

GOVERNMENT OF INDIA

CENTRAL INLAND FISHERIES RESEARCH STATION
CALCUTTA

ANNUAL REPORT FOR THE YEAR 1956-57

BANGALORE CITY

PRINTED AT THE BANGALORE PRESS, MYSORE ROAD

1959

ANNUAL REPORT OF THE CENTRAL INLAND FISHERIES RESEARCH STATION, CALCUTTA, FOR THE YEAR 1956-57

GENERAL

1. The year 1956-57 marked considerable expansion and intensification of the research programmes of the Central Inland Fisheries Research Station. The headquarters of the Station continued to be located at Calcutta and the two Substations were located at Cuttack and Allahabad. The Chilka Fisheries Investigation Unit established at Balugan was further strengthened by the appointment of additional laboratory and field staff and a detailed programme of investigations on the fisheries of the lake has been initiated. The Lacustrine Fisheries Research Unit and the Hilsa Fisheries Research Unit established under the Second Five-Year Plan continued to function at Calcutta. A Tilapia Investigation Unit and a Paddy *cum* Fish Culture Unit were established at Cuttack. A Weed Control Unit and a Research Unit to study the role of soil composition in fish ponds have also started work there. A scheme of investigations on the fisheries and fish populations of the Hooghly, Matlah and Mahanadi estuaries has been initiated at Calcutta and in this connection survey centres have been established at Diamond Harbour, Port Canning and Chinsurah in West Bengal and Kujang in Orissa. Preliminary studies in connection with investigations on the culture of brackish-water fishes have also been initiated at Calcutta. A scheme of investigations on the fisheries of the River Ganga started functioning at Allahabad. A Water Pollution Unit has also been established there recently. For the implementation of the additional programmes of work accepted under the Second Five-Year Plan schemes, 1 post of Research Officer (senior scale), 6 posts of Research Officers (junior scale), 9 posts of Assistant Research Officers and 2 posts of Research Assistants (selection grade) in addition to 80 Class III and Class IV posts were sanctioned during the year.

2. Dr. V. G. Jhingran who was Research Officer (Riverine and Lacustrine) was appointed as Research Officer (Chilka Investigation), Dr. Y. R. Tripathi, Assistant Research Officer (Pathology), as Research Officer (Lacustrine), Dr. M. P. Motwani, Assistant Research Officer (Riverine and Lacustrine), as Research Officer (Riverine and Lacustrine) and Dr. K. K. Sarojini, Assistant Research Officer (Estuarine) as Research Officer (Hilsa). Shri A.

David, Research Assistant (Zoology), was promoted as Assistant Research Officer (Riverine and Lacustrine) and Shri N. R. D. V. Thampuran, Research Assistant (Statistics), was appointed as Assistant Research Officer (Statistics). Shri J. M. David joined as Administrative Officer of the Station.

3. Even though unusually heavy rains and the consequent flooding of the fish farms of the Station hampered the progress of experimental work in the Pond Culture Section, considerable progress was made in investigations on *Tilapia*, culture of fish in paddy fields, weed control in fish ponds and the role of soil composition in fish production. In the Riverine and Lacustrine Section, important studies were made on the fisheries of the Ganga River and the fishery biology of important riverine fishes. Further surveys of fish seed resources were also made in the western districts of Uttar Pradesh. In the Estuarine Section, very satisfactory progress was made in the investigation on the fisheries and fish populations of the Hooghly and Matlah estuaries. A sampling survey scheme to estimate total catches and catch-per-unit of effort in the estuaries was successfully conducted for the first time. A detailed study of the fisheries of the Sundarbans, along with an intensive environmental investigation, was also carried out for the first time. Considerable advance was made in the studies on Hilsa fish populations and the productivity of brackish-water *bheris*.

4. Essential glasswares, chemicals, scientific equipment, furniture and office equipment required in connection with the normal and expanded activities of the Station were procured during the year. Under the T.C.M. Programme 1 Dan Boat, 1 Thermograph with weekly drum, 1 Turbidimeter with 12 candles, a laboratory furnace with accessories and steam steriliser, 11 rolls of fisheries films and miscellaneous laboratory supplies and apparatus were obtained during the year.

5. The two Substations at Cuttack and Allahabad were housed in rented buildings and accommodation for the Chilka Investigation Unit was provided by the Orissa Fisheries Department. The training section of the Station was located in a rented building in Calcutta. The available accommodation for the headquarters at the Old Mint Buildings at Calcutta was very insufficient, especially after the appointment of additional staff. Efforts were, therefore, made during the year to procure additional accommodation, but without success. The construction of permanent office and laboratory buildings for the Station at Barrackpore at a cost of Rs. 4,49,293, the trainees' hostel at a cost of Rs. 2,18,090 and residential buildings at a cost of Rs. 4,85,360 made appreciable progress during the year.

