and rotifera, but the unicellular alga Characium became very dominant during winter and Chlamydomonas during January. Generally speaking, the algae occurred in larger numbers in the surface layers whereas the animalcules occurred abundantly in all the layers without distinct stratification except in July when there was a steady increase towards the bottom. Water conditions at different levels were also studied simultaneously. Identification of algal flora commonly found in fish ponds of Jaysagar (Assam) and surrounding areas was done.

Studies on the biology, life history and bionomics of Ompok bimaculatus, O.pabda and Labeo gonius and on the cultural possibilities of O.bimaculatus and L.gonius were carried out. Heavy mortality of O.bimaculatus at the fry rearing stage was observed. Studies on the feeding habits at various stages of growth of O.bimaculatus and O.pabda indicated a planktonic feed at the early fry stage to insectivorous and piscivorous diets at later stages while in L.gonius, a change from planktonic to column-bottom habit was marked. The fecundity of O.bimaculatus was found to range from 3,174 to 23,423 and that of L.gonius from 9,892 to 230,000. Detailed systematic studies supported by life-history studies showed O.bimaculatus and O.pabda to be two distinct species.

2. Induced breeding of fishes

Further experiments on standardization of dosages and improvement of induced breeding and hatching techniques conducted during 1965-'66 indicated that (i) administration of a preparatory low dose to the female breeder followed by a higher effective dose after an interval of six hours is more effective than single higher knock-out dose. A knock-out dose, however, has been found useful during the peak spawning period when the breeders are in ideal condition and the weather is favourable; (ii) during the peak period the fishes could be bred successfully by reducing the interval between the two injections from six to three hours and giving a slightly higher initial dose; and (iii) that 75,000 to 100,000 eggs can be released in each inner hatching hapa, 1.75 m X 0.75 m X 0.45 m (of outer hapa: 1.8 m X 0.9 m X 0.9 m) in size, depending upon the percentage of fertilization (70-90%).

Incidantal to various experiments carried out during the fish breeding season at Killa Fish Farm, Cuttack (Orissa), a total of 69.39 lakhs of major carp spawn comprising catla (2.63 lakhs), rohu (58.27 lakhs) and mrigal (8.49 lakhs) were produced. About 33 lakhs of spawn were obtained by inducing breeding in catla, rohu, mrigal, calbasu and gonius at Jaysagar (Assam).

With a view to simplifying the technique of induced breeding for commercial production of fish seed, experiments were carried out to study the effect of preserved extract of pituitary glands on the spawning of fishes, since in the present procedure the extract ones prepared has to be used up immediately. The results were higher encouraging, as extracts prepared in distilled water and kept in glycerine were found effective even after two months' preservation. Preserved extracts which were earlier stored in air-tight bottles were later on replaced by sealed ampoules. Since preserved extracts gave sediments when stored, the extracts were first allowed to settle down for 3-4 days after centrifuging and the supernatant fluid alone was then sealed in ampoules.

Five batches of extracts were prepared during the season and 34 sets of major carps (rohu and mrigal) were injected after different periods of preservation (9 to 61 days). All the batches, excepting one, gave cent per cent successful results. Extracts stored both at room temperature and also under refrigeration were found to be effective. These experiments have demonstrated that the extracts could conveniently be prepared well in advance and used when needed thus saving the trouble of preparing them every time before the injections.

Studies on the effect of fish pituitary hormone, extracted by Trichloracetic acid (T.C.A.), in inducing spawning showed that when glands of known weight were immersed for six hours in 1.5% T.C.A. and the fluid injected to major carps, successful spawning occurred in 11 out of the 12 sets tried. The minimum effective dose was found to be 14 mg/kg body weight of the female breeder. With a view to find out whether any gonadotropins were left behind in the glands after extraction, the immersed glands were homogenised in distilled water and the extract injected to fishes but with no result. The failure might be attributed either to the complete extraction of hormones by the TCA or to the quantity of the hormone, left behind after extraction, being insufficient to precipitate spawning.

In another set of experiments, when pituitary glands were immersed for 12 hours in 1.5% TCA, the minimum effective dose was observed to be 18 mg/kg. Negative results were obtained when glands were immersed for 6 hours in 2.5% TCA but successful results were obtained when the duration of immersion was reduced to 3 hours. TCA (1.5%) extracts of mrigal glands kept under refrigeration for 10 days gave positive results. To study the effectiveness of TCA extracts after an year's storage, 10 cc of the extract (400 mg of glands) filled in 10 ampoules have been kept under refrigeration.

Experiments with sheep pituitary hormones (12-20 mg/kg), TCA extract (1.5% for 6 hours) of the pituitary and the immersed gland, confirmed the previous findings that mammalian pituitary glands are relatively ineffective when injected to fishes.

An experiment to determine the effectiveness of preserved milt, collected from injected rohu and preserved in Ringer's solution containing 1% and 2% glycerine, centrifuged and kept at room temperature (28°C) for 4 hours, gave successful results when eggs stripped out of injected females were fertilized separately by the milt from the top and bottom layers, indicating their viability. The fry produced are being reared separately to find out whether there will be any difference in the percentage of male and female sexes in the progeny produced by fertilization with milt taken from the top and bottom layers.

Experiments to estimate the rate of consumption of oxygen by developing eggs of carps showed that a developing rohu egg, on an average, consumed 0.006111 mg of oxygen in 12 hours (from 1 hour after fertilization till hatching) while mrigal egg consumed 0.00829 mg of oxygen during the same period (from hatching to fertilization). It was further observed that oxygen consumption per rohu egg at 4 hours after fertilization was 0.0004 mg/min and the rate of consumption gradually increased as development proceeded upto 14 hours when it was the maximum (0.00153 mg/min). An interesting observation, however, was that there was a decrease in the rate of oxygen consumption (0.00087 mg/min) just prior to hatching (i.e. 16 hours after fertilization).

Further haematological studies on rohu in relation to different maturity stages have indicated that the RBC counts (average values) in females gradually increased from 1.07-2.42 millions/cu mm with the progress of gonadial development from I to V stage of maturity. The same trend was seen in WBC count also which increased from 964-10,680/cu mm. Among males, though the RBC counts had increased from 1.52-2.16 millions/cu mm from I to oozing stage, there was a sudden fall in the III stage. The trend in WBC counts in males and haemoglobin level in both the sexes did not show any definite correlation and no conclusion could be drawn.

Studies on the effect of x-irradiation on the developing eggs and progeny of Cyprinus carpio showed that though a great majority of the eggs (doses given - 2,500 r; 5,000 r; 7,500 r and 10,000 r) hatched out normally, some fry were deformed and lacked the caudal fin. When mature, after an year, they were bred to study the effect of x-irradiation, if any, on the progeny. These are being reared in nursery ponds for further study.

Studies on storage of milt at low temperatures gave the best results with Ringer's solution containing 1% glycerine when a drop of milt was put in 1 cc of the solution.

3. Exotic fish culture

Natural spawning in a set of injected silver carp was achieved for the first time with a single knock-out dose of 15 mg/kg to the female and 2,4 and 6 mg/kg to the males but it could not be achieved, during this year, in injected grass carp as the breeders were not in a good condition. Altogether 50 sets of silver carp and 35 sets of grass carp were tried, of which 18 sets of the former and 7 sets of the latter gave successful results. During the course of

these experiments, 2.82 lakhs of Silver carp fry and 1.81 lakhs of grass carp fry were produced.

Laboratory experiments conducted to study the tolerance of the fry and fingerlings (20-135 mm) of grass and silver carp showed them to withstand high values of temperature (40°C), pH (9.5), dissolved oxygen (38 ppm), chlorine (0.08 to 0.2 ppm) and sodium sulphide (5 ppm). In general, grass carp young ones could withstand greater range of physico-chemical variations than silver carp.

A number of field experiments to study the efficacy of juveniles and adults of grass carp in clearing various water weeds, compatability of catla and silver carp, mixed culture of silver, grass and scale carps, and intensive cultivation of Tilapia are in progress.

46 out of 50 sets of scale carp were bred successfully yielding 40 lakhs fry. 34.5 lakhs of these were supplied to the Orissa Fisheries Department. One pair of mirror carp was bred yielding 1.2 lakhs of healthy fry.

4. Brackishwater fish farming

Gut content studies of 200 fry (16-50 mm) of Mugil parsia from two ecological habitats viz. the estuaries (Hooghly and Mutlah) and the bheris (fed by the Muriganga, Mutlah and Bidyadhari rivers) indicated copepods (Diaptomus sp., Daphnia spp. and Cypris sp.) to be the major food items present throughout the year except in November and December when the species was not available in the fry stage. Diatoms (Pleurosigma, Gyrosigma, Coscinodiscus, Surirella and Navicula mainly) constituted 42.9% of gut contents between June to September in the estuarine samples. Blue green algae (Lyngbea sp., Oscillatoria spp., Microcystis sp., Nostoc sp., Merismopedia sp. and Phormidium sp.) and green algae (Closterium sp., Ankistrodesmus sp. and Staurastrum sp.) were also encountered. In some guts, sand particles constituted 48% of the feed.

Experiments on the transportation of mullet fry with and without anaesthesia were conducted after an initial conditioning of 24 hours. About 100 M.parsia fry (30-40 mm) could be transported in 6 litres of estuarine water to a distance of 50 km in 4 hours in a plastic bag placed in an 18 litre tin. Sodium amytal was found to help in increasing the number of fry per tin.

Studies on the growth of benthic algae indicated their maximum abundance during August to November associated with simultaneous

high fish production in bheris. Observations on the hydrological conditions of the bheris also suggested a definite correlation between the chemical nutrients, algal abundance and fish yield.

5. Weed control

Reinfestation due to the ingress of water hyacinth plants with inflow in a tank cleared during 1964-'65 was again treated with 4-6 kg/ha of 2,4-D with addition of a detergent and kerosene at an approximate total cost of Rs.70/- per hactare. Laboratory experiments have indicated that at least 1-2 mg of 2-4,D (80% sodium salt) is necessary to kill plants weighing below 100 gm and that the minimum lethal dose is directly correlated with the weight of the plant.

Field trials during summer with 2,4-D sodium salt (Taficide-80) at 4-6 kg/ha, mixed with a small dose of detergent ('Surf' at 0.25-1.0%), completely uprooted water liLy, Nymphaea stellata permitting easy manual clearance.

In a field trial, injection of 0.2% aqueous emulsion of Tafazine-80 (active ingredient Simazime) at a depth of 15 cm and at the rate of about 2 gm/sq metre, did not show any appreciable effect upon a mixed stand of young Cyperus and Eleocharis during an observation period of 2 months.

In another field trial, about 80% of Ceratophyllum demersum was reduced to a sludge at the pond bottom in about two weeks when treated with ammonia at about 11 ppm N. Left over scanty plants were then netted out and the speedy overgrowth of Spirodela, originally present, over the entire water surface helped in checking further reinfestation.

Complete kill was obtained with acidified mud-pelleted and crystalline copper sulphate in Hydrilla and Limnanthemum when applied to raise the copper-ion concentration to 6 ppm in glass jars in the laboratory.

Observations made on the presence of copper in natural waters with and without weeds indicated that the water and soil in ponds with weeds showed a range of from traces to 0.03 ppm of copper-ion and from 0.06 to 0.10 mg of soluble copper per 100 gm of soil respectively; in those without weeds the respective values ranged from 0.02 ppm to 0.1 ppm of copper ion and 0.66 to 0.14 mg per 100 gm of soil.

6. Soil chemistry and fish production

Detailed field experiments were carried out to determine the response of different types of pond soils to a mixed inorganic fertilizer, N-P-K (18-8-4), using it @ 90-40-20 ($N-P_2O_5-K_2O$)kg/ha in one instalment and in three divided doses. Moderately alkaline soil with very low available phosphorus showed the maximum response to the fertilizer, increased production being 472.0 and 368.2 kg/ha/annum for single and divided doses of fertilizer. In slightly alkaline soil with medium concentrations of available nitrogen, phosphorus, organic carbon and total nitrogen, the response was less marked, the increased production being 194.6 and 226.7 kg/ha/annum for the two treatments. Moderately acidic soil with low available nitrogen and phosphorus gave a poor response while moderately alkaline soil with low available nitrogen and organic carbon and very high total alkalinity of water gave practically no response.

Detailed soil sampling of the 284 acre site proposed for Experimental Fish Farm at Panna was done. Physically, the percentage of stone and gravel in the whole sample appeared to be very high. Mechanical analysis of the soil fraction showed that it contained about 50% of sand, coarse and fine clay and 50% of silt. Soil reaction was generally acidic (pH 6.0-6.5). Concentrations of nitrogen and phosphorus were extremely low, being less than 0.05% while organic carbon also showed a value less than 0.5%.

Studies to determine the efficiency of different types of nitrogenous fertilizers in the preparation of nursery ponds were made with three different types of nitrogenous fertilizers, viz. (i) urea, (ii) calcium ammonium nitrate and (iii) ammonium sulphate on equivalent nitrogen basis @ 70 kg N/ha alongwith a basal dose of superphosphate @ 40 kg P_2O_5/ha. Rohu spawn was reared in the pond for 15 days. Owing to heavy infestation of fairy shrimps, the survival, in general, was very poor. The results indicated that the average production of fry by weight per pond was 8.01 kg for urea, 6.08 kg for calcium-ammonium nitrate and 5.30 kg for ammonium sulphate as against 4.06 kg for control ponds. The survival figures were 29.8% for urea, 20.2% for ammonium sulphate, 8% for calcium-ammonium nitrate and 7.7% for untreated control ponds.

Ecological studies of fish ponds with special reference to bottom fauna indicated significant differences between the stocked and unstocked portions, the unstocked portion always showing a higher concentration. Available nitrogen and phosphorus in soil showed a slightly higher value in the unstocked portions.

7. Fish production and supply of fish seed

Incidental to experimental fish culture at the Killa Fish Farm (9 ha water area), 2173.5 kg of carps, 1165 kg of Tilapia and miscellaneous fishes were sold in addition to 30,600 carp fingerlings realising in total Rs.9,142.53 which was handed over as cash to the Orissa Fisheries Department. The department was also supplied with 572 kg of carps and Tilapia, 91.5 lakhs of carp spawn and 31,765 carp fry and fingerlings, the calculated cost of which comes to about Rs.11.029.00.

26.64 lakhs of spawn and 2000 fingerlings of Indian major carps were supplied to Andhra Fisheries Department. Chinese carps were supplied to various Departments as mentioned below:

State	Grass carp		Silver carp	
	Fry	Fingerlings	Fry	Fingerlings
Madhya Pradesh	600	-	300	-
Delhi	1000	-	500	-
West Bengal	2000	-	-	-
Andhra Pradesh	2000	-	-	-
Himachal Pradesh	200	-	-	-
Tripura	250	-	-	-

Private parties were supplied with 1,450 fry of grass carp and 250 fry and 2,150 fingerlings of Silver carp.