Technical Assistance to the State of Andhra

6. The Department of Fisheries, Andhra State, requested this Research Station to investigate the alleged depletion of carp fingerlings in the irrigation canals and flooded paddy fields in the various districts. The Pond Culture Section of the Station undertook a survey of the problem in the State and detailed studies of the fish seed catches, as also large-scale fry collection from rivers and their rearing in nursery ponds, were undertaken. The correct technique of fry collection from rivers was demonstrated to the State Fisheries field staff at Dowaleshwaram (river Godavari) and Vijayawada (River Krishna). Detailed printed forms to record the period of catches and fluctuations thereof were prepared and distributed for collection of detailed information by the field staff.

Fish seed supplies and extension work among fish farmers

7. The Fisheries Extension Unit attached to the Station organised the despatch of fish seed by air and by rail to the deficit States in India through the Fish Seed Syndicate. On the basis of results obtained in experimental despatches during the previous year, all air consignments during the year under report were transported in plastic bags filled with oxygen. This served to reduce the mortality very considerably and packing and despatch became much easier. During the year 66,15,450 fry, 16 kunkas of spawn and 1,33,200 fingerlings of carps were despatched by rail and 21,00,680 fry by air to various States in India and to Nepal, Penang and Malacca. The Fisheries Extension Unit gave technical advice and help to several fish farmers in West Bengal and neighbouring States for improving fish culture. A large number of enquiries received from various organisations especially State Fisheries Departments and Community Development Projects were also attended to.

Training

8. The 9th Session of the Inland Fisheries Training Course was conducted during the year. Thirty-three candidates from all over India consisting of 18 Government deputees, 9 Government stipendiaries and 6 private candidates were trained in various aspects of Inland Fishery Development and Administration. In the final examination conducted in January, 32 candidates were declared to have passed.

9. Four officers of the Philippine Fisheries Bureau, who came to India as T.C.M. trainees, were given general training in inland fisheries work at the headquarters of the Station at Calcutta and the Pond Culture Substation at Cuttack. Shri Arthur Indrasena, Superintendent of Fisheries, Ceylon,

who came to India as F.A.O. trainee, was also given general training in inland fisheries work with special reference to fish culture at both the headquarters and the Pond Culture Substation at Cuttack. Three special trainees from the States of Andhra, Manipur and Vindhya Pradesh were given special training in Pond Culture work at Cuttack. A Refresher Course for fisheries extension workers was organised at Cuttack from 2-2-1957 to 14-2-1957 which was attended by four Assistant Fisheries Extension Officers, 2 Fisheries Extension Assistants of the Ministry of Food and Agriculture and Mr. Charles Wade, T.C.M. Fisheries Extension Specialist.

Meetings

10. Dr. B. S. Bhimachar, Chief Research Officer of the Station, convened the third meeting of the Committee on Standardisation of Names of Fishes and Fishing Subjects at Bombay in April 1956. He also participated in the second and third meetings of the Fisheries Research Committee at Mandapam in April 1956 and Calcutta in January 1957, and the All-India Fisheries Conference held at Madras in September 1956. The third meeting of the Fisheries Research Committee at Calcutta was attended also by Shri K. H. Alikunhi and Dr. T. V. R. Pillay as observer and co-opted member respectively. The Syllabus Committee consisting of the senior officers of the Station appointed to revise the existing syllabus of the Inland Fisheries Training Course met at Calcutta in January 1957.

Deputations

11. Shri S. J. Karamchandani, Research Assistant, underwent a six months course of training in lake fisheries management at Michigan in U.S.A. under the T.C.M. Programme. Shri A. David, Assistant Research Officer (Riverine and Lacustrine), has left on deputation for training in lacustrine hydrology and fishery biology in Canada for a period of six months, under the Colombo Plan.

Visitors

12. During the year, a number of foreign fishery experts visited the Research Station at Calcutta and some of the Substations among whom may be mentioned Dr. Van Cleve, T.C.M. Fisheries Expert; Mr. J. A. Tubb, Regional Fisheries Officer for Asia and Far East; Dr. Boon Indrambrya, Director-General of Fisheries, Thailand; Mr. H. Saanin, Chief, Laboratory for Inland Fisheries, Bogor, Indonesia; Mr. Ole J. Heggam, T.C.M. Consultant; Mr. Charles Wade, T.C.M. Fisheries Extension Specialist and Mr. S. Shirely, Colombo Plan Expert and Mr. F. Dovring, Economic Analysis Branch, F.A.O.

Shri R. L. Mehta, I.A.S., Joint Secretary to the Ministry of Food and Agriculture, Shri A. M. Dam, I.C.S., Development Secretary to the Government of Assam, Dr. B. N. Chopra, Fisheries Development Adviser to the Government of India, Dr. D. Bhatia, Deputy Fisheries Development Adviser to the Government of India, Dr. N. K. Panikkar, Chief Research Officer, Central Marine Fisheries Research Station, Shri S. Majid, Director of Fisheries, Assam, Shri M. Kantiraj, I.A.S., Director of Agriculture and Fisheries, Manipur, Shri C. B. Gulhati, Deputy Secretary, Ministry of Finance, Shri S. D. Manaktala, Under Secretary, Ministry of Home Affairs and Shri K. Chidambaram, Assistant Fisheries Development Adviser to the Government of India, also visited the Station during the year.

13. The research work of the Station continued to be conducted mainly in the three sections—Pond Culture, Riverine and Lacustrine and Estuarine. The Chilka Investigation Unit and the Lacustrine Unit functioned as separate research Units. A brief report of the results of investigations conducted in the various sections and in the newly established Units is given below. A list of publications from the Station is given at the end of the report.

POND CULTURE SECTION

14. During the year under report fish culture experiments and observations were carried out at the Killa and Zobra farms at Cuttack, the Linghipur fish farm at Bhubaneswar, the Brickfield fish farm at Puri and the new farm at Chaudwar, which were very kindly placed at the disposal of the Station for the purpose, by the Government of Orissa.

Tilapia investigations

15. Systematic investigations on the natural food of *Tilapia* of all sizes taken from various types of environments during the different months of the year have been in progress. Tentative inferences that can be drawn from the available data are: (a) fry, 7 to 10 mm. long, feed almost entirely on zooplankton, though in ponds with poor zooplankton algal items might occasionally be found in the gut contents, (b) from about 11 mm. to 60 mm. the fish feed almost equally on zooplankton and phytoplankton, the latter gradually preponderating in larger fish, (c) in specimens above 60 mm. in length the main food is phytoplankton, filamentous algæ and rarely leaves of higher aquatic plants. It is remarkable that sand or mud in appreciable quantities is rarely met with in the gut contents of *Tilapia*. The feeding habits and the food conversion capacity of *Tilapia* of various sizes as compared to carps are also under study.

16. To ascertain the role of *Tilapia* in carp ponds, a field experiment has been initiated, stocking *Tilapia* and the major carps *Catla*, *Rohu* and *Mrigal* singly or in combinations, on a comparable basis.

Fish culture in paddy fields

17. An experiment was successfully undertaken in the Central Rice Research Institute fields which were further remodelled into 8 larger plots when a second crop of paddy was being raised from January. The plots were stocked with advanced carp fingerlings during the first week of February and thereafter regular observations on fish-food fluctuations in the fields, fluctuations in depth and temperature of water, etc., are being maintained. Deep trenches about 2 feet deep from the field level have been provided in the same fields as shelter for fish from rising heat and predators. The experiment is to be completed in April 1957.

Soil composition in relation to fish production

18. *Survey of soil conditions in fishery tanks.*—A general survey of fishery waters in different States in India was initiated to collect information on soil conditions in them. To begin with, the work was taken up in Orissa and Madhya Pradesh. During the year 1956-57 eighteen fishery tanks in different districts of Orissa have been sampled for analysis of their soil and water conditions. These tanks belong to the State Fisheries Department and for most of these approximate fish production figures are available. When the survey in the different areas is completed, the correlation between soil composition and fish production will be examined.

Samples, so far analysed show, that in Orissa many of the fish pond soils are either slightly acidic (pH 6.0-7.0) or slightly alkaline (pH 7.0-8.0). Only in a few cases the pH is above 8.0 or below 6.0. Available phosphorus may be considered rather low and available nitrogen fluctuates irregularly showing practically no correlation with soil reaction or available phosphorus.

In Madhya Pradesh 8 fishery tanks in four different districts have been surveyed during the year. The soil reaction is slightly alkaline in all the tanks and available phosphorus and available nitrogen are fairly high.

19. *Studies on the soil and water quality of reclaimed swamps.*—In Orissa a number of swamps have been reclaimed into fish farms which are under cultivation for the last three to five years. These fish farms vary in their production figures which may be classified as (1) fairly good, (2) medium and (3) poor. A comparative study of water and soil conditions of five such

reclaimed swamps and of one unreclaimed swamp was taken up to find out the correlation between the soil and water conditions and the fish production in these reclaimed swamps. From the data collected it was observed that for fairly productive swamps soil reaction is slightly acidic with pH 6.6 to 6.9 while available nitrogen and available phosphorus ranged from 16.4 to 30.8 and 5.0 to 8.0 respectively. Comparing the data of the unreclaimed swamp (Lakhisagar) it was observed that the available nitrogen (16.4 to 39.4) compared fairly well with that of the productive swamps but the soil reaction was fairly acidic and available phosphorus was comparatively poor. It was noted that there was no correlation between available nitrogen and productivity but the available phosphorus in soil and the soluble inorganic phosphate in water seem to be limiting factors in determining the productivity.