III. INVESTIGATIONS ON CAPTURE FISHERIES

1. Fisheries of freshwater rivers

(a) Ganga river system

Landings

Species-wise monthly estimates of fish landings at 5 centres on the Ganga (Kanpur, Varanasi, Buxar, Patna and Bhagalpore), 2 centres on the Jamuna (Agra and Sadiapur) and one centre on the Padma (Lalgola) were continued during the year 1965-'66. The estimated annual total landings at the above centres amounted to 775.85 tons as against 728.8 tonnes of 1964-'65. The break-up of the total landings is (a) Ganga - 422.34 tonnes, (b) Jamuna - 287.3 tonnes and (c) Padma - 66.21 tonnes as against 290.0 tonnes, 311.6 tonnes and 127.2 tonnes

respectively of the preceding year. The decline in the landings by 47.97% at Lalgola centre appeared to be due to the failure of the Hilsa fishery. The catches from the Ganga were dominated by cat fishes (20.72%) followed by Hilsa (20.40%) and Carps (18.13%). Other miscellaneous forms comprised the rest of the total. Carps were abundant in the landings from Jamuna comprising 46.98% of the total, the species C.mrigala contributing to nearly 50% in the total group followed by catfishes (23.37%) and Hilsa (13.99%). Hilsa contributed to over 94% of the total landings at the Lalgola centre.

Fishery biological investigations

Cirrhina mrigala

Studies on the age and size composition of the commercial catches landed at Sadiapur fish assembly centre, were continued and altogether 4,052 specimens of mrigal were examined during the year for this purpose. Analysis of the length frequency data indicated that the commercial fishery was represented by individuals mostly in their 2nd and 3rd year of life, accounting for as much as 30.20% and 57.56% respectively of the annual catch of the species. One year old specimens entering the commercial fishery formed only 2.32% of the total catches. The percentage composition of older specimens from 4 year class onwards showed a sharp decline, indicating thereby a heavy exploitation of the younger age groups.

Scales from 280 specimens of Mrigal were also examined for age and growth studies and on the basis of results obtained the sizes of Mrigal at various ages were found to be as under:

Year	Length in mm
I	268
II	458
III	644
IV	738
V	817
VI	867
VII	924
VIII	959

These results are well comparable to those obtained by using Peterson's method and by plotting the polymodal frequency distribution on an arithmetic probability paper and agree in general with the pattern of growth of mrigal in the Ganga at Buxar.

Catla catla

Hard parts of Catla, other than scales, were examined for ageing the fish. Though vertebrae, operculum, first ray of the pectoral fin and otoliths were tried, only vertbrae yielded promising results. Biometric measurements of individuals ranging in length from 217 - 685 mm were recorded and their gonads preserved for determination of stage of maturity and fecundity.

Labeo rohita

Specimens of rohu, ranging from 101 to 1020 mm in total length, were analysed for determination of age and growth. Analysis of the length frequency data of Rohu, collected from the commercial catches, indicated the participation of 18 size groups in the fishery with their modal lengths at 135, 200, 280, 335, 400, 445, 505, 545, 625, 675, 715, 765, 815, 845, 885, 915, 935 and 995 mm. Of these, fish with modal lengths of 135 and 200 mm were landed during September - February, while those with modal lengths of 335 mm and above were landed all round the year, being maximum during the monsoon. Scales, opercular bones and otoliths were examined for evaluating their use for ageing the fish. While the scales and opercular bones showed growth checks, the otoliths were not found to be useful for the study.

Gut contents in the case of individuals ranging in size from 76 - 200 mm consisted of 70 - 90% sand and 10.-20% plankton, the latter comprising mainly rotifers and diatoms. In the case of those ranging in size from 200 - 500 mm, the gut contents consisted of only 40 - 50% sand and the rest phytoplankton, comprising in the main, Spirogyra, Anabaena, Nostoc, Microcystis, etc. Examination of the rectal contents revealed that blue-green algae were not digested. Green algae appeared to constitute the most important food of the fish, ranging in length from 200 - 500 mm.

Labeo calbasu

Specimens examined for biological studies ranged in total length from 222 to 586 mm. A total of 2,453 specimens were measured in the market for length-frequency studies. Age and growth studies were attempted by length frequency method and by the examination of scales. The scales examined were from specimens measuring below 500 mm. Length frequency studies illustrated that the commercial fishery of L.calbasu was represented by eight year classes. The mean length calculated from length frequency studies were compared with the length calculated by probability paper method. The size at ages calculated

by the two methods fairly agreed. The back calculated lengths as determined from by different methods are given below :

Age group	Probability paper method	Petersen's method	Scale method
I	155	-	158
II	290	326.5	294
III	390	386.5	371
IV	460	476.5	456
V	545	516.5	-
VI	615	626.5	-
VII	680	716.5	-
VIII	740	806.5	-

The '0' and 'I' age-groups were not represented in the commercial catches landed at Sadiapur during 1965.

Volumetric analysis of gut contents revealed the following percentage composition :

Algae and Diatoms	-	43.7 (24.7 + 19.0)
Crustaceans	-	6.7
Decayed organic matter	-	44.0
Rotifers	-	1.0
Desmids	-	4.9

Thus the fish was found to subsist mainly on phytoplankton and decayed organic matter. These items were encountered in the gut consistently all through the year.

The gastrosomatic index was observed to touch the highest in March (7.1 for ♂ and 10.8 for ♀) and lowest in July (4.4 for ♂ and 4.7 ♀).

The specimens examined during this period were mostly in the maturity stages I to V.

Mystus (Osteobagrus) aor

Aor of total length ranging from 105 to 1075 mm were represented in the commercial landings. Fish with modal lengths at 175 and 265 mm were landed by the commercial gear during the month May to September. Larger fish with modal lengths at 895, 945 and 975 mm were landed during January to May and in December. Fish with modal lengths at 315, 385, 445, 515, 575, 665, 735 and 855 mm were landed during all the months, but the landings in the months March to May were of higher magnitude.

The possibilities of using hard parts like opercular bones, otoliths and cleithrum for the estimation of age and growth in Aor were examined in detail. Cleaning agents like glycerine, cedarwood oil, clove oil and kerosene oil were used. While otoliths and cleithrum did not give encouraging results, opercular bones cleaned in glycerine indicated the presence of markings, the authenticity of which as age indicator is being investigated.

Fishery biological investigations on the Bhagalpur population of the above species was also continued. No marked variation was, however, observed between the populations of Allahabad and Bhagalpur at different ages when the results were compared. It therefore appears that the populations of the above two places are homogeneous in nature, which is further substantiated by the comparative length-weight relationship of the populations at these two centres.

Mystus (Osteobagrus) seenghala

Length frequency analysis of 1991 specimens by Petersen's method indicated the presence of 10 age-groups in the commercial landings at Bhagalpur centre during the year under report. The modal values of individual year groups along with the increment of lengths between the succeeding years are presented below :

Age group	Modal values in mm	Annual increment in length in mm
0 year	170, 210	-
I	330	-
II	450	120
III	550	100
IV	670	120
V	770	100
VI	870	100
VII	930	60
VIII	990	60
IX	1050	60
X	1090	40

Wallago attu

Individuals of Attu ranging from 385 to 1275 mm, with modal lengths at 385, 485, 555, 645, 685, 755, 805, 865, 925, 995, 1036 and 1095 mm were represented in the landings by the commercial gear. Fish with modal lengths at 385 and 485 mm were landed during May to September and those with modal lengths at 925, 995, 1035 and 1095 during January to April. Fish of modal lengths 555 to 865 mm were landed all through the year, but in higher magnitude during January to May.

Opercular bones, otoliths and cleithrum were examined for the estimation of age. Otoliths and cleithrum did not show any marking, but opercular bones, cleaned in glycerine, indicated the presence of markings, the authenticity of which as age indicator is being examined.

Rita rita

Studies on the maturity and fecundity of R.rita in the river Jamuna have been completed by using ova-diameter measurements. It was observed that 50% of the specimens examined were mature at 295 mm. Whereas during October to April, immature and maturing fish were dominant, mature individuals dominated during May to August. 60% of the mature specimens examined occurred in July. In September, spent gonads were encountered. This indicates that the spawning season of Rita extends from May to August and the peak is probably during July. Month-wise gonadosomatic index was calculated independently for the years 1962 and 1963, and it was observed that these values were high during May to August in 1962 and during June to August in 1963. This adds further weight to the observation that the spawning season of R.rita is from May to August.

To examine the feeding intensity in Rita during different months, monthly gastro-somatic indices were calculated independently for the years 1962 and 1963. These indices point to the variability in feeding intensity. The lowest values were obtained during July and August, the peak breeding season.

Studies on primary organic production

Observations for assessing the comparative organic production in the Rivers Ganga and the Jamuna, initiated during December 1964 and carried out only in the Jamuna till March 1965, were extended to the Ganga also. To have a clear picture of the production, one centre each on the Ganga above the confluence and below the confluence was selected in addition to the one on Jamuna. The estimated primary organic production at the above centres showed that the organic production was at its peak in June in the Jamuna as well as in the Ganga above the confluence, but July marked the peak period in Ganga below the confluence.

To find out the correlation between the abundance of plankton and primary organic production, studies on plankton were also conducted at all the three centres. The phytoplankton peaks generally coincided with peak periods of primary organic production, except at the centre on the Ganga below the confluence.

(b) Kosi river

Landings of fish from the above river for the seven-month period January to May and November to December, 1965, were estimated to be 66.98 tonnes. The bulk of the landings was that of Wallago attu which formed 62.10% of the total catch. The major carps contributed to 5.99% of the total landings, out of which Catla catla dominated with 46.03% in the group total followed by Labeo rohita (30.35%), Cirrhina mrigala (22.14%) and Labeo calbasu (1.48%).

(c) Narmada river

Landings

Observations on fish landings at Hoshangabad were continued and the annual fish landings at this centre were estimated to be 33.78 tonnes as against 32.32 tonnes in 1964, showing thereby a slight improvement in the commercial catches.

During the year, carps accounted for 58.9%, catfishes 33.4% and other fishes 7.7% of the total catch.

Analysis of commercial landings

Carps contributed to 58.9% of the total catches. Tor tor which was the most dominant species in this group, made up about 28.0% in the annual landings and ranked first, with its quarterly contribution ranging from 20.0-33.0%. Age groups II-III (281-400 mm) and IV-V (401-508 mm) of this species contributed 33.6% and 40.1% by weight. This species made up 26.3% and 7.6% respectively in the cast net and long line catches. Labeo fimbriatus, the next dominant species, accounted for 17.0% in the total catches and ranked second (17.3 to 22.0%) in the quarters I, II & IV and third (9.3%) in quarter III. Age groups IV-V (310-411 mm) and VI-VII (412-520 mm) of this species were the most dominant and made up 43.1% and 36.5% by weight. It contributed 26.1% in the cast net fishery. Other important species in this group were Labeo calbasu (4.0%), Cirrhina mrigala (4.1%), Labeo bata (1.6%) and Catla catla (0.6%). Labeo dyocheilus, L.gonius, Cirrhina reba and Puntius sarana were the other carps which together made up 3.7%.

Catfishes, which came next in the order of importance, constituted 33.4% in the annual landings. Mystus seenghala, the most dominant catfish, accounted for 12.2% in the total annual catches and ranked third in the quarters I (15.6%), II (12.1%) and IV (14.0%). 55.2% (by weight) of this species was represented by size group IV

(651 mm and above). Other dominant catfishes were Wallago attu (7.4%), Mystus aor (6.3%) and Rita pavimentata (5.0%). The former two species constituted comparatively important fisheries in the IV quarter (October - December). 60.7% and 74.1% by weight of the catches of these two species were represented by size groups IV (651 mm and above) and III & IV (471 mm and above) respectively. Rita pavimentata constituted a seasonal fishery mainly during the monsoon months (July to October) and was poorly represented in the landings during the rest of the year. Age groups IV & V (164-203 mm) and VI and above (204 and above) of this species were the most dominant in the catches and made up 30.1% and 48.5% respectively. It ranked first (26.9%) in the long line fishery. The remaining catfishes, namely Clupisoma garua, Ompok bimaculatus and Mystus cavasius, together made up 2.5% in the landings.

Miscellaneous group, comprising Ophicephalus marulius, Mastacembelus armatus, Notopterus notopterus, small fish and prawns, made up 7.7% in the total landings.

Age/size composition of important fisheries

Observations on age/size composition of important fisheries of the section of river under investigation were continued during the year. The percentage composition by weight and estimated number of fish of various age groups were determined in respect of Tor tor, Labeo fimbriatus and Rita pavimentata. 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 results are tabulated below:

AGE COMPOSITION

Species	Age/size group	Length range in mm	Percentage by weight	Estimated number
1	2	3	4	5
Tor tor	0-I	100-280	9.9	4,454
	II-III	281-400	33.6	4,271
	IV-V	401-505	40.1	2,859
	VI & above	506 & above	16.4	450
Labeo fimbriatus	0-1	82-208	1.1	607
	II-III	209-309	11.3	1,898
	IV-V	310-411	43.1	2,934
	VI-VII	412-520	36.5	1,305
	VIII-& above	521 & above	8.0	106

Species	Age/size group	Length range in mm	Percentage by weight	Estimated number
1	2	3	4	5
Rita pavimentata	0-I	75-123	5.9	4,489
	II-III	124-163	15.5	6,560
	IV-V	164-203	30.1	6,674
	VI & above	204 & above	48.5	1,647
		SIZE COMPOSITION		
Mystus seenghala	I	Upto 265	3.2	550
	II	266-470	8.1	508
	III	471-650	33.5	322
	IV	651 & above	55.2	474
Mystus aor	I	Upto 265	4.3	806
	II	266-470	21.6	1,118
	III	471-650	37.5	614
	IV	651 & above	36.6	189
Wallago attu	I	Upto 265	0.1	24
	II	266-470	4.9	205
	III	471-650	34.3	528
	IV	651 & above	60.7	314
Labeo calbasu	I	Upto 165	0.4	26
	II	166-320	21.8	547
	III	321-470	71.5	1,108
	IV	471 & above	6.3	109

Catch per unit of effort

In order to determine the fluctuations in the relative abundance of fish, observations on catch per unit of fishing effort, mainly in respect of cast net and long line operations, were continued in the river stretch under investigation. The estimates are furnished in the following table:

CAST NET

	Total gear	No. of hours	Catch per gear per hour
January-March	65	299	0.515 kg
April-June	227	973	0.5 kg
July-September	166	781	0.781 kg
October-December	153	690	0.553 kg

Dominant species: Tor tor (26.3%), Labeo fimbriatus (26.1%), Labeo calbasu (8.1%) and Wallago attu (7.4%).

LONG LINE

	Total gear	No.of hours	Catch per gear per hour
January - March	26	221	0.152 kg
April - June	79	727	0.275 kg
July - September	90	704	0.378 kg
October - December	66	607	0.237 kg

Dominant species: Rita pavimentata (26.9%), Wallago attu (15.1%), Tor tor (7.6%) and Clupisoma garua (4.4%).

Fishery biological investigations

Labeo fimbriatus

Altogether 490 specimens of this fish, varying in total length from 96 mm to 643 mm, were examined for biological studies. The data on food habits of this fish were further analysed to determine the food composition of various size groups. The analysis showed that there was no marked variation in the food habits of various size groups, except that the larger fishes subsist more frequently on large-sized organisms like Spirogyra, Nitzchia, Surirella and Synedra. The gut length showed curvilinear relationship to body length.

The feeding activities in all the size groups of this fish, irrespective of maturity of their gonads, were found to be low during the monsoon (July to September), which coincided with its breeding season. Low feeding intensity during floods was therefore attributed mainly to non-availability of food organisms in abundance during this period. The condition factor of all the size groups was also observed to be low during the period corresponding to low feeding activities.

As the fish of 0-group could not be obtained from riverine habitat for food analysis, the fry (16-32 mm) reared in natural nursery pits were examined to determine the food habits of this size group. The analysis of gut contents of 50 fry showed that the fry were feeding mainly on bottom mud and decayed organic matter mixed with stray diatoms. Cosmarium and copepods were also encountered in in few guts.

For age and growth study, 3714 specimens of this fry were measured and scales were collected from 3081 specimens during the year under report.

(d) Godavari river

Landings

The total landings of fish including prawns, from a stretch of 208 km of the freshwater area of the River Godavari extending from 8 km below the anicut at Dowleishwaram near Rajahmundry to Dummuguden anicut, were estimated to be 245.6 tonnes during the year 1965-'66. Specise-wise and zone-wise landings with percentage in the total are shown in the following table:

(Figures in tonnes)

Species	Zone I	Zone II	Zone III	Total	Percentage in total
C. mrigala	6.958	10.919	0.579	18.446	7.51
L. fimbriatus	7.618	7.238	7.160	22.016	8.96
C. catla	1.039	1.387	0.392	2.818	1.15
L. calbasu	0.845	2.846	2.133	5.824	2.37
M. seenghala	5.176	2.243	1.378	8.797	3.58
W. attu	0.604	0.775	0.609	1.988	0.82
S. childrenii	1.256	1.153	0.480	2.889	1.18
H. ilisha	46.025	0.296	.013	46.334	18.86
Prawns	51.795	4.155	4.933	60.883	24.78
Miscellaneous species	51.838	11.222	12.546	75.606	30.79
Total	173.154	42.234	30.223	245.611	100.00

Although the prawn fisheries dominated the landings, it recorded a 50% fall from that of the preceding year. M.seenghala which showed about 50% decline from 1963 to 1964, registered a further decline during 1965. The landings of Catla in the commercial fishery however increased from 1.5 tonnes in 1964 to 2.8 tonnes in 1965.

Total types of nets operated in the stretch remained the same as were in the previous year, but long-line fishing was almost

disappearing. In the entire stretch covering all the three zones, Jaruguvala (shore-seine) landed the maximum catches of 72.7 tonnes followed by Cast nets (45.0 tonnes), Drift gills (36.2 tonnes), Set gills (29.9 tonnes), Large seines (28.8 tonnes), Drag nets (6.7 tonnes) and Drag gills (3.8 tonnes). Catches of shore-seines, large seines, drag and cast nets recorded a decline through the last 3 years. Long-line fishing has become most un-economic. The general trends in catch per man-hour of each main type of gear in all the three zones and especially in the main riverine fishing seasons, combined with no great change in overall relative effort indicated that there might be a certain amount of overfishing in the river. This might perhaps have been helped by environmental failure like lack of proper water levels, etc.

Fishery biological investigations

Fishery biological studies on L.fimbriatus, L.calbasu, C.mrigala, M.seenghala, H.ilisha, S.childrenii and M.malcolmsonii were continued. The salient features of the findings in regard to each species are stated below:

Labeo fimbriatus

Distribution:- Maximum juvenile distribution at Zones I & III
Maximum 3rd to 6th year group at Zones II & III.
Otherwise extending from Kotipalli downstream to upper reaches.

Size/Age composition in fishery.

Age :	1	2	3	4	5	6
Size in mm	201	320	408	494	571	630

L_∞ 1090 mm K = 0.1422

Mean/Weight/age in fishery

Age :	1	2	3	4	5	6
Wt./g	93	286	704	1393	2344	4497

Mean size/age at first maturity 334 mm/Second year.

Breeding period: (Maturing from May) July to August/September.

Mean size at recruitment to fishery 80 mm

Mean fecundity/numbers Fecundity range: 1,50,000 to 2,56,950;
Length range : 381 to 448 mm; 3rd year to 5th year.

Mean percentage mortality	By all gear			By nylon gill net		By Benduvala Zone III		
	2/3	3/4 5/6	4/5	4/5	5/6	3/4	4/5	5/6
1963-64	58%	19% 50%	75%	68%	63%	-	91%	-
1964-65	-	- 75%	76%	76%	78%	41%	87%	83%

Total mortality coefficient: 1963: 0.2754; 1964: 0.2739 and 1965: 0.2888.

Cirrhina mrigala

Distribution: Maximum juvenile distribution at Zones I & II. 4th to 7th year at Zones II & I. Otherwise extending from few miles below Dowleishwaram Anicut to Dummugudem Anicut and above.

Size/age composition

Age :	1	2	3	4	5	6	7	8
Size in mm	230	358	470	580	676	760	828	885

$L\infty$ 1400 mm

Mean weight age in fishery

Age :	1	2	3	4	5	6	7	8
Wt/g	61	373	873	1533	2888	4818	6029	7264

Mean size/age at first maturity: 349 mm/2nd year.

Breeding period: (Maturing from March) July to September (earlier, depending on flood in River Sabari in Zone II).

Mean fecundity/age/numbers

Age:	2nd	3rd	5th	6th	7th
Nos.	1,25,895	1,82,802	3,74,000	8,33,954	11,23,200

Mean size at recruitment to fishery: 80 mm

Mean % mortality all gear	3/4th	5/6th	6/7th	7th above	By Nylon net 5/6th	6/7th	7th/above
1963/64	45%	45%	88%	-	44%	84%	-
1964/65	20%	22%	67%	-	35%	60%	-

Total mortality coefficient (F+M): 1963 = 0.2126
1964 = 0.2111
1965 = 0.2074

Labeo calbasu

Distribution: Zones II & III maximum.

Size/age composition	Age :	1	2	3	4	5	6	7
	Size in mm	175	265	350	425	495	565	-

Mean weight/ age in fishery	Age :	1	2	3	4	5	6	7
	Wt. g	45	215	553	1141	1897	2787	-

Mean size/age at first maturity: 340 mm/3rd year.

Breeding period: June/August

Mean fecundity :

	Total length	Fecundity
Range	378 mm to 578 mm	71,526 to 5,17,500

% Mortality (all gear)		2/3rd	3/4th	4/5th	5/6th
	1964/65	46%	97%	34%	80%

Mystus seenghala

Distribution: Almost uniform distribution of all age groups over the entire stretch.

Size/age composition	Age :	1	2	3	4	5	6	7
	Size in mm	236	344	440	529	593	657	740

L ∞ 1470 mm K = 0.0943

Mean weight/ age in fishery	Age :	1	2	3	4	5	6	7
	Wt./g	50	240	500	864	1450	2190	2650

Mean size/age first maturity: 448 mm/3rd year.

Breeding period: 1) March/April peak; 2) June to August peak.

Mean fecundity/age/number: Between 5th to 7th age groups. Average Fecundity is 32,834.

Mean size recruitment to fishery: 70 mm in all the three years

Mean % mortality/all gear

	2/3rd	3/4th	4/5th	5/6th	6/7th	7/8th
1963-64	70%	50%	50%	17%	20%	38%
1964-65	54%	-	22%	25%	60%	75%

Total mortality coefficient: F+M = 1963 = 0.2948
1964 = 0.3514
1965 = 0.4427

M.malcolmsonii

Distribution: Mainly in Zone I, but also in Zones II & III. Adults from February to June and November/December. Juveniles from November to February-year-round generally.

Fishable biomass index (Annual): 1963: 0.1039
1964: 0.2036
1965: 0.0807

Size/age composition: Males & Females

	Males	Females
End of 1st year	45- 58	44- 48
2nd year	100-110	75- 90
3rd year	135-150	115-130
4th year	170-180	-
5th year	195-200	-

$L\infty$: Males: 240 mm; Females: 155 mm

Numbers per lb of (entire) prawns

Size group:	Small 40-80 mm	Medium 80-120 mm	Large 120 & above
Per lb/Nos.	200-250	30-60	18-20

Mean size/age at first maturity: 40 mm; 1st year

Breeding period: April/May extending upto October/November.

Mean fecundity by numbers: 3,465 to 63,080, in length range 54.0 to 164.0 mm.

Recruitment: Throughout river stretch; concentration at Dowleishwaram Anicut; Recruitment to fishery after attainment of 1st maturity.

Mortality : 83.3% after 2 years.

S.childrenii

Distribution: Uniform distribution in all zones.

Size/age composition

Age:	1	2	3	4	5	6	7	8 & above
Size in mm:	166	265	350	424	488	542	590	630 & above

L_∞ 890 mm

Mean weight/age/sex in fishery

Age:	1st	2nd	3rd	4th	5th	6th	7th
Wt. g	21.7	59.1	201.6	409.5	589.9	1041	1360
Sex/females	-	-	-	518.0	718.0	1005	1450

Mean size/age at first maturity: 400 mm/3rd year.

Breeding period: 1) March/April and 2) June/August.

Mean fecundity: Not estimated.

Mortality all gear:

	2/3	3/4	4/5	5/6	6/7
1963-64	87%	87%	50%	50%	100%
1964-65	92%	85%	75%	50%	100%

Hydrobiological investigations

Water temperature, dissolved oxygen and pH were recorded at two stations at Rajahmundry from November onwards. The temperature ranged from 30.0°-32.0°C, 28.7°-30.3° and 26.3°-29.7°C during summer, monsoon and winter respectively. The trend of fluctuation was more or less similar to that during 1964. The dissolved oxygen content decreased progressively, pH remained almost unchanged.

Plankton was also studied at the above two centres. During December, the percentage of copepod was high at both the stations, followed by algae and clupeid larve. On the other hand, during January and February, algae were the most prominent, followed by clupeid larvae, copepod, rotifers and diatoms. During March, clupeids were the maximum followed by algae.

Spawn prospecting investigations

With a view to locate new riverine resources for commercial exploitation of fish seed spawn prospecting investigations were undertaken, after extensive premonsoon surveys, in the Rivers Yamuna and Rapti in Uttar Pradesh, Sone and Kosi in Bihar, Godavari in Maharashtra, Cauvery, Tungabhadra and Vedavathi in Mysore and Cauvery and Bhavani in Madras. The salient features of the observations made at the various centres are given below:

(A) UTTAR PRADESH

River Yamuna

(i) Anwara (Agra district): A total of 15102 ml* of desirable spawn was collected in five standard nets at this village situated on the northern bank of the river, 10 km south of Tundla Railway Station and connected with it by an all-weather road. This catch formed 40.7% of the total spawn available in six spurts, the second spurt lasting for 40 hours in the receding phase of flood I and accounting for 86.4% of the total desirable spawn at this site being the most important. The analysis of spawn samples of the second spurt showed the major carp content to be 24.8% but the reared samples revealed a major carp content of 87%.

Major carp spawn was mainly available in the receding phase of different floods at this site, the breeding grounds being situated at an elevation of about 3.5 metres above the summer level. It was further found that the position of a net vis-a-vis the others in

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* 1 ml of spawn is estimated to contain approximately 350 hatchlings.

operation does not affect the catching effeciency of the net and a specially designed net, half the size of the standard net, caught similar quantities of spawn as the standard net.

A stretch of 72 km extending from Kailash (Agra district) to Chandwar (Firozabad district) was also prospected and it was revealed that spawn were available throughout the above stretch.

(ii) Dhumanpura: Dhumanpura is situated on the northern bank of the Yamuna, 10 km off Etawah and connected with it by an all-weather road. A total of 8,017 ml of desirable spawn forming 92.6% of the total spawn yield were collected by 3-4 standard nets in four spurts, either in the receding or the rising phase of the floods, each lasting from about 32 to 92 hours. Spurt 1, which occurred in the receding phase of flood I and lasted for 32 hours, yielded only desirable spawn and accounted for 6.1% of the total desirable spawn yield. Spurt 2, lasting for 92 hours during flood II contributed 88.4% of the total catch of desirable spawn. This flood had a subsidiary peak preceding the main and spawn were first available in the receding phase of the subsidiary peak and continued thereafter in the rising as well as in the receding phases of the main peak. While spawn spurt 3 occurring in the rising phase of the flood III contributed 2.5% of the entire season's desirable spawn, the last spurt occurred in the receding phase of the same flood and accounted for 2.8% of the total desirable spawn.

Spawn spurt 1 and 2, which together lasted for 120 hours, accounted for 94.5% of the season's catch of desirable spawn and the peak periods commenced two and four hours respectively after the appearance of spawn. Major carp percentages as revealed by spawn analysis and nursery rearings for spurts 1 and 2 were 35.2% and 67.9% and, 10% and 59%, respectively.

With a view to finding out the effects of current velocity and turbidity on the catching efficiency of 1/8" and 1/16" meshed net, trouser type of shooting nets having 1/16" meshed belly and with one of the legs made of 1/16" meshed netting and the other of 1/8" meshed netting were operated. No significant difference in the catching efficiency of the two sizes of mesh was found. A special experimental net of the type used at Anwara was also operated to determine its catching efficiency and it was observed that its catches did not differ significantly from those of the standard net. The effect of the position of the net on its catching efficiency was statistically tested at this centre. It was found that neither the distance from the bank nor the operational depth affected the catch significantly over the range of distances and depths examined.

Prospecting investigations carried out between Batesar and Kandesi on the Yamuna indicated the availability of spawn throughout this streth.

River Rapti

Bansi

The village of Bansi is situated at a distance of about 37 km from Basti on the southern bank of the Rapti and is connected with another village, Narkatha, on the other bank by an all-weather road through a bridge. The first spawn spurt appeared at this centre on July 1 and the same day 6,122 ml of spawn were collected in five Midnapore type nets. There were altogether six spawn spurts at this centre amounting to 560 hours, of which 416 accounted for desirable spawn. The total yield of desirable spawn at this centre amounted to 24,668 ml, estimated at 72.9% of the season's total spawn yield. The quality and quantity of spawn were most conspicuous during spawn spurts 2 and 4, which yielded 82.2% of the total spawn catch of the desirable quality. The catch per net per hour during these spurts were computed to be 89.4 and 36.2 ml respectively. The major carp percentage was the highest in the III flood.

The overall assessment of the site as to its spawn yielding potentiality is that spawn is available in the season throughout the Bansi stretch and can be successfully collected at suitable sites. The index of spawn quality at this centre was, major carps, 77.7%, minor carps, 21.6% and other fishes 0.7%.

(B) BIHAR

River Sone

(i) Dhundhua

A 35 km stretch of the Sone from Koiridih in the south to Mahuaon in the north was prospected for spawn availability, while Dhundhua was chosen for detailed investigations. Of the sites prospected those at Koiridih, Baghadabar, Naur, Banjari, Tumba, Tilauthu, Mahuson, Mandhania and Majhiaon had precipitous bank and were unfit for net operation. Sites at Nawadih and Ragunathpur, besides Dhudhua, were found suitable.

At Dhundhua, spawn was available in five spurts, of which the first four occurred either in the rising or receding phases of the floods and spurt 5 in the vacillation period between floods IV and V, the index of spawn quantity at this centre was 687 ml (about 2.2 lakhs). Qualitative index was 3.5% major carps, 94.9% minor carps and 1.6% others. The low percentage of major carps in reared samples, on which the index of spawn quality is based, appears to be an underestimate as desirable and undesirable spawn of different

spurts was reared in unprepared nurseries due to paucity of ponds. Catla catla followed by L. calbasu were the dominant major carps in the reared samples.