Weed Control Investigations

20. *Survey of common aquatic weeds in Orissa State.*—To get an idea of the common types of weeds and their relative abundance in fishery waters of Orissa, surveys of fish farms and other waters situated in the vicinity were carried out in various districts of Orissa during the current year. Fish farms situated in seven districts have so far been covered. With a view to obtaining detailed information on the types of weeds, their relative abundance during the different seasons, the mode and time of their reproduction and the conditions of their existence and abundance, observations were carried out in two abandoned stocking tanks at Puri at intervals of 4–8 weeks, starting from July 1956. The study is in progress.

21. *Soil sterilants for controlling submerged weeds.*—From preliminary experiments carried out in 2 seasonal ponds subject to heavy growth of weeds at Athmalick, it appeared that a mixture of copper sulphate and ammonium sulphate applied as a soil sterilant at the rate of 400 lb. per acre has probably a temporary inhibiting effect on the growth of submerged weeds, whereas superphosphate applied at the same rate acts more as a fertiliser than as a soil sterilant. Further work with varying rates of copper sulphate and ammonium sulphate is necessary to confirm these observations.

22. *Effect of sodium arsenite on submerged weeds.*—Field experiments carried out in the Killa moat, Cuttack, confirmed that sodium arsenite at 5 p.p.m. was very effective against submerged weeds without any adverse effect on fish. It also showed that the underground parts of emergent weeds are not affected and that an area cleared of submerged vegetation has to be utilised immediately to prevent it being run over by other types of vegeta-

tion. The cost of chemical for the treatment worked out to be Rs. 18 per acre foot.

Carp nursery and rearing-pond practices

23. Twenty-six ponds were duly prepared for stocking and the fry were artificially fed in the ponds. The growth and survival of fry in the Killa and Zobra ponds were, as usual, satisfactory but in the Linghipur ponds, in spite of comparable stocking and subsequent treatment, the survival was generally lower and growth of fry extremely slow. Regular study of plankton from these ponds did not reveal any paucity of plankton; on the other hand zooplankton was fairly rich in the pond. The water and soil conditions at Linghipur are, however, different from those at Killa and Zobra. The soil is almost purely sandy or with a slight mixture of clay, the water acidic to slightly alkaline and nutrients and total alkalinity low. It is possible that under such conditions the fry are incapable of adjusting and assimilating even the available plankton fully. Even when the population was very much thinned out the growth was not satisfactory.

24. *Pond fertilization and weed control.*—With a view to studying whether the submerged aquatic weeds would be controlled by changing the nutrient status of the soil, two ponds at Athma lick were treated with (1) superphosphate and (2) a mixture of copper sulphate and ammonium sulphate. These seasonal ponds remained heavily choked with weeds, mainly *Hydrilla* for the most part of the year and dried up completely in summer. One plot in each pond about 1/10th of an acre was separated by a raised bundh and treated with (1) superphosphate and (2) a mixture of copper sulphate and ammonium sulphate at 400 lb. per acre. The chemicals were mixed with the soil by first ploughing the area and sprinkling the powdered solid uniformly and finally by repeated ploughing. Observations made on the chemically treated plots showed that owing to unusually heavy rains during the year the bundh gave way and the chemicals diffused to the whole bottom area of the pond getting greatly diluted. At this diluted concentration, superphosphate, as expected, had not shown any detrimental effect on weeds, while the mixture of copper sulphate and ammonium sulphate even at this dilution seemed to be effective in checking the growth of the weeds to a fair extent.

25. *Clearing ponds of unwanted fish and insects.*—Heavy application of oilcakes was attempted with a view to eradicating unwanted fish and at the same time manuring farm ponds. Though the water became foul, the majority of fishes withstood the strain and did not die. The method was,

therefore, uneconomical and unsuccessful. Plankton production was, however, heavy after oilcake application.

Preliminary experiments were carried out in the laboratory to find out whether the common insecticides like Folidol, Sweet flag (*Acorus calamus*) extract, etc., could be economically used either for clearing ponds of unwanted fish or for controlling predatory aquatic insects. Results obtained so far have not been very encouraging.