(ii) Dangwar

Situated at a distance of about 35 km from Dehri-on-sone and about 15 km from Dundhua, Dangwar was the only site suitable for spawn collection in the entire stretch which had a rocky terrain and a precipitous bank. The spawn was available at this centre in seven spurts which were either associated with the rising or the receding phases of the floods, no spawn being available during the vacillation periods. A total of 11,953 ml of desirable spawn catch, forming 82.1% of the entire season's yield at the site, was taken by 5 standard nets. Major carp content in the spawn samples was found to be 22.6, 23.9, 8.2, 39.5, 47.0, 33.7 and 52.1 percent of the total desirable spawn catch in spurts 1, 2, 3, 4, 5, 6 and 7 respectively. Spawn samples of spurts 1,3 and 4 were reared in nurseries and found to be comprised of 13.5, 8.6 and 36.9% major carps. C. catla was the most dominant species followed by L.rohita, C. mrigala and L. calbasu.

The index of spawn quantity at Dangwar was 2,417 ml (about 8.5 lakhs) and of quality 25.2% major carps and 74.8% minor carps.

River Kanua Kosi Dhar

Babuaghat

The 15 km stretch of Kanua Kosi Dhar runs from Balwara in the West to Babuaghat in the east. Sites at Chanan, Laghuri and Balwara were also prospected but found unsuitable for shooting net operations because of steep bank. Contrary to expectations, Kanua Kosi Dhar at Babuaghat yielded very little spawn probably due to poor flooding, the maximum rise in recorded water level being only 3.5 m above the summer level of the river, and possible loss of breeding grounds due to construction of eastern and western Kosi embankments.

(C) MAHARASHTRA

River Godavari

(i) Paithan/Shahgarh:

Investigations were conducted at Paithon during the early part of the season but later the site had to be shifted to Shahgarh as the collection area at Paithon turned entirely unsuitable. The

centres yielded no major carp spawn, spawn being available only in one spurt. B.tor, L.fimbriatus and L.porcellus made up 37.5% in the reared samples. Major carps are absent in the upper reaches of Godavari.

(ii) Nanded

This centre is situated 243 km downstream of Paithan. Three spawn spurts were discerned at this centre and yielded 863 ml in 80 hours in 3-5 nets, accounting for 63.1% of the total spawn yield at this site. Due to high peak (8.74 m on August 25) in the floods, nets could not be operated for eight days, including four in the receding phase, whence some desirable spawn might have escaped collection. This restriction imposed by high water level points out a serious limitation of spawn collection at Nanded. 29.3, 24.6 and 12.2% of major carps were found in the spawn samples of spurts 1 to 3 respectively. Samples of spawn from all spurts reared in the only available nursery showed C.catla to be the only major carp present, forming 12.3% of the reared samples. Of the other important carps of the region, L.fimbriatus formed 35.6% while C.cirrhosa and Tor sp. together formed less than 1%.

(D) MADRAS

River Cauvery

Six centres viz. Hogainakal, Chettipatti, Bhavani, Kulitalai, Tirupparathurai and Lower Anicut, covering a stretch of the Cauvery from just above the Mettur reservoir to Lower Anicut on the Coleroon river in Cuddalore district, were selected. Detailed observations were, however, made at two centres.

(i) Hogainakal above Mettur reservoir

This centre yielded 1052½ oz of fish eggs in the early stages of development and 2 oz of spawn during 89 days of observations extending from 31.5.65 to 27.8.65. The egg collections comprised of C.reba (70%), L.kontius (20%), Oxygaster spp.(4%), Cirrhina spp. (5%) and Ompok spp. (1%). The spawn associates were P.ticto (67.2%), C.reba, Oxygaster spp., Barilius barna, P.amphibius, P.atpar, A.morar, Danio aequipinnatus, P.stigma and N.notopterus.

(ii) Kulitalai below Mettur reservoir

This centre, an established catla fry collection site (from pools and puddles), yielded nearly 5.0 lakh hatchlings (4.0 - 7.0 mm in length) even in the absence of major floods during a two-month

period. Flooding in this stretch of the Cauvery is mainly due to the letting out of water from Mettur reservoir and water incursion from Amaravathi, a tributary draining into the Cauvery some 43 km above Kulitalai. Further two regulators control the flow of water in the Cauvery above Kulitalai. The spawn comprised of mostly L.kontius in the initial collections but C.reba and C.latius dominated during the later stages. L.kontius (28.97%), C.reba (24.7%), C.latia (19.47%), L.fimbriatus (2.5%) and others (24.5%) contributed to the collections.

Moolathurai above Bhavani reservoir

This centre yielded a total of 62 oz of eggs in the wake of two minor floods during the course of 53 days of observations. The occurrence of fish eggs was accompanied by an increase in current velocity and turbidity from 81 to 110 cm/sec and 100 to 900 ppm respectively. Eggs in the early stages of development were obtained on almost all days in the evenings and invariably proved to be of C.reba. A major collection of L.calbasu eggs could be had in the III flood. Stray numbers of C.mrigala were also represented in later collections.

(E) MYSORE

River Tungabhadra

Hesarur centre above Tungabhadra reservoir

A total of 184.6 ml of eggs and 19,553 ml of spawn were collected in two minor floods during the 40 days of observations. The first minor flood showed exclusive occurrence of eggs of the catfishe, P.taakree. The latter flood gave L.porcellus (62.5%), L.fimbriatus (2.5%), Puntius spp. (12.5%), C.reba (10%) and others (12.5%).

Modalighatti

40 ml (1300) eggs were collected in the only major flood on 16th July during the ascending phase and comprised of L.porcellus (65%), C.reba (25%), L.fimbriatus (5%) and L.bata (5%).

River Vedavathi

Kellodu centre above Vani Vilas Sagar

A total of 43,500 eggs, mostly of Chela spp. were collected during 3½ months of observation at this site. The species composition

of the reared spawn was Chela spp. (64%), C.reba (27%), A.morar (4.2%) Rita spp. (3%), L.porcellus (1.3%) and L.bata (0.5%).

Due to the almost complete failure of south-west monsoon, no floods of any consequence were observed in the Cauvery, Tungabhadra and Vedavathi rivers, hence a correct assessment of spawn availability under normal flood conditions could not be made.

2. Fisheries of the estuaries

Hooghly-Matlah estuarine system

The total fish, including prawns, landed from different zones of the Hooghly estuary during the year 1965-66 amounted to 6516 tonnes as against 10,413 tonnes of last year. This sharp decline was due to the absence heavy catches of T.jella at Digha. In fact, T.jella contributed to over 24% of the total estuarine landings in 1964-65. As in previous years, highest landings, viz, 83.3% of the total catch came from zone III (Lower Sunderbans areas). The major fisheries which contributed to the commercial landings were H.neherens (23.1%), Hilsa ilisha (13.7%), prawns (13.2%), Setipinna spp. (6.8%), and Trichiurus spp. (6.1%). Among gears, bag nets were the most widely employed and like last year accounted for bulk of the landings, viz, 62.5% of the total annual catch. Other gears were large seine nets (14.7%), hooks and lines (3.8%), small seine nets (3.7%) and set-barrier nets (3.6%). Estimated catches, zone-wise, gear-wise along with catch-per-unit of effort and species-wise are furnished in the following tables.

(A) Zone-wise estimates of catch (in tonnes).

1965-'66

Zones	Total catch	Percentage in total catch
I. Nabadwip to Calcutta	610.8	9.4
II. Calcutta to Diamond Harbour	118.2	1.8
III. Lower Sunderbans including Digha	5289.9	81.2
IV. Rupnarayan	282.1	4.3
V. Port-Canning	215.1	3.3
Total:	6516.1	100.0

(B) Zone and gear-wise catch and catch-per-unit of effort
1965-'66 (In kg)

Type of gear	I		II		III		IV		V		Total Ca
	Catch	C/UE	Catch	C/UE	Catch	C/UE	Catch	C/UE	Catch	C/UE	
1. Trawl	89,073	3.45	-	-	-	-	-	-	-	-	89,07
2. a) Large Seines	8,787	19.66	-	-	951,780	N.A.	-	-	-	-	960,56
b) Small Seines	98,747	11.69	-	-	139,543	N.A.	-	-	4,745	9.55	243,03
3. Purse	24,243	0.88	-	-	3,619	N.A.	-	-	-	-	27,86
4. Drift	44,597	2.38	1,765	0.87	44,221	N.A.	12,479	2.93	-	-	103,06
5. Lift	73,544	3.09	-	-	2,004	N.A.	-	-	-	-	75,54
6. Cast	10,501	2.82	-	-	7,917	N.A.	-	-	-	-	18,41
7. Bag	231,623	5.12	116,467	4.25	3,257,960	N.A.	269,631	8.32	205,631	12.26	4,081,31
8. Set-gill	4,009	1.29	-	-	143,878	N.A.	-	-	-	-	147,88
9. Set-barrier	2,921	11.41	-	-	226,141	N.A.	-	-	4,414	7.25	231,47
10. Traps	-	-	-	-	112	N.A.	-	-	-	-	11
11. Hooks & Lines	22,757	2.29	-	-	222,350	N.A.	-	-	-	-	245,10
12. Unclassified and Unknown	-	-	-	-	209,358	N.A.	-	-	2,279	4.87	292,63
T O T A L :	610,801	-	118,232	-	5,289,883		282,110	-	215,069	-	6,516,09

or 6516.1 to

N.A. - Not available

(C) Species-wise catches (in kg) - Hooghly-Matlah Estuary

1965-'66

Species	Total catch	Percentage in the total
M.tade	7,878	0.1
M.parsia	59,749	0.9
L.calcarifer	29,768	0.5
S.panijus	24,797	0.4
P.paradiseus	46,389	0.7
P.indicus	91,483	1.4
E.tatradactylum	19,148	0.2
S.biauritus	27,100	0.4
S.miles	6,509	0.1
P.pama	186,705	2.9
H.ilisha	887,764	13.7
H.toli	7,784	0.1
I.elongata	88,029	1.4
C.ramcarati	106,649	1.6
C.borneensis	12,940	0.2
S.phasa	148,203	2.3
S.taty	291,780	4.5
P.pangasius	48,748	0.7
T.jella	189,963	4.5
O.militaris	6,992	0.1
P.canius	9,385	0.1
T.savala	114,954	0.8
T.haumela	278,341	4.3
H.nehereus	1,505,930	23.1
S.cinereus	17,003	0.3
Prawns	857,374	13.2
Miscellaneous	1,344,732	20.4
Total:	6,516,096	100.0
	or 6,516.1 tonnes	

Analysis of commercial catches

As a group, clupeoids dominated the catches of the year and formed 23.8% of the yearly total. Hilsa ilisha contributed to 13.7% in the total followed by Setipinna spp. (5.8%). Next in order of abundance was Harpodon nehereus accounting for 23.1% in the total. Although the percentage contribution of this species increased during the year under report, the catch actually declined by about 27% than that of last year. The individuals represented in the commercial fishery ranged from 31.0 mm to 300.0 mm. Five size groups were observed at 59.0, 90.5, 154.0, 211.0 and 260.5 mm belonging to 0 to 2nd year groups forming a bimodal distribution in 1st and 2nd years. Females specimens caught in the Zone III during December 1965 and January, 1966 belonging to 2nd year were in their III & IV stages of maturity. Prawns came third and details are furnished under the heading "Prawn fisheries". Trichiurids represented by Trichiurus savala and T.haumela came next and contributed to 6.1% of the annual total catch. Both the species registered increase over the last year's catches. The size ranged from 40.0 mm to 144.0 mm (V.L.) with two modes at 77 mm and 122 mm in the former while it was 35.0 mm to 165.0 mm (V.L.) with two modes at 62.5 mm and 114.0 mm in the latter. Cat-fishes represented by Pangasius pangasius, Tachysurus jella, Osteogeniosus militaris and and Plotossus canius accounted for 5.4% of the annual estuarine total landings. Size ranging from 21.0 mm to 390.0 mm were observed in the commercial landings of P.pangasius. Sciaenids contributing to 3.4% in the total were represented by Pama pama, S.biauritus and S.miles. practically remained at the same level and the size in the commercial landings ranged from 30.0 mm to 220.0 mm with one mode at 85.0 mm. Polynemids were represented by Polydactylus indicus, Polynemus paradiseus and Eleutheronema tetradactylum and the three together contributed to 1.7% in the total fish landings. The catch of E.tatradactylum decreased by about 2 tonnes over the last year and the size ranged from 30.0 mm to 462.0 mm with two modes at 85.0 and 235.0 mm. P.indicus also registered a decline in the catch as compared to last year and the size of the individuals in the commercial fishery ranged from 20.0 mm to 496 mm (F.L.). Mullet fishery was represented by Mugil tade and M.parsia forming 1.0% of the total landings. The catch of M.parsia increased by about 16.0 tonnes over last year. The species ranged from 25.5 mm to 235.5 mm and three size groups were observed at 68.5 mm, 119.5 mm and 171.5 mm belonging to 0-2nd year groups respectively. Female specimens collected in January from Ichamati river with lengths ranging from 121.0 to 140.0 mm were found to be in their III & IV stages of maturity. Spent specimens with a length of 225.0 mm were collected from Ichamati river in February. Sillago panijus showed a decline in the catch by 35 tonnes from the last year's catch. The size in the commercial fishery ranged from 21.0 mm to 390.0 mm. Six-size groups belonging to 0-5 year groups were discerneble at modes 44.5, 72.0, 144.5, 205.5, 271.0 and 336.0 mm respectively.

/The catch of S.miles

Hydrological studies

The whole estuarine system showed a slight decline both in salinity and in surface water temperature, than the previous year. The range of salinity and temperature were traces to 33.83 ppt and 18.5°C to 33.5°C respectively.

Plankton studies

Like preceding years, the general downward trend observed in plankton production continued during the year under report. Diatoms were the most important phytoplankton both in quantity and quality. Important forms of phytoplankton encountered in the samples were Melosira granulata, Coscinodiscus granii, Synedra ulna, Spirogyra spp, Microcystis sp, Oscillatoria, Nitzschia sp, Biddulphia sp, Pediastrum, Sleletonema costatum, Chaetoceros sp and Lithodesmium sp. Compared to last year, dinoflagellates were totally absent during this year. Among zooplankton, copepods like Cyclops sp and Diaptomus spp. and cladocerans Daphnia sp, Ceriodaphnia sp. and Bosmina sp. were mainly observed Rotifers represented by Brachionus sp, Filinia sp, Distyla sp, Asplanchna sp. were dominant in Zone I. A few specimens of Hydracarina sp., free nematodes, protozoans were also encountered. In Zone IV and V, larval forms like nauplius, lamellibranchs, gastropods and polychaetes were also met with.

Studies on larval abundance

Total number of fish larvae caught in the tow nets was less than that of the last year. In a few cases, larvae of Hilsa ilisha and Pama pama outnumbered the rest of the species in samples. It was observed that the larvae of stages I and II predominated in the upper most reaches of Zone I, while stages III & IV were few and scattered along the entire area. In the larvae of P.pama, yolk was absorbed by the time they attain 6-7 mm length and they get the hump shaped appearance. In May and June, they were in stage II at Uchitpur (Zone I) and in September in stages III and IV at Govindapur (Zone I). In Zone IV, a homogeneous distribution of various developmental stages at different centres was observed.

3. Fisheries of freshwater lakes

Tungabhadra reservoir

During the year under report the total yield of fish from the reservoir was assessed to be 243.6 tonnes (141.7+101.9 tonnes for the left flank of the reservoir) as against 202.8 tonnes (118.9+83.9

tonnes for the left flank of the reservoir) during 1964-'65. The catches were poor during the monsoon and post-monsoon months due to high water level and heavy wind velocity. Shore seine units viz. 'alivi' contributed to bulk of the catches during April-June 1965 and January-March 1966, each unit averaging 99 kg/day during the former and 52 kg/day during the latter period. An estimated 129.2 tonnes of the total yield is attributable to these nets, the rest of the catches having been landed by surface gill nets and longlines operated by commercial fishermen.

Catfishes contributed to 67.1% of the total landings, followed by carps (28.3%) and miscellaneous forms (4.6%). Amongst the catfishes, M.seenghala, M.aor, W.attu and S.childrenii were of high commercial importance and accounted for 25.0, 12.6, 10.6 and 10.0% respectively of the total yield. Puntius kolus, L.fimbriatus, P.dobsoni, P.sarana, for spp. and O.vigorsii subscribed to the carp fishery and formed 8.5, 5.8, 4.0, 3.1, 2.0 and 1.6% respectively of the total yield. With intensified 'alivi' operations capturing catfishes, proportion of P.kolus in the catches had declined. Though the gangetic major carps figured rarely in the catches, catla accounted for 1.5% and rohu 0.2% of the commercial catches.

Gill nets (without sinkers) were operated by commercial fishermen and were computed to land 1.9 to 22.4 kg of fish/day/unit, a unit consisting of a coracle and 2 fishermen using 500 metres of net length. A hook and line unit consisting of 500 hooks, 1 coracle and 2 fishermen landed 7.5 to 9 kg of fish/day.

Experimental fishing was conducted at the Dam site, Karkihalli, Tambrahalli, Katarki, Hampasagar, Sovinahalli, Modalighatti and in adjacent bays and pockets. Bottom set nets introduced to cover the deeper areas of the reservoir with mesh ranging from 30 to 150 mm (bar) proved more effective than the surface nets. However, both surface and bottom set nets having 30, 40, 50 mm bar mesh were found effective. In the riverine stretches of the reservoir too, bottom-set gill nets proved highly effective than surface nets irrespective of the depths covered from 7 to 20 metres.

Fishery biological studies of the commercially important species of the lake were continued. (1) Puntius kolus has been found to be a bottom-feeder, mainly feeding on crushed molluscan shells, bottom insects (chironomid larvae, Corixa, caddisfly cases and Chaoborus parts), algae (mainly Spirogyra), diatoms (Navicula, Amphora, Surirella, Pleurosigma, Nitzschia, Synedra and Fragillaria), grass seeds, vegetable and organic matter and mud. This species has a prolonged breeding season, individuals being found to spawn from

July to December with two peaks, the first in July-August (main peak) and the second in November-December. A few specimens with gonads in IV-V stages of maturity have been recorded in February-March also. (2) P.dobsoni was observed to be a voracious vegetable feeder subsisting mainly on Chara, Vallisnaria and Hydrilla of which Chara alone formed 47.7% of the total average feed. Diatoms, other vascular plant matter, decayed organic matter, gastropods and ciliates formed other items. The species migrated into the main river for spawning during the monsoon months. (3) The gut contents of P.sarana were found to consist of gastropods, Chara, decayed organic matter, mud, plant tissues, insect matter, diatoms and Hydrilla. (4) L.fimbriatus, a more or less selective bottom feeder, with diatoms forming the dominant food item, was scarce in the reservoir, adults escaping into the river on attainment of maturity for breeding. (5) L.calbasu, also a bottom feeder, subsisted mainly on diatoms (32.5%), mud (30.5%), decayed organic matter (26.7%), insects (5.8%), chlorophyceae (3.3%) and miscellaneous food items (1.2%). (6) Osteobrama vigorsii, a column and sub-surface feeder, principally feeding on fishes (24.0 to 97.5%) and insects (3.0 to 53.9%) had a prolonged breeding period extending from May to November. (7) Almost 100% stomach contents in M.seenghala and 50.9% in M.aor comprised of fish and fish remains, Oxygaster spp, Puntius spp, O.vigorsii, G.giuris, C.bimaculatus, M.cavasius constituting the major forms ingested. In addition, prawns (19.1%), insects (20.2%) and other miscellaneous items formed the food of M.aor. These two species migrated into the river proper during February-March and breed before the onset of the monsoon. At no time, however, specimens with their gonads fully matured were recorded in the reservoir proper. (8) The stomach contents of W.attu have been found to be exclusively composed of Oxygaster spp., P.stigma, C.reba, O.bimaculatus, Rita spp. and G.giuris. The fish breeds in the river during monsoons and the young ones drift down into the reservoir with the flood waters. (9) Silonia childrenii had fishes contributing to 86.8% of its food, the other items being insect matter (6.0%), animal matter (5.5%) and decayed organic matter (1.7%). (10) Pseudotropius taakree was found to be predominantly an insect feeder (68.3%), fish remains, crustacean appendages, bivalves, etc. forming the other items of food.

Limnological investigations, based upon the collections of the seven centres, covering the entire reservoir were continued. The physico-chemical conditions of water showed that temperature varied between 21.2°C and 31.9°C. The range of variation in pH was mostly between 8.1 and 8.4 except on some rare occasions when values as low as 7.9 or as high as 8.7 were reached. The lowest values were recorded during July to September while the highest values were during October to March. Dissolved oxygen generally ranged between 6 and 10 ppm. Productivity experiments indicated March and April to be the main

productive period for the reservoir. The water was slightly alkaline having carbonates and bicarbonates of calcium and magnesium. Alkalinity usually ranged between 70-85 ppm with a slight depression during monsoon (22-33 ppm). Chlorides, nitrates, iron, silica and phosphorus varied between 16-25, 0.2-0.5, 0.1-1.0, 9-12 and 0-02 and 0.03 ppm.

Analyses of soil samples from seven centres, grouped into four zones viz. riverine zone (Nowli), admixture zone (Sovinahalli and Hampasagar), shallower zone (Tambrahalli and Katarki) and deeper zone (Karkihalli and Vyasankere) has indicated that (1) the riverine zone is rich in rubbles, stones and sand and very poor in all the chemical constituents with pH (7.0-8.0), calcium (2000 lb/acre), magnesium (nil to 500 lb/acre), organic matter (8.0-23.5%) and specific conductivity (76-104X10^{-6} mhos). Silt precipitation was low due to the flushing effect of the currents as also the disintegration of organic matter. (2) The admixture zone consists mainly of gravel, stones, sand and fine silt brought by the floods. An improvement in the values of all the chemical constituents over the riverine zone is indicated as pH varied between 7.2-8.2, calcium 2000-6000 lb/acre and magnesium 500-1000 lb/acre. The disintegration of organic matter and subsequent release of ammonia and soluble salts are also high (ammonia 50-100 lb/acre, organic matter 8.6-23.5 lb/acre and specific conductivity 35-255X10^{-6} mhos). (3) The most productive zone is the shallower zone as indicated by the highest values of all chemical constituents, the pH ranging from 8.0-8.5, calcium 4000-6000 lb/acre and magnesium 500-2000 lb/acre. Nitrogenous organic matter probably suffered the maximum disintegration as ammonia-N and other adsorbed salts in the humus were quite high (ammonia-N 50-100 lb/acre and specific conductivity 82-261X10^{-6} mhos). (4) The deeper zone, except in some very deep areas, consisted of a hard compact mass completely free from silt precipitation. Since the deeper areas remain undecomposed until late summer, the contribution of their deposits in terms of organic or inorganic salts is not considerable and this is reflected by the specific conductivity value varying only between 66-118X10^{-6} mhos, which is almost similar to the riverine zone. The pH ranges from 7.2 to 8.2 while calcium and magnesium are found to be similar in concentration to the admixture zone.

The littoral biota of the reservoir, though richer in variety, was poorer in density when compared with the bottom macrofauna and was dominated by prawns, 56 prawns/sq m on an average being available. The distributional trends with reference to annual production of littoral fauna indicated that the shallower zone was the richest, the other zones in order of relative richness being the admixture zone, deeper zone and riverine zone. In general, the insect group forming 72.4% by numbers of the littoral fauna dominated.

The other groups in order of abundance of numbers were prawns 11.1%, molluscs 9.9%, fishes 5.3%, oligochactes 0.8% and tadpoles 0.4%. The littoral fauna were the most affected by the physical factors like wind velocity, fluctuations in water levels and temperatures.

The bottom macrofauna, though not as rich in variety as the littoral, was rich both by numbers and weight, the shallower zone being the richest (552 units/sq m), the other zones in order of relative richness being the deeper zone (539 units/sq m), the admixture zone (534 units/sq m) and the riverine zone (378 units/sq m) respectively. The riverine zone was dominated by insects (77.7%) while they formed the second dominant group in the other three zones. Again, the bivalves (Corbicula spp.) almost exclusively dominated the riverine zone whereas gastropods showed an increasing trend in the other three zones. The bottom fauna studies for the year showed a dominance of molluscs both by numbers (86.3%) and by weight (89.2%) in the entire reservoir, next to which were insects (12.4%) by numbers and (9.6%) by weight and aquatic oligochaetes (4.2%) by number and (0.1%) by weight. The molluscan dominance during the summer months and insect dominance from September to March was observed.

The plankton production in the reservoir in general showed clear demarcation into a productive period (December-February), retardation period (March-April), low water period (May-July) and recovery period (August-November). In general, zooplankton was higher (53.2%) than phytoplankton (46.8%), the ratio being 1:1.1. The domina groups in order of abundance were: copepods (25.4%), diatoms (19.7%), rotifers (18.6%), myxophyceae (15.9%), chlorophyceae (11.2%), cladocerans (6.8%) and protozoans (2.4%). The shallower zone was the richest in plankton abundance showing 34.8% of phytoplankton and 45.2% of zooplankton, the other zones in order of abundance being the deeper zone (26.8% phyto- and 20.3% zooplankton), the admixture zone (24.6% phyto- and 12.2% zooplankton) and the riverine zone (13.8% phyto- and 22.3% zooplankton).

A survey of the main canals of the reservoir and their distributaries indicated L.fimbriatus to be the most dominant form in the first stretch of the river, L.potail being dominant in the second stretch. The fishery resembled that of the river in comprising of species such as L.panggusia, Schizmatorhynchus nukta, Tor spp., etc., with M.aor and M.seenghala appearing as stray forms.

4. Fisheries of brackishwater lakes

(a) Chilka lake

During the 9-month period from April to December, 1965, the estimated yield from the lake amounted to 3,687 tonnes, the prawns forming 46.26%, mullets 18.05%, catfishes 11.58%, sciaenids 5.79%, clupeoids 5.72%, threadfins 4.89%, perches 4.32%, beloniforms 0.82% and miscellaneous fishes 1.85%.

The prawns gave a record catch during the period with 1731.59 tonnes and the details are furnished under the heading 'Prawn fisheries' under item no.10 of this report.

The mullets were the next abundant group, forming 18.05% (666 m tonnes) of the total yield. M.cephalus and Liza macrolepis constituted 52.23% and 42.7% respectively. The fishery of L.macrolepis is becoming an important fishery of the lake and in 1965 was the best recorded so far. Specimens of M.cephalus upto 349 mm in size formed 59.44%, 350-524 mm 36.10%, 525-649 mm 4.44% and above 650 mm 0.01% of the fishery. L.macrolepis was represented by specimens upto 179 mm (6.29%), 180-319 mm (48.83%), 320-419 mm (33.06%), 420-499 mm (10.47%), 500-559 (1.24%) and 560 mm and above (0.11%) in the catch.

The catfish fishery contributed 427 m tonnes (11.58%) to the total catch. M.gulio was the most dominant of the group, the specimens upto 149 mm (66.51%), 150-199 mm (32.39%), 200 mm and above (1.09%) representing the catch. Plotosus canius formed 7.37% and other catfishes 20.17% of the fishery.

Pseudosciaena coibor was the most dominant of the sciaenids (97.77%) which formed 213 tonnes (5.79%) of the total catch. The specimens upto 174 mm (1.02%), 175-324 mm (40.09%), 325-424 mm (30.50%), 425-524 mm (19.00%), 525-624 mm (5.61%) and 625 mm and above (3.77%) were represented in the fishery.

The clupeoids constituting 5.72% (210.75 tonnes) of the total catch were represented mainly by Nematolosa nasus (33.02%) and Hilsa ilisha (9.43%).

Eleutheronema tetradactylum, the sole representative of the threadfin fishery, formed 4.89% (180.25 tonnes) of the total catch. Specimens upto 149 mm (7.66%), 150-374 mm (85.95%), 375-549 mm (5.38%) and 550-599 mm (0.87%) were represented in the fishery.

Lates calcarifer (43.21%), Gerres setifer (23.35%) and Etroplus suratensis (19.45%) represented the perches which constituted

159 tonnes (4.32%) of the total yield. Specimens of L.calcarifer upto 199 mm (0.43%), 200-474 mm (45.67%), 475-624 mm (29.10%), 625-724 mm (14.04%), 725-824 mm (7.47%), and the rest 2.50% were represented in the catches.

Studies on fish eggs, larvae and juveniles

The eggs and larvae of M.corsula occurred in large numbers in Tua Nali near Daya mouth and off Borokundi area during July to October. Eggs, larvae and juveniles of Mugil spp. occurred in the Central Sector during July-September but in the outer channel during October-December.

Large numbers of postlarvae and juveniles of H.kanagurta were available in August-December in the outer channel and Palur canal area. However, eggs, larvae and juveniles of H.coval and N.nasus occurred sparingly during April-August in the tidal reaches of mugger mukh and Palur canal, and, in the Southern Sector off Chhalkhani and Kumarpur. Eggs, larvae and juveniles of Anchoviella spp and Thrissocles spp. were collected in large numbers in all parts of the lake during April-November and May-June respectively.

Juveniles of M.gulio occurred in all parts of the lake during June-December. Larvae and juveniles of T.strongylurus, (April-May and October-November), H.gaimardi (April-May and October-November) and T.brevirostris (May-July, September and November) occurred in all parts of the lake. Eggs and larvae of E.tetradactylum were collected during April-June in the Northern Sector while the juveniles occurred throughout the lake from April-August.

Hydrographical studies

The water temperature in the main lake and the outer channel ranged from 21.0°C to 32.3°C and 22.5°C to 32.8°C respectively. Minimum and maximum values of alkalinity for the lake and outer channel were 52.0 ppm (August) and 57.0 ppm (September) and 121.31 ppm (May) and 132.8 ppm (April) respectively. The pH varied from 6.95-8.7 in the lake and from 7.4-8.6 in the outer channel. Dissolved oxygen ranged from 7.2 to 16.0 ppm in the main lake and 6.0 to 14.4 ppm in the outer channel.

The salinity in the main lake ranged from 0.822‰ (September) to 29.334‰ (June) and in the outer channel from 5.57‰ (October) to 34.27‰ (April). In the main lake, phosphate and nitrate, ranged from

0.015-0.06 ppm and 0.03-0.075 ppm respectively while in the outer channel the values both for phosphate and nitrate ranged only between 0.02-0.08 ppm. The values for silica and iron ranged from 1.0-4.8 ppm and traces to 0.005 ppm respectively for the main lake as well as the outer channel.

(b) Pulicat lake

As estimated total catch for 1173 tonnes was landed, of which prawns (40.80%) and mullets (27.06%) were the most dominant groups. While the northern zone of the lake contributed 35.66%, the southern zone contributed 64.34% (the increased landings being due to prawns).

Gearwise catch data shows that Suthuvalai caught 342 tonnes followed by Kondavalai (307.5), handlines (135), Badivalai (86.2) and Kattuvalai (67.8). Suthuvalai and Kattuvalai were selective for prawns while mullets were caught mainly by Oivavalai. The average catch/net/day during the quarter ending March'66 varied from a minimum of 18.48 kg for Kondavalai to a maximum of 131.86 kg for Badivalai in the southern zone while in the northern zone it ranged from 4.98 to 7.61 kg.