A number of laboratory experiments were conducted to ascertain whether chlorinated lime with high percentage of available chlorine could be used for eradicating predators and unwanted fish populations in nursery ponds. Experiments showed that owing to high chlorine demand of the pond water, particularly after rains, a very high dose (about 6 p.p.m.) was required to maintain the residual chlorine at a lethal level (about 2 p.p.m.) for about half an hour and the method did not appear to be economical. However, chlorinated lime (33% chlorine) was applied in conjunction with derris powder (5% rotenone) for removing fish from a number of nursery ponds but the results were not conclusive.

In order to study the effect of commercial insecticides *Aldrin*, *Dieldrin* and *Endrin* on fishes, prawns, insects and zooplankton, a number of experiments were conducted in the laboratory in 5-litre and 10-litre jars. The study was undertaken not only to find out the minimum dose necessary for the control of common predatory aquatic insects and prawns but also to study the minimum dose necessary to eradicate fishes as rotenone was not available for clearing the ponds. The fishes used in the experiments were *Colisa lalius* (1½"), *Barbus stigma* (2"-3½"), *B. ticto* (1½"), *Ambassis nama*, *A. ranga*, *Badis badis*, *Amblypharyngodon mola* (2-3"), *Esomus danricus* (2-3"), *Catla*, *Rohu*, *Mrigal* (5-8") and *Tilapia* (1-7").

Amongst these three organochlor insecticides, *Endrin* has been found to be most effective and can be used for the eradication of fishes, insects, prawns, etc., even at a very low dose. *Aldrin* is the least effective of the three. Further field studies on the effect of these chemicals is in progress.

26. *Productivity and physicochemical conditions of waters.*—Several observations made on different types of waters so far tend to show a direct relationship between the total alkalinity of the water and its organic productivity. A laboratory experiment carried out to confirm this correlation shows that there is a definite increase in the yield of organic matter as the total alkalinity of the water increases.

A field experiment was undertaken in the Linghipur fish farm for raising the low total alkalinity of these waters by liming and thereby if possible, improving their organic productivity. In this particular experiment regular observations made during a period of 6 months show that liming does not seem to have altered the water qualities. This may be because sufficient free CO₂ was not evolved on account of the lack of organic debris of silt at the bottom of the ponds to make the lime available to the water in the form of bicarbonates.

27. *Rearing advanced fry to fingerling stage.*—As survival of early fry in nursery ponds appreciably improved when improved nursery practices worked out during the last few years are employed, attention was concentrated since last year to evolve techniques for enhancing the yield of advanced fingerlings which are in high demand for stocking large ponds and irrigation tanks. Comprehensive experiments to ascertain the mortality of fingerlings during the rearing period were conducted.

Experiments in transport of spawn and fingerlings

28. On the basis of the results obtained by laboratory experiments conducted in previous years, some field experiments were conducted this year for transporting fish spawn in closed containers with oxygen. Polythene bags of about 20 litre capacity and 4 gallon tin-containers provided with a valve (which served as inlet for the gas) and an outlet, were used in these experiments.

Each carrier, containing about 80,000 early spawn, was filled with about 12 litres of water and 6 litres of oxygen. Plastic bags were filled with oxygen at atmospheric pressure while in tins a higher pressure of oxygen was applied by forcing the gas through the valve inlet keeping the outlet closed. It was observed that both the plastic bag and the tin-container were equally efficient. In one trip to Sambalpur which was done in 16 hours, covering a distance of 160 miles, there was practically no mortality at the destination and fairly high concentration of dissolved oxygen was maintained in both. In another trip to Jeypur about 400 miles were covered in 25 hours, out of which about 120 miles were covered by truck through the ghat road of Koraput hills and the rest by train and boat. In this trip also the result was fairly satisfactory. There was practically no mortality in tins and in most of the plastic bags. About 20% of the spawn died in a few of the bags owing to leakage and in some bags probably due to very high carbon-dioxide tension.

Inducing breeding of fishes by hormone injections

29. As a preliminary to experiments in breeding of Major Carps by hormone injections, small-scale experiments were conducted with some riverine and pond fishes.

Pseudeutropius atherinoides.—This riverine catfish was collected from a pool adjoining Katjuri river. Two females and one male were kept in separate jars for two days. On the third day, extract of pituitary gland from *Rohu* was injected into all these fishes. A second injection was given after 6 hours and the male and one of the females were kept in a 10-litre jar. Heavy spawning took place. The eggs hatched out within 15 hours after the second injection at a temperature of 82–84° F. All the life-history stages were studied. Thirteen days' old fry reached the length of 12.5 mm. and had adult characteristics. Although the catfish thrives in ponds, there is so far no record of its spawning in confined waters.

30. *Rohtee cotio*.—A pair of mature specimens of *Rohtee cotio* were injected with fish hormone. On the second day, the pair received a second injection and a second male was introduced. A few hours later, a number of fertilised eggs were collected. The eggs developed up to the 4–8-celled stage and then suddenly the development stopped. The reason for the failure of further development of the eggs is not known.