P.indicus was the dominant species amongst the prawns. (The details are reported in item 10: 'Prawn Fisheries').

Mullet landings were heavier in the northern (206 tonnes) than the southern zone (111 tonnes) and M.cephalus (163 tonnes), M.parsia (29 tonnes), M.macrolepis (23 tonnes) and M.tade (10 tonnes) contributed to the fishery.

The perches were represented mainly by Gerres oyena (29 tonnes) and Sillago sihama (26 tonnes). The food of G.oyena (91-285 mm) consisted of polychaetes, gastropods, bivalves, crustaceans, debris and sand. Fishes caught in southern zone subsisted chiefly on gastropods and polychaetes while those from the northern zone on amphipods. Sex ratio was observed to be 1.4 ♂ : 1 ♀ . Majority of the specimens were immature or maturing. Three modes were observed at 135, 175 and 245 mm. The food of S.sihama comprised of polychaetes, crustaceans, organic matter and debris while that of the juveniles (45-57 mm) mainly of amphipods. Five modes were observed at 135, 215, 265, 315 and 375 mm.

The clupeoids (28 tonnes) were represented mainly by Namatotolosa nasus (13 tonnes), Chanos chanos (6 tonnes), and Elops saurus. Specimens measuring 145-430 mm in length constituted 81.78% of the

C.chanos fishery. Juveniles of Chanos occurred throughout the period. The food of this species consisted of diatoms, insects and insect larvae, crustaceans, debris and sand. Four modes were observed at 125, 205, 335 and 375 mm in N.nasus. Diatoms, filamentous algae, gastropods, foraminiferan shells, organic debris and sand constituted the food of the species. Sex ratio was observed to be 1 ♂ : 2.62 ♀ .

Three modes at 260, 340 and 520 mm were observed in the specimens of Elops saurus. Fishes, prawns, amphipods, mysids, polychaetes and organic matter formed the food of the species.

The crabs, represented by the two species, Scylla serrata and Neptunus pelagicus, contributed 81 tonnes to the total catch. Mature N.pelagicus females were available in August, the smallest being 104 mm in carapace length. A berried female of 140 mm was observed in November.

Studies on fish eggs and larvae

Collections made during the nights and during the full moon period showed a greater abundance of eggs and larvae. However, the larvae of engraulids, carangids and gobiids were more abundant durin new moon nights. Low tide collections made during the nights yielded more eggs than during other tides.

5. Exploratory fishing in Sunderbans

Exploratory and experimental fishing cruises were made by the fishing vessel 'Sunderabans' in the lower reaches of the Hooghly estuary. Two, of the total six, cruises were made for fishing in the Rupnarain river, an area not fished so far. 39 days were spent in fishing. Repairs of the vessel, non-availability of a suitable person for the post of Serang and preparation of the gill nets accounted for the comparatively fewer days of fishing during the year.

A report on exploratory fishing conducted in the Hooghly estuary, from the inception of the Unit till March 1965, was prepared and submitted.

The specifications of the trawl nets operated for fishing were: (a) 13 m, 4 seam, cotton trawl with 42"X24" rectangular wooden otter boards, (b) 17 m, 4 seam, Nylon trawl with 42"X24" rectangular wooden otter boards. A total of 92 hrs. 30 mins. were utilized for trawling and, on an average, about 12 kg of fish were caught per hour of operation. H.nehereus, sciaenids, rays and eels dominated the catches in the lower estuary (R.Saptamukhi and Thakuran) while

P.pangasius and H.neherens wholly contributed to the catches from the R.Rupnarain. The areas trawled were mostly near the sea-face of the distributaries, R.Thakuran and R.Saptamukhi, and were different from those subjected to trawling in 1964-'65.

Bottom-set gill nets were tried using cement sinkers and polythene floats. The mesh-size varied from 3" to 7" and a combination of different mesh sizes was used in all the operations. The length of the net employed, at a time, was mostly 350 fathoms. The following are the details of the webbings used:

Mesh size	Pieces	Total length (Combined)	Height
7"	5	126 fathoms	5 meters
5"	2	54.5 "	5 "
4"	7	122.5 "	3 fathoms
3"	3	48 "	3 "

A total of 301 hours were spent in gill netting, landing about 663 kg of fish. The catch comprised mainly of sharks, catfishes and Lutianus vaigensis.

6. Hilsa fisheries

(a) Ganga river system

Landings

The total landing of Hilsa during the year at five selected assembly centres on the Ganga, two on the Jamuna and one on the Padma has been estimated at 170.55 tonnes as against 183.11 tonnes of the preceding year. The break up of the total is 68.06 tonnes from the Ganga, 40.15 tonnes from the Jamuna and 62.50 tonnes from the Padma as against 38.7 tonnes, 23 tonnes and 120.61 tonnes respectively during 1964. The main stay of the Hilsa fishery in the Ganga comprised of size group II, followed by size group III.

Delimitation of spawning grounds

(i) Upper sector

Observations towards delimiting the breeding grounds of Hilsa ilisha, initiated during October, 1964, were continued. The investigations which were carried out only in the vicinity of Allahabad

till March, 1965, were extended to three more centres, one each at Varanasi, Buxar and Ballia. Results obtained indicated that there were two spawning seasons of Hilsa, one during monsoon to early winter (August-December) and the other during the spring and summer months March-May. Of these, the former appears to be the main breeding season, with September-October constituting the peak period. The observations showed that Hilsa was breeding at all the four selected centre extending from Allahabad to Ballia.

(ii) Lower sector

Encouraged by the results obtained during 1964, regular systematic survey of the Ganga between Mokameh and Barh in Bihar was initiated. Inspite of better fishing during the monsoon season, regular sampling with tow net and shooting nets operated upto a maximum depth of 6' failed to collect any larva or egg from this stretch. This lends support to the earlier finding that the Hilsa breeding grounds in the lower stretch of the Ganga extend from Mahadebpur to Dhulian. Regular sampling for Hilsa larvae was also undertaken at Patna and Bhagalpur in the Ganga and Lalgola on the Padma from June onwards. While Hilsa larvae were available in the samples collected at Bhagalpur and Lalgola during the months August to October, no larva was encountered at Patna during the period June, 1965 to February, 1966. This further supports the broader delimitation of the spawning grounds in the lower stretch of the Ganga system and also indicated that in all liklihood the spawning of the monsoon run is over by about October.

Identification of Hilsa stock in the Ganga system

The discriminant function, arrived at earlier, when applied to the data, a large number of specimens were found to fall in the doubtful regions. Ratios of different morphometric characters against total length were worked out to set up the confidence limits to segregate homogeneous groups out of the total samples collected from the lower stretch of the Ganga system. It has been possible to discern three such significantly homogeneous groups of H.ilisha on the basis of a pair of characters. The discriminant score for individual groups was worked out and found to be as follows:

$$L_1 = -0.01647A + 0.24023B - 8.92019$$

$$L_2 = 0.03053A - 0.12299B - 9.42156$$

$$L = 0.15927A - 0.44187B - 9.88599$$

When applied to a large number of data, the method of application of discriminant score in segregating the populations of Hilsa has been found to be satisfactory.

The overall pattern of intermingling of different sub-populations of H.ilisha in the entire Gangetic system has been worked out and tabulated as below:

Place	Variety		
	Slender	Broad	Broader
Allahabad	20.00%	54.54%	25.46%
Varanasi	14.47%	30.26%	55.27%
Buxar	27.64%	30.25%	42.11%
Bhagalpur	47.24%	31.20%	21.47%
Rajmahal	12.50%	78.13%	9.37%
Lalgola	20.83%	37.50%	41.67%

The overall pattern of intermingling indicates that all the three sub-populations are existent throughout the river system upto Allahabad.

Fishery biological investigations

(i) Upper sector of Ganga system

Observations, made on the basis of data on the length frequency distribution, indicated that landings of Hilsa in the Rivers Ganga and Jamuna were dominated by size group II, corresponding to fish of 2-2½ years of age. It was further observed that while the larger specimens of Hilsa were available mainly during the winter months, the monsoon catch consisted essentially of smaller specimens. Further, analysis of the monthly length frequency distribution of Hilsa for the years 1963-1965 showed that new recruits enter the fishery when they are between 105 and 125 mm in size, during the period of June - July.

(ii) Lower sector of Ganga system

During the year, Hilsa ilisha ranging in total length from 25 mm to 512 mm were available in the commercial catches in the region supplying to Bhagalpur assembly centre on River Ganga. The length

frequency data of 4841 specimens pooled for the entire year and grouped in 10 mm class intervals indicated the presence of the following modal groups.

Group	Modal size in mm
1.	35 and 95
2	315
3	375
4	425
5	465
6	505

When compared with the modal values for the preceding year, it was observed that in group 1, two modal values at 35 mm and 95 mm were available during the current year, while in 1964 the modal value were located at 45 mm and 75 mm. The modal value at 215 mm seen in 1964 was absent during the year, while the size represented by 325 mm in 1964 was represented by 315 mm during the current year. The modal values at 375, 425 and 465 mm were maintained through these two years In addition, another mode at 505 mm appeared during the current year. The strength of the later modes from 325 mm onwards were considerably lower as compared to 1964.

In River Padma, fish ranging from 31 mm to 530 mm were available during the year and the analysis of the length frequency distribution at 10 mm class intervals for a total sample size of 5804 specimens indicated the presence of following modes :

Group	Modal size in mm
1	45 and 155
2	205 and 265
3	335
4	375
5	415
6	455
7	505

When compared to 1964 it was observed that in group I only two modal values at 45 and 155 mm were available during the current year, as against three modal values at 75, 125 and 185 mm during 1964. The rest of the groups represented by 205, 265, 335 and 375 mm were maintained through these two years, while new modes at 415, 455

and 505 appeared during this year and the mode of 435 mm seen in 1964 was absent. The relative strength of different modes indicates that the size groups represented by the modes at 265, 335 and 375 mm were most dominant.

Early growth rate of Hilsa

The analysis of 8677 specimens in the size range of 21-140 mm collected from Bhagalpur region during dufferent months of the years 1963, 1964 and 1965 and grouped at 5 mm class intervals indicated the following monthly pattern of growth.

Length at the end of	Modal value in mm	Size range in mm	Standard deviation	Increment in growth in mm
1st month	28.6	25.0 - 32.0	± 3.5	-
2nd month	43.6	37.0 - 50.0	± 6.5	15.0
3rd month	63.6	56.0 - 71.0	± 7.5	20.0
4th month	81.0	72.6 - 88.6	± 8.0	17.4
5th month	99.3	92.0 - 107.0	± 7.5	18.3
6th month	121.0	115.0 - 127.0	± 6.0	21.7

The growth rate estimated on the basis of analysis of 4376 specimens collected during the monsoon season of 1964 from Bhagalpur, Rajmahal and Dhulian and ranging in size from 9-140 mm, indicated the early growth pattern to be slightly less than the one arrived at by analysing the data collected from Bhagalpur alone. The possible reason for this anomaly may be the differential pattern of early growth between these three stations, controlled by the available food in the respective areas and other hydrological factors.

Length-weight relationship of juvenile Hilsa

The length-weight relationship of juvenile Hilsa in the identical size range of 27-105 mm for the samples drawn from Bhagalpur and Lalgola was estimated by the method of least squares and the results obtained are as follows:

For juvenile Hilsa (Bhagalpur)
log wt. = - 1.74444 + 2.81003 log T.L.
for juvenile Hilsa (Lalgola)
log wt. = - 2.35381 + 3.14126 log T.L.

When the values obtained for these two stations were tested statistically, they were found to be significantly different, indicating thereby the differential pattern of growth at these two stations.

Maturity and fecundity of Hilsa

Results obtained by analysing the data on percental distribution of adult and female Hilsa in the commercial fisheries in different stages of maturity during different months of the year, indicated that mature individuals and specimens in penultimate stages of maturity were available during the months January to April, July, August and October to December, while mature female Hilsa in V and VI stages of maturity, according to the international scale, were availabel during the months February, March, July, August and October. Therefore it may be guessed that in months of January, April and December only mature males are available and that the male Hilsa attain maturity earlier than the female Hilsa.

Fecundity of the mature female Hilsa in IV, V & VI stages of maturity and ranging in size from 341 mm to 522 mm was observed to range between 3,41,719 and 11,04,715. The range of fecondity in different sub-populations of H.ilisha, identified on the basis of discriminant scores, is presented below, along with the size-range of the specimens.

Variety	Size range of the fish (in mm)	Range of fecundity
Broader	341 - 522	3,41,719 - 10,97,086
Broad	396 - 474	4,49,410 - 11,04,716
Narrow	390 - 473	4,22,560 - 8,72,935

It appears that the fecundity of the narrow variety is comparatively low as compared to the other varieties. However, to ascertain the correctness of this finding, comparative length-specific fecundity of different sub-populations is being attempted.

Food and feeding habits

The pattern of seasonal feeding intensity indicated that the fish abstained from taking food during monsoon months. Overall size-specific feeding intensity indicated that percentage of occurrenc of stomachs with high feeding intensity were more in the early size groups (151-250 mm) and declined in the older size groups (251-500 mm)

Analysis of stomach contents showed that besides organic debris and sand particles, crustacesns ranked high in order of perference followed by rotifers and algae. Crustaceans encountered were Diaptomus sp., Cyclops sp., Bosmina sp., Daphnia sp., and eggs and fragments of other crustaceans. Of the rotifers, Keratella sp., Brachionus sp., Filinia sp. and Noteus sp., formed the major portion of the group while algae were represented chiefly by Spirogyra, Microcystis, Oscillatoria, Pediastrum and Closterium. Among the less preferred food items, molluscs, diatoms and protozoans were important.

Age and growth

The length frequency data collected from the River Ganga and Jamuna were analysed for studying the growth of the fish. Observations made on the growth during the year are tabulated below:

	Initial modal length	Final modal length	Increment in length	Period
Jamuna				
a) Sadiapur	205	345	140	1 year
	335	435	100	1 year
	405	435	30	3 months
Ganga				
a) Sirsa	230	300	70	8 months
	355	405	50	7 months
b) Buxar	305	355	50	7 months
	345	395	50	7 months

(b) Godavari river system

The total landings of Hilsa ilisha during the year under report from the 3 zones of the river amounted to 46.3 tonnes. The failure of floods upto July, 1965 and subsequent lack of proper water level at the anicut prevented ascending migration of the fish and the fishery continued to be very poor upto the end of August. By September, however, the conditions improvement and 75% of the total landings of the year was made during this month. In the juvenile fishery of the Hilsa, the 1964 spawned recruits continued to occur in abundance upto the end of July, 1965. The 1965 recruitment was a failure upto the end of March, 1966, due to the failure of adult Hilsa migration over the anicut. Drift gill, Stake net, Rangoon net and Alivivala were the chief gears. Catch-per-man-hour of Stake net was 0.59 kg, followed by Alivivala (0.34 kg) and Drift gill (0.21 kg). In the size composition,

greater abundance of younger age/size group and male component were noticed during the entire season. Larger sizes and females appeared late in the season, by September and October. The size groups that entered the fishery during the year 1965 monsoon had greater abundance of smaller ones than those of the year 1964. The following modes were observed during different months of the year.

April	-	83 mm
May and June	-	112 mm
July	-	138 mm
August	-	438 mm
September and October	-	438 mm & 438 mm
November	-	88 mm & 438 mm

In December, no Hilsa was encountered and in February, 1966, very few individuals were noticed. The length/weight relationship in adults and juveniles was found as follows :

Adults : $\log W = -5.6538 + 3.2643 \log L.$

Juveniles : $\log W = -4.6886 + 2.8072 \log L.$

(c) Hooghly estuary

The total landings of Hilsa ilisha from the Hooghly during 1965-66 amounted to 887.8 tonnes as against 1475.6 tonnes of the preceding year and accounted for 13.7% of the total annual catch from the estuary.

Larvae of Hilsa belonging to stages I & II predominated in the upper stretch of the river between Nabadwip and Calcutta, while stages III & IV were few and scattered. The yolk was observed to remain till stage II, and by the time they attained stage III, larvae of average length of 10.0 mm were seen to be devoid of yolk. Hence, stage II may probably be called as "Critical stage", since the larvae change their feeding pattern and mass mortality occurs at this stage. Further, no continuity was observed in the length analysis of stage II larvae, probably due to heavy mortality. But in stage III, continuity was observed in the length analysis.

(d) Chilka lake

Hilsa fishery of the lake during the year was very poor and the total landings was estimated to be 19.9 tonnes approximately. Individuals of the size upto 124 mm formed 20.31% of the group total

while the size ranges 125-324 mm, 325-474 mm and 475 mm and above contributed respectively to 77.62%, 2.00% and 0.77% of the fishery. Prolarvae, post larvae and juveniles occurred during the August - December period with a peak in October. They occurred in Tha Nali near Daya mouth and off Borokudi area.

7. Tank fisheries

Three tanks viz. Bidarguppa (20 acres), Jigani (300 acres) and Hutchammankere (3 acres) in Anekal Block were taken up for development under the Applied Nutrition Programme in November, 1965. Studies in the first two tanks could be continued only for a few months as their water was taken off for agricultural purposes. As such three 'kuntas' viz. Someswara pond (¼ acre), Narayanghatta (½ acre) were provisionally stocked with major carp fingerlings in January, 1966.

Bidarguppa tank

Studies of the physico-chemical condition of water revealed the temperature, pH, dissolved oxygen, alkalinity, hardness and specific conductivity to fluctuate between 23.6-27.8°C, 7.9-8.5, 6.09-8.2 ppm, 176-200 ppm, 96-100 ppm and 320-360X10^{-6} mhos respectively. Phosphates were available in traces, while nitrates and silicates ranged from 0.096 to 0.192 ppm and 5.85-6.3 ppm respectively. The soil was alkaline (pH 7.5-8.2). While phosphates could not be detected in the soil, even potassium (40 lb/acre), magnesium (250 lb/acre), and calcium (1000 lb/acre) were present in low concentrations.

Phytoplankton accounted for 73.2% in December, 1965 and 63.3% in January, 1966 and while all the four groups Myxophyceae (54.6%), Bacillariophyceae (36.1%), Desmidiaceae (2.7%) and Chlorophyceae (6.6%) were represented in December, only Myxophyceae (36.8%) and Bacillariophyceae (63.2%) constituted the phytoplankton in January. Protozoa, Rotifera and Copepoda constituted the zooplankton.

This tank, with little water, did not exhibit any marked difference between the littoral and bottom biotal complex. The density of invertebrate fauna ranged from 45 to 54/sq m and it mainly consisted of molluscs (Unio, Viviparus & Melanoides) mayfly and dragon-fly nymphs, prawns (Leander spp.) and fishes.

Jigani tank

Hydrological studies of the tank water indicated the temperature, pH, dissolved oxygen, alkalinity, hardness, specific

conductivity, nitrates, silicates and iron to vary from 20.6°C-22.9°C, 7.6-9.3, 4.0-8.2 ppm, 96-148 ppm, 46-72 ppm, 274-380X10^{-6} mhos, 0.114-0.204 ppm, 6.0-7.3 ppm and 0.192 to 0.24 ppm respectively. Phosphates were present in traces. It is noteworthy that the pH and dissolved oxygen recorded a sharp fall on account of the draw-down of water and consequent exposure and drying up of the vegetation. Soil analyses showed that the pH was on the neutral size (7.0-7.5) but potassium (40 lb./acre), magnesium (250 lb./acre) and calcium (1000 lb./acre) were low. Ammonia concentration was high (50-100 lb./acre) due to greater organic disintegration taking place in the tank.

Phytoplankton dominated over zooplankton. Diatoms and Myxophyceae constituted the bulk of phytoplankton while protozoans dominated the zooplankton owing to the rich disintegrating medium.

The tank, with its submerged (Hydrilla and Aponogeton) and emergent (Nymphaea, Polygonum, Marsilia) vegetation and low level of water resulted in a greater disintegration on exposure, ... offered an organically rich medium enriching the invertebrate fauna (57-84 sq/m).

The wild fish population consisted of P.chola, P.sarana, P.stigma, P.dorsalis, E.danricus, R.daniconius, C.punctatus and H.fossilis. On account of organically rich bottom and littoral areas, the tank recorded a good growth of L.rohita and C.carpio.

Hutchammankere tank

Water analyses showed that the dissolved oxygen (6.62-8.19 ppm), alkalinity (168-220 ppm) and hardness (40-86 ppm) fluctuate considerably. The dissolved salts were moderate as reflected by the specific conductivity (322-420X10^{-6} mhos). Phosphate was in traces, except in February, 1966 (0.15 ppm), while nitrates varied from 0.128 to 0.192 ppm. The soil was acidic (pH 5.8 to 6.8) in nature. This acidity, even in the presence of alkaline earth metals like magnesium (500 lb/acre), potassium (40 lb/acre) and calcium (2000 lb/acre), may be due to the disintegrating vegetation and other organic matter at the bottom, a fact supported by high ammonia concentration (50-1000 lb/acre).

The density of plankters declined from 676 to 115 units/l from December, 1965 to March, 1966. The sharp fall of zooplankters from 97.2% in December, 1965 to 38.5% in January, 1966 indicated the remarkable grazing on zooplankters by the introduced catla. Rotifera as a group dominated over other zooplankton while Myxophyceae was the dominant group among phytoplankton. The littoral fauna consisted

of insects and insect larvae. Clodocera and Ostracoda and accounted for 45-72 organisms/sq m in the littoral area. The wild fish population consisted of P.chola, P.parrah, R.daniconius, A.mola, M.vittatus and O.gachua.

A study of the growth of the introduced major carp fingerlings in these tanks and 'kuntas' showed that C.catla attained the maximum growth in Hutchhamankere tank and L.rohita and C.carpio in the Jigani tank, because of the richness of available food resulting from organically rich bottom and littoral areas. Someswara pond recorded a fairly good growth of both catla and rohu on account of the varieties of the food items available while kadagrahara pond exhibited very poor growth of rohu.

Clearance of Microcystis blooms in Nandi Temple tank (95'X95'X14'), holding about 35,78,332 litres of water, was tried by adding sulphuric acid (0.1 cc/4 litres) to bring the pH (8.7) to about neutral before spraying the copper sulphate solution at the rate of 0.3 ppm. Microcystis colonies turned whitish and were found to float on the surface as scum. To bring down the phosphate content, which increased from 0.15 to 0.85 ppm, 18.7 kg of lime was added which brought down the value to 0.05 ppm immediately. Water was clear with the settling of Microcystis by the 4th day after the application of copper sulphate and counts decreased from 7400 units to a few per litre. With reappearance of Microcystis after a lapse of a fortnight, a second application of copper sulphate (0.7 ppm) was resorted to and both on the second and fourth day of application 14 kg of lime were added. This treatment imparted complete clarity to water. To ensure that free phosphate was not available in the water, floating vegetation like Eichhornia and Pistia were introduced into the tank confining them within bamboo frames.

8. Water pollution

Studies on the nature and effects of industrial pollution on fish life into the River Hooghly and to evolve suitable remedial measures were continued. A survey of about 27 discharge points of various factories on the banks of the River Hooghly revealed that the temperature of wastes discharged into the river were higher than that of the river water adjoining the discharge points. The temperatures of wastes ranged from 31.5-57.5°C, that of air from 34.0-41.5°C and that of river from 31.5-36.0°C. The wastes of Serampore Distillary, Bengal Distillary, Kesoram Cotton Mill, Titagarh Paper Mill No.2, and Bagh Canal (Rishra) were void of dissolved oxygen. The D.O. range of 1.14-2.20 mg/l was observed in the wastes of Dunlop Rubber Factory, Tribeni Tissue, Hazinagar Paper Mill and WIMCO (Match Factory). The

wastes of the rest of the factories had a D.O. range of 3.04-7.80 mg/l. The D.O. of the river water near the outfall of the wastes of Kesoram Rayon, Serampore Distillary, and Bagh Canal ranged from nil to 0.74 mg/l. The river water near the discharge points of other factories contained 3.69-6.84 mg/l of D.O. The range of C.O.D. values of wastes was very wide, being 50,127 mg/l in Serampore Distillary, 14,969 mg/l in Bengal Distillary, 1,856 mg/l in Kesoram Cotton, 1,550 mg/l in Hazinagar Paper Mill, 20-816 mg/l in other factories and traces in Gouripore Jute Mill and Ichapore Rifle Factory. The range of total solids in various wastes was 520-47,364 mg/l, maximum in Serampore Distillary and minimum in Ichapore Rifle Factory. The pH of the various wastes ranged from 4.2 to 9.8, the pH range of water being 8.0 to 8.3. Samples of factory wastes discharged by Messrs Alkali & Chemical Corporation of India Ltd. (Rishra, West Bengal) into the Bagh Canal both near its entrance into the factory and at the exit were collected and analysed. Samples of effluents were also collected from factories manufacturing polythene, paints, rubber chemical and chlorine. The relation between atmospheric temperature and the temperature of water in the canal at the time of entrance and exit remained same, though the temperatures of wastes dicharged by above industries were high. The colour of water at the inlet was black and the same changed to grey at the outlet. The pH changed from 7.1 at the inlet to 6.5 at the outlet. This might be due to the acidic nature of polythene and chlorine wastes. pH varied from 8.4 to 8.7 in the wastes from paints and rubber chemical sections. The dissolved oxygen however increased from nil to 0.72 mg/l, which may probably be due to discharge of freshwater after cooling the machines. The C.O.D. value increased from 440 mg/l at the inlet to 919 mg/l at the outlet, the increase being due to high C.O.D. values of polythene (13,688 mg/l), rubber chemical (2111 mg/l) and chlorine (623 mg/l). Nitrate nitrogen content of water leaving the factory was less than that of the canal water entering the factory. Suspended solid contents were maximum in the chlorine plant waste (2,689 mg/l). Albuminoid ammonia was lower than free ammonia in all the effluents except those from the rubber chemical plant. The composition of the chlorine plant waste varied from time to time within a day, the colour from slight yellowish to pinkish and pH from 4.4 to 9.8. The waste was a highly turbid one having a total solid contents of 24,250 mg/l. Samples of wastes were also collected from the discharge lines of Dunlop Rubber Company and analysed. The pH of the waste ranged from 7.4 to 76, D.O. from 2.80 mg/l - 5.56 mg/l and C.O.D. from 15.2 to 83.2 mg/l. Total solids and suspended solids ranged from 384-540 mg/l and 18-422 mg/l respectively.

9. Cold water fisheries

An extensive survey of the streams and rivers of Himachal Pradesh has indicated that O.plagiostomus forms the main fishery in River Ravi and its principal tributaries (Suil, Sal and Chanet) in the Upper Chamba region. Though it was reported by the local anglers that during monsoon the mahseer mrigrate upstream of Chamba in the River Ravi, not even a single specimen was collected during a sampling survey of the river from Thein (Jammu and Kashmir) to Chamba. The trout thrived well in River Ravi before the 1947 devastating floods. A small trout hatchery existed 5 miles upstream of Chamba town and the water from River Ravi was taken to feed the hatchery. The water temperature of River Ravi in May was 12°C, pH 8.2, D.O. 12.5 ppm and total alkalinity 32.0 ppm. Efforts are now being made by the State Fisheries Department to transplant trout in the snow-fed streams of Suil valley. There are possibilities of trout thriving well in the Sal khud near Saho, Hul nala and near Chamba. In the lower Chamba region, Tor putitora and Labeo dero constitute the fisheries of Chakki, Deher and Bharal khuds which are the important tributaries of River Ravi.

In Mandi district, O.plagiostomus forms the main fishery in the River Beas and its tributaries (Tirthan, Bakhili and Jhl khuds) upstream of the Mandi town while downstream of the town O.plagiostomus, T.putitora and L.dero constitute the fisheries in River Beas and its tributaries (Suketi, Rati, Seon and Rana khuds). It is noteworthy that the fishery of T.putitora consists mainly of juvenile forms.

In Bilaspur district, T.putitora and L.dero form the fisheries of the River Sutlej and its main tributaries (Seer, Suker, Alaed, Barari, Ali, Ghambrola and Gambhar khuds). Mystus seenghala and M.aor, which were hitherto unknown in Himachal Pradesh, have extended their limits upto Bilaspur probably due to the changing of the mountain torrent conditions of the Sutlej to a practically lacustrine condition of the Gobind Sagar Lake.

The trout fishery in the Mandi and Bilaspur districts is confined to the Tirthan, Bakhili and Jhl rivers.

In Mahasu district, the mahseer fisheries in confined to River Giri and Ashmi below Chaila - tributaries of the Jamuna. Salmo trutta and O.plagiostomus constitute the fisheries of the River Paber and its tributaries.

All the streams in Kinnaur district are snow-fed, highly turbulent and flow through deep gorges. The Sutlej flows through so

deep gorges that fishing is not feasible. No fish could be collected in any of the tributaries (Gasso, Mangla, Mangad and Panwi khuds) of the Sutlej, except the Baspa, as they were in high floods due to the melting of snows. In the Baspa, S.trutta has established well. The survey party also did not encounter a single specimen of O.plagiostomus which is reportedly available in these streams.

The fisheries in Sirmur district is constituted by T.putitora, L.dero and Bagarius bagarius in River Giri and River Tons (tributaries of the Jamuna). Barilius bola affords a good fishery in the vicinity of Nahan in River Markanda. No trout streams exist in this district.

In all, samples of 44 species of fish were collected during the survey, of which Glyptosternum reticulatum collected from the Chamba valley and B.bola from River Markanda near Nahan were recorded for the first time from the hilly area of Himachal Pradesh.

The fishing methods in vogue are very much limited, the main gear being the cast net. In certain areas of the Mandi district bordering the Kangra district of Punjab, drag nets are used for fishing in River Beas when the water level is at its minimum. The other gear used are long lines and rod and line. There are no fish landing or assembly assembly centres and no fish markets. The catches are disposed off individually. However, gill nets are operated by the State Fisheries Department in Gobind Sagar Lake near Bilaspur and the catches disposed off departmentally.