31. *Perilampus* sp.—Four *Perilampus* specimens (three females and one male) were injected similarly and released in a jar. After three hours the male was found dead, but several transparent unfertilised eggs were collected from the jar. The male was very small and probably died due to shock received at the time of injection. One female was observed to ooze fully mature transparent eggs.

Fish production in stocking ponds

32. To gather accurate data on this subject, twelve ponds covering an aggregate area of about 14 acres have been stocked with advanced fingerlings of major carps on a comparable basis. The ponds are being treated differently with a view to comparing natural production with the production under cultural practices. The experiment is in progress at the Chaudwar fish farm.

Natural history studies on fishes and other aquatic animals

33. *Food and fecundity of the minnow Esomus danricus*.—*Esomus* is a common minnow in Cuttack ponds. The study was made in order to find out the efficiency of the species to be introduced as a forage fish with

murrels. The average size of the adult male is less than that of adult females. Fecundity study of 55 females was made. Volumes and weights of the ovaries were taken, number of eggs counted and average size of eggs noted. Although the young minnow fed almost exclusively on small crustaceans, the adults fed mainly on phytoplankters.

34. *Study of predatory aquatic insects.*—Studies of the systematics, bionomics and life-histories of some of the important predatory aquatic insects were made. The dragon fly naiads and their adults have been described and provisionally identified. *Cybister* beetle larvæ were collected from Kausalyaganga and reared in jars and their development studied.

Larvæ of the aquatic Hydrophilids are highly carnivorous. They are very often found in troughs and cisterns and also in nursery ponds manured for rearing carp fry. The whole life-cycle is completed in 16–17 days. The larvæ fed voraciously on mosquito larvæ and pupæ. Pupation took place inside the mud and the adult emerged within a week. The breeding season seems to be extended, as the eggs and larvæ were obtained from July to February.

35. *Studies on fish food organisms.*—Detailed studies on planktonic rotifers, copepods and cladocerans were continued with a view to preparing comprehensive accounts of the same.

The small fresh-water prawn, *Palæmon lamarrei*, almost invariably occurs in nursery ponds. In some cases they occur in such large number that they become very harmful to carp fry. A systematic study of the natural history of this species, including the conditions under which it thrives, has been started.

RIVERINE AND LACUSTRINE SECTION

Studies on the fisheries of selected areas of the river Ganga, survey of fish seed collection centres in Uttar Pradesh and the investigation on the fishery biology of several species of riverine fishes, were conducted in the section during the period under report.

Fishery Investigations of the Ganga River

36. *Fisheries at Buxar.*—The fishery of *Hilsa* was the predominant one in Buxar accounting for 50·8% of the total annual catches in the area. The maximum quantities of *Hilsa* were landed in the period, October to January when 61% of the annual landings of *Hilsa* was obtained. The lowest catches of *Hilsa* were in the month of June (2·5% of total fish catches) although the month of April was only slightly better (3·4% of the month's catch). The

predominant size range of *Hilsa* in commercial catches was 14-18". The data show that the catch peaks of *Hilsa* at Buxar and Allahabad are separated by about a 20-day interval suggesting that *Hilsa* caught at these centres perhaps belong to the same racial stock since the 20-day interval may be the "migration" time required by shoals for negotiating a distance of over 230 miles from Buxar to Allahabad.

The major carps together made up about 15% of the total annual catches with *C. mrigala* contributing over 60% of the carp catches. The fishery of major carps was poor in the months, July to January (4.1-7.3%). The most productive months in regard to major carp fisheries were April, May and June (29.5-32.6%). The period of low catches of major carps incidentally coincides with the heavy landings of *Hilsa* in those months. The catfishes as a group formed a substantial fishery at Buxar, comparatively more important than that of major carps, and made up over 22% of the total annual catches. The fishery of catfishes was on the whole quite steady and substantial in all the months (18.3-56.3%) except in the months, October to January, when the landings were comparatively low (1.95-16.8%). The lowest catches were in January (1.95%) and the highest in April (56.3%). Among the catfishes, the fisheries of *Mystus* spp. and *Wallago* were most important, being respectively 34.4% and 32.5% of the total catfish landings of the year. The fishery of *C. garua*, which ranked third in order of importance, made up 10.5% of the catfish catches. It is interesting to note that 90% of the *garua* catches for 1956-57 were landed in the month of February 1957. The fishery of *silondia* made up 9.3% of the total catfish catches. *Fish landings at Sadhiapur, Allahabad*

37. A total of about 12,900 maunds of fish were estimated to have been landed at Sadhiapur, Allahabad, in 1956-57, as against 8,960 maunds in 1955-56.