Observations on the ecological conditions of a mahseer stream (Baner khud) in Kangra Valley were completed. Weekly samples of water, plankton, fish and insects were collected from four stations viz., A, B, C & D located on the Baner from its origin to its confluence with River Beas. The pH and dissolved oxygen ranged from 8.1 to 8.8 and 8.4 - 15.6 ppm respectively at the four stations. The values of total alkalinity, silicates and nitrates did not show much of fluctuations. The phosphates were present only in traces at all the four stations. Though the plankton life in the stream showed some fluctuations at the four stations, two peaks were common at all the stations during pre-winter and post-winter periods. As to the composition of the plankton, it consisted mainly of phytoplankton. The zooplankton was recorded very rarely. Pleurococcus, Cymbella, Cyclotella, Diatoma, Frustulia, Gomphonema and Navicula formed the bulk of phytoplankton population while Difflugia, Brachionus, Monostyla, Sida and Cantho-camptus were the rare records of zooplanktonic forms. The insect fauna at the four stations consisted of the nymphs of Odonata, Ephemeroptera and Neuroptera, larvae of Trichoptera and Diptera and the larvae and adults of Hemiptera and Coleoptera. The fish fauna

consisted of O.plagiostomus, L.dero, T.putitora, B.bendelesis, Garra gotyla, Nemacheilus botia aureus.

The life history from an advanced egg to post-larval stages of O.plagiostomus, Glyptothorax canirostre and N.montanus were studied. Fertilized eggs of O.plagiostomus, yellowish in colour, were collected from among the gravels in the side streams of River Ravi and Sutlej. The eggs, which were in fairly advanced condition hatched out in the laboratory within 12 to 24 hours. The hatchlings were yellow in colour and had an elongated yolk sac which was absorbed with 36 hours after hatching. Slower development marked the post-larval stages. The eggs of G.conirostre, translucent and dirty-white in colour, were found attached to leaves and other debris and were collected in May from the small side streams of River Suil in Chamba district. The important features of development were the appearance of the first pair of maxillary barbels at 3.9 mm stage, formation of all pairs of barbels at 5.2 mm stage and the impression of future adhesive disc on the ventral side. The eggs of N.montanus were collected from among the gravels in small streams of Chamba valley and were white translucent in colour. The important features in the development of this species were appearance of maxillary pair of barbels at 4.9 mm stage and the formation of 12 transverse bands extending from the back but hardly reaching the lateral line. These bands extended further towards the lateral line during development and almost joined the row of lateral blotches in the axis of lateral line.

The larval and post-larval stages of B.bendelesis and T.putitora were also studied. While/former were characterized by the formation of lateral bands which started appearing at 7.8 mm stage and were completely formed by 13.7 mm stage, the latter had a thin elongated body, typical dorsal and lateral chromatophore pattern and the caudal spot.

Biological investigations on T.putitora and O.plagiostomus were initiated. Material for biological studies on T.putitora being not available either at the landing centres of the plains of Punjab or the hills of Himachal Pradesh, it was decided to confine this problem to the catches of Gobind Sagar at Nangal and Bilaspur. Preliminary studies have shown that both immature and fully ripe gonads are found in the fish of the same size group. Further, the weight of the right ovary in the female was found to be more than that of the left. Two spawning seasons, the first in May - June and the second from August to October, were noted in the hill streams of Kangra Valley. Morphometric studies of the two broods have been initiated to find out whether or not it is the same stock which breeds twice an year.

Specimens of O.plagiostomus are collected fortnightly from the Baner (Dadh), Nigal (Paror), Awa (Dhraman) and Binwa (Baijnath) khuds. The food of O.plagiostomus consists mainly of diatoms, blue-green and green algae. In the juvenile specimens, dipteran larvae and corixiid bugs are recorded in addition to the phyto-planktonic forms. The females mature at 174.0 mm while the males at 96.0 mm. The fish has a prolonged breeding season extending from January to March.

A total of 2.12 lakhs of fry were produced, of which 1.63 lakhs were of mirror carp, 6000 of scale carp and 41,500 of hybrid between the mirror and scale carp. About 2 lakhs fry were handed over to the Punjab State Fisheries Department.

Experiments on the rate of survival and growth of common carp were undertaken in cement cisterns as natural ponds were not available at Kangra. Natural conditions were simulated in these cisterns by providing a six inch layer of soil and the bottom was manured with mustard oil cake and ammonium sulphate at 500 and 50 lb/acre respectively. Artificial feeding of fry was done with finely-powdered mustard oil cake and gram flour. After 3 months of stocking, a survival of 36.7% was achieved in the cisterns where artificial feeding was done as against 5.2% in the control where no artificial feeding was done. The fry grew from an initial size of 5.5 mm to 36.42 mm and 21.0 mm in the ponds with feeding and without feeding.

Investigations to study the various causes of mortality in the trout hatcheries of Himachal Pradesh, Punjab and Jammu and Kashmir were initiated and Barot hatchery (Himachal Pradesh) was selected for this purpose during the period under report. The maximum mortality was recorded in the case of green eggs, almost twice as that in eyed ova. The causes of mortality were attributed to white spot disease, rough handling of the eggs, overcrowding in trays, and possible oxygen deficiency in the water supply.

No mortality of adults in stocking ponds was noticed although 'fin-rot' in rainbow and 'blue-slime' disease in brown trout were recorded.

Comparative studies on the period of hatching at Barot (Himachal Pradesh) and Katrain (Punjab) have indicated that the hatching period at Barot is considerably less than at Katrain. At Barot, the green eggs took 22 days to become eyed and 16 days to hatch as compared to 40-48 days to become eyed and 29-41 days to hatch at Katrain. The hatchery at Barot is fed with spring water, average temperature of which from December to February was 11.2°C while at

Katrain with stream water, the average temperature of which for the corresponding period was 5.4°C.

The survey of River Beas and its tributaries between Manali and Bajaura (Punjab) to find out the state of trout fisheries in these streams has indicated that the stretch of River Beas between Kulu and Kalat appears to be rich in S.trutta and O.plagiostomus.

10. Prawn fisheries

Hooghly estuary

During the period under report, a total of 857.374 tonnes of prawns and landed from the Hooghly estuary. This quantity formed 13.2% of the total annual estuarine landings. Last year's figures were 997.809 tonnes and 9.6% respectively. Eight species of the prawns were represented in the commercial fishery and brief description of each of them are furnished below.

Metapenaeus brevicornis was fished from all zones except zone I. Length range of the species in the fishery was 94.0 - 104 mm. Two year groups of males having modes at 45.0 mm ('0' year), 50.0 mm ('I' year) and 71.0 mm ('I' year) and females having five modes at 29.0 mm and 41.0 mm ('0' year), 50.0 mm and 77.0 mm ('I' year) and 95.0 mm ('II' year) represented the fishery. Fishery was dominated by individuals belonging to '0' and 'I' year groups. Females above 80.0 mm from zone III were in mature condition indicating breeding season during December to January. Sex-ratio was 1 male to 1.42 female. Parapenaeopsis sculptilis was represented in the fishery by individuals ranging in length from 19.0 - 131.0 mm and was landed from all zones except zone I. The fishery consisted of '0', 'I' and 'II' year males having modal lengths of 47.0, 62.0 and 77.0 mm respectively. The females also exhibited three year groups, viz., '0' year (mode at 39.0 mm), 'I' year (mode at 49.0 and 68.0 mm) and 'II' year (mode at 96.0 mm). As above, '0' and 'I' year groups formed the main fishery. Females above 120.0 mm caught in lower sunderbans (zone III) during December/January indicated the spawning season. Sex-ratio was 1 male to 2.49 females. Leander styliferus was also available in the middle and lower zones of the estuary. Length range of the individuals forming the fishery varied from 16.0 mm to 90.0 mm. '0' year group of both male and female dominated the landings. Females measuring 75.0 mm in length were encountered during the period November to June in zone II and were in berried condition. Sex-ratio was one male to 1.66 females. Macrobrachium mirabilis was caught from zones I, II and IV. The length range was from 10.0 mm to 61.0 mm. Males showed one mode at 32.0 mm ('0' year) and females two modes at 32.0 mm ('0' year)

and 47.0 mm ('I' year). Females above 40.0 mm in size encountered in zones I and II were in mature condition throughout the year indicating a continuous breeding season. Sex-ratio was 1 male to 1.46 female. M.rosenbergii was available in zones I and II. The length of the individuals contributing to the fishery ranged from 30.0 mm to 305.0 mm. Males and females grouped under four modal lengths at 108.0 mm and 100.0 mm ('0' year), 130.5 mm and 135.0 mm ('I' year), 165.0 mm and 185.0 mm ('II' year) and 265.0 mm and 221.0 mm ('III' year) respectively were observed in the commercial fishery. 'I' and 'II' year groups dominated the fishery. Presence of females above 150.0 mm during February to July in zone II indicated spawning season. Sex-ratio was 1 male to 1.9 female. M.malcolmsonii was mainly caught from zone I, length of individuals in the fishery ranged from 19.0 mm to 200.0 mm. Modal lengths for males were at 44.0 mm ('0' year), 97.0 mm ('II' year) and 140.0 mm ('III' year). The model lengths for females were at 35.0 mm ('0' year) 86.0 ('I' year) and 109.0 mm ('II' year). Females above 95.0 mm showed advanced stages of maturity and berried conditions during June to September. Sex-ratio was 1.37 male to 1.0 female. M.villosimanus was observed in the catches of zone I of the estuary. Males showed modal lengths at 68.0 mm, 92.0 mm and 113.0 mm while females showed at 35.0 mm, 67.0 mm, 88.0 mm and 101.0 mm. Females above 90.0 mm were in berried condition during June to October. Sex-ratio was 1 male to 1.32 female. Metapenaeus monoceros was caught in the middle and lower zones of the estuary and the fishery was poor. Individuals ranging in length from 45.0 mm to 80.0 mm were encountered in the commercial landings.

Chilka lake

The prawns formed a record catch of 1731.6 tonnes accounting for 46.96% of the yearly total landings from the lake. The landings registered an increase of 1031.2 tonnes over the last year's total prawn yield. Four species, viz., Penaeus semisulcatus, P.indicus, Metapenaeus monoceros and M.dobsoni mainly formed the fishery and contributed to 25.94%, 56.12%, 11.70% and 6.01% respectively in the prawn total.

Pulicat lake

The total landings of prawns from the Pulicat lake amounted to 478.8 tonnes, forming 40.80% of the total annual production of the lake. Of this quantity, bulk of the catch, viz. 443.3 tonnes came from the southern sector of the lake and the rest from the northern sector. The fishery was contributed mainly by Penaeus indicus (20.15% in the yearly total) followed by M.monoceros (9.05%), P.monodon (2.09%), M.dobsoni (1.86%) and P.semisulcatus (1.82%). Other miscellaneous types

contributed to 5.83% in the total catch of the lake.

P.indicus dominated the prawn fishery. The size ranged from 30.0 mm to 155.0 mm with a prominent mode at 95 mm. The size range 65.0 mm - 110 mm formed over 78% of the fishery of the species. The incursion of the post larvae was observed throughout the year but they were maximum in November (240/haul) and February (466/haul). The incursion was relatively significant on the new moon day. No mature specimen was observed in the lake. Sex-rat o was 1 male to 1.2 female. M.monoceros was next in order of abundance. Individuals ranging in length from 35.0 mm to 100.0 mm represented the fishery and the individuals belonging to 55.0 mm - 75.0 mm group contributed to nearly 79% of the fishery. Post larvae were rich in February and were caught only during night time and more on new moon nights. Sex-ratio was 1 male to 1.02 female and they were all immature. P.monodon was represented in the fishery by the size ranging from 40.0 mm to 245.0 mm with a single mode at 155.0 mm. Size group 115.0 mm to 175.0 mm formed 72.7% of the fishery of the species. All specimens above 210.0 mm were females. No mature specimens were encountered. Sex-ratio was 1 male to 1.01 female, with males outnumbering females upto a length of 165.0 mm. The ingress of post larval forms occurred throughout the period both during day and night at high tide, the maximum being in the month of November (40/haul). They were more numerous on new moon day than on full moon day. Individuals ranging in length from 45.0 mm to 65.0 mm formed 92.48% of the fishery of M.dobsoni. The overall size range of the fishery was 30.0 mm to 80.0 mm with a mode at 55.0 mm. Sex-ratio was 1 male to 1.18 female, with males outnumbering females upto 55.0 mm. All females were immature and males over 60.0 mm were found to be mature. P.semisulcatus contributed to 1.82% in the lake's annual total landings, bulk of the catch (79.53%) being comprised of individuals of length range 65.0 mm to 110.0 mm. The overall size range observed in the commercial fishery was from 45.0 mm to 145.0 mm, with a mode at 95.0 mm. Sex-ratio was 1 male to 1.03 female.

IV. ANCILLARY PROJECTS

1. Investigations on fish pathology

Instances of Trichodinasis in major carp fry and fingerlings were studied in detail and the etiology and pathology of this disease described. The control methods tried in the field were dip treatment for 10 minutes in 3% common salt solution, 7 minutes in 1:500 acetic acid and 5 minutes in 1:3000 formalin.

Studies on the incidence of gill rot caused by the fungus Branchiomyces sp. on Labeo rohita showed clear obstruction of the blood vessels due to the fungal growth. Use of malachite green against this infection is being tried.

Cases of fish mortality were investigated in 14 stocking ponds of West Bengal. The important diseases associated with the mortalities were fin-rot, myxosporidiasis, dropsy, gas disease, and asphyxia due to lack of dissolved oxygen and pollutants.

To study the spoilage processes in freshwater fishes under Indian condition, a new programme of investigations was taken up. Initial training of the staff in methods of collection and handling the microbiological material, preparation of culture media, bacteriological examination of water and diagonatic methods was arranged. Preliminary observations indicated that bacteria isolated either from the environment or from the body surface of a freshwater fish are not responsible for the spoilage.

2. Research training scheme

Necessary facilities were afforded to the Research Scholars working at this Institute under the Research training scheme of the Union Ministry of Education. Two of the three Research Scholars completed their assignment. One of them has submitted his findings in the form of a thesis to the Agra University and the thesis of the other Scholar is also now ready to be submitted to the Punjab University. The third Scholar made satisfactory progress and the problem taken up and the nature of work done is stated below.

Investigations on the anatomy and histology of the organs of ingestion and digestion of fishes, Pseudosciaena coibor and three species of the genus Oxygaster, with reference to their food and selected aspect of their biology.

743 specimens of P.coibor and 459 specimens of Oxygaster spp. were examined during the period. The studies included the recording of morphometric data, analysis of gut contents and determination of age, maturity and fecundity. Histological studies of the organs of ingestion and digestion were also continued.

Three new Research Scholars started their studies, one of whom has been allotted the following problem:

Experimental and observational studies on the influence of light and temperature on the gonadial cycle of Indian carps.

Survey of the stocking ponds for the type of suitable fish available for the studies and the preliminary work in connection with the setting up of the experiment proper were done.

(ii) The second Research Scholar made preliminary attempts to study the chromosomes from various organs in a few common pond fishes.

(iii) The third Research Scholar made preliminary attempts to find out the most suitable organ or organs in common pond fishes for cytological studies.

Documentation

The Documentation Unit continued to compile and publish the "Bibliography of Indian Fisheries" the changed title of the "Quarterly Bibliography of Current Indian References on Fisheries and Allied Subjects" and Vol.4, Nos.1-4, were brought out during the year. The Unit also processed, edited and brought out departmentally 1 Bulletin, 1 Survey Report and 2 Miscellaneous Contributions. Work on the subjectwise and taxonomic indexing of publications received in the library was continued. Editing and preparation of various periodical scientific reports of the Institute were continued. Exchange relationships with other Institutes, scientific bodies, Universities, etc. both in India and abroad were continued and substantial number of useful publications were acquired.

The Documentation Unit also attended to 60 requests received from different State Government Fisheries Departments, other Governmental agencies, private individuals interested in fish culture, fisheries training, education etc., and from fisheries workers of foreign countries.

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