The maximum catches during the year were made in the month of December (3,329 maunds) and the minimum in August (332 maunds). The period, October to January, was found to be the season of heaviest catches in Allahabad with over 67% of the total catches of the year landed in these months. During the year 1956-57, the maximum catches were made in October (1,247 maunds) and minimum in August (306 maunds.).

The status of the major fisheries was determined from the species composition in the total landings. *Hilsa* alone formed 63.5% of the total annual landings and were available in greatest abundance in the months, October to December, with poorest landings in the month of August. Among major carps which contributed 14.9% of the total catches of the year, *C. mrigala*

was the most important species and made up 9.9% of the annual landings. The fishery of *C. mrigala* was on the whole quite steady, although the months September to November were the most productive. Among catfishes the fishery of *Mystus* spp. was the most dominant, followed by that of *Wallago attu*, contributing 5.8% and 3.8% respectively of the total annual landings. In the final analysis, the fisheries of *Hilsa*, *Mrigal*, *Mystus* spp. and *W. attu*, in order of dominance, were the most important, together contributing 83% of the total annual catches at Allahabad.

The sizes of the more important species of the fish which form commercial catches at Allahabad have been recorded.

During the year under report analysis of data gathered on the quantitative study of the capture fisheries of Allahabad for the year 1954-56 was completed. The total catches in the year 1954, 1955 and 1956 were 6,812, 8,308 and 12,788 maunds respectively. *Hilsa* catches were in much greater abundance in 1956 than in the previous two years (3,048 maunds in 1955 against 7,598 maunds in 1956) which were mainly responsible for heavier landings in 1956.

Hilsa fishery accounted for 36.7% and 59.4% of the total annual catches for 1955 and 1956 with the peak season in the months October to December, during which period the *Hilsa* landings represented 64.5% and 86.4% of the total annual *Hilsa* catches for 1955 and 1956. The fishery of major carps contributed 32.5% of the total catches made in 1955 and 1956 respectively. *Mrigal* which was found to be the most predominant of the major carps species accounted for 20.8% and 10.8% of the total annual landings in 1955 and 1956 and made up 64.1% and 56.5% of the major carps landings for these two years. In 1955 the fishery of major carps was maximum in June and minimum in August; in 1956 the maximum was recorded in September and minimum in April. *Mrigal* and *Rohu* of the size range 23-30", *Catla* of 30" and above, and *Calbasu* of 13-20" were predominant in the commercial catches in 1955 and 1956 suggesting that the type of gear used for fishing the major carps remained more or less the same.

The catfishes constituted 25.1% and 17.7% of the annual landings in 1955 and 1956. *Mystus* spp. which formed the most dominant species of the catfishes accounting for 35.1% and 38.4% of the total catfish landings in 1955 and 1956; 8.8% and 6.8% of the total annual catches in the two years.

Observations of catch-per-unit-of-effort

38. Observations of fish catches from Allahabad with different types of gear were made in all the months of the year 1956-57 excepting July,

August and September 1956, and February 1957. These data were utilised in calculating the catch per-unit-of-effort, which would furnish an idea of relative abundance of fish.

Survey of fishing villages of Allahabad District

39. A survey of the fishing villages located along the banks of river Ganga, Jumna and Tons in the district of Allahabad has been completed. The survey pertained to the fishermen populations (men, women, children), fishing gear, fishing boats, etc., 79 villages in Allahabad District have been so far surveyed. Fishermen population has been estimated to be 16,558 of whom only 1,676 are actively engaged in fishing.

Investigations on the availability of major carp seed in western districts of Uttar Pradesh

40. With a view to locating new sources of major carp seed in Muzaffarnagar, Saharanpur, Bijnor and Dehra Dun Districts of Uttar Pradesh, investigations were conducted in July and August 1956 by operating trial "Spawn" nets at 10 sites located on the Ganga and Jumna. Only small quantities of spawn of major carps were available at these sites. However, large quantities of fertilized eggs and fry of *L. dyocheilus* and *L. dero* were available in the Jumna near Kairana in Muzaffarnagar and in the Ganga near Balawali in Bijnor District.

Investigations on the fishery biology of several commercial species

41. *Cirrhina mrigala*.—(a) *Fishery*.—In the year 1956 (January to December) about 1,377 maunds of *Mrigal* valued at Rs. 82,620 were estimated to have been landed at Sadhiapur which assembles over 81% of the total catches of Allahabad. In 1955 the *Mrigal* landings were estimated to be 1,732 maunds valued at Rs. 1,03,920. The fishery of *Mrigal* made up 10.8% of the total annual landings and 56.9% of the total major carp catches in 1956. In the first quarter of 1957 (January to March) approximately 268 maunds were landed.

It is seen that size group 23-30" is the most predominant one in the commercial catches of both 1955 and 1956.

(b) *Age and growth*.—It has been established that scales are reliable indices of the age of *Mrigal*. Otoliths, opercular bones and vertebrae were not found suitable for age determination.

(c) *Food and feeding habits*.—Gut contents of 141 specimens ranging from 8.5 cm. to 98.5 cm. were examined during the year. 79.2% of the contents consisted of decayed organic matter, 10.4% sand, 5.9% mud, 2.5%

semidecayed organic matter and 2.0 planktonic food. October to January was found to be the period of active feeding. From March onwards up to July the feeding was poor.

(d) *Sex and maturity*.—Of 139 specimens examined 70 were males and 69 females. The mature gonads were encountered in May and June. The fecundity of 5 mature specimens was found to be 4,63,670 to 1,809,536. The smallest mature female recorded in 1956 was 584 mm. and the largest 959 mm. in total length. Gonadosomatic indices were maximum in June in case of females (12.68) and in males it was maximum in July (0.41).

42. *Mystus aor* and *Mystus seenghala*.

(a) *Fishery*.—A total of over 480 maunds of *M. aor* and 252 maunds of *M. seenghala* has been estimated to have been landed at Allahabad (Sadhiapur) during 1956–57. The value of *Mystus* fishery was estimated to be about Rs. 33,900.

Fish of the size range 16–30" formed the predominant group in *Mystus* catches.

(b) *Food and feeding habits*.—73 stomachs of *M. aor* and 40 of *M. seenghala* were examined. 37.0% of the stomachs of *M. aor* and 32.5% of stomachs of *M. seenghala* were almost empty. The composition of food appears to be more or less the same, mainly consisting of small fish, insects, plant debris, shrimps and crabs. *M. aor* has preference for insects whereas *M. seenghala* exhibits preference for teleosts. A few cases of cannibalism were noted in both.

(c) *Sex ratio*.—The sex ratio in the commercial catches of the two species was (males first) 51.1 : 48.9 in *M. aor* and 50 : 50 in *M. seenghala*. In the months June to October males and in the months December to May the females, were in greater number.

(d) *Condition of gonads*.—*M. aor* : The specimens, examined in the laboratory in the period May to August, were found with gonads in the I or II stage of maturity. From the knowledge so far gained it appears that this fish perhaps breeds in May continuing to the end of monsoon season.

43. *Labeo calbasu*.—The study was commenced from September 1956. The gut contents of 58 specimens of size range 12.8 cm. to 73.6 cm. were examined. 69.0% of the total contents consisted of decayed organic matter, 24.3% sand and mud, 0.8% semi-decayed organic matter and 5.9% plankton items. In its feeding habits, *Calbasu* resembles *Mrigal*.

44. *Pangasius pangasius*.—36 adult specimens of *Pangasius* ranging in length from 667–1,207 mm. were examined at Allahabad where only adults are available. The stomach contents show that this fish subsists mainly on decaying animal flesh and molluscs, and is not predaceous in habits. The examination of gonads shows that the fish breeds only during the monsoon months.

Survey of Ganga fisheries

45. With a view to assessing the fishery resources of the Ganga system and determining the status of different fisheries, a scheme for the survey of the Ganga River has been initiated. During the year under report a stretch of about 250 miles of the Ganga in Uttar Pradesh from Siyana (Bulandshahar District) to Baksar (Unnao District) has been surveyed.

ESTUARINE SECTION

46. The investigations on the fisheries and fish populations of the Hooghly–Matlah estuarine system, studies on the racial composition of *Hilsa* and survey of productive potential of brackish-water *bheris* along with pot-culture experiments to study the conditions favourable for the growth of benthic biota in *bheris*, initiated last year, were continued during the period under report and satisfactory progress was made in all these studies. A *Hilsa* Investigation Unit with the necessary laboratory and field staff was established in the section during the year, after which the scope of investigations on the *Hilsa* fisheries was considerably expanded. With the help of additional staff appointed under the Second Five-Year Plan, the studies on fisheries and fish populations of the estuaries were intensified. Observations were also made on the indigenous practice of culturing brackish-water fishes in paddy fields in certain areas of the Sunderbans.

Studies on the fisheries and fish populations of the Hooghly and Matlah estuaries

47. Under this programme, the estimation of total catch and catch-per-unit-of-effort in the estuaries and biological studies of the fish populations are contemplated. During the period under report a complete inventory of the fishing units in the Hooghly estuary was made and considerable progress was made in similar work in the Matlah estuary. There are at present 2,07,131 fishing units (boat-net-manpower combinations) belonging to 41 types in operation in the Hooghly estuary. On the completion of the inventory in the Hooghly, the sampling programme for the estimation of catch from the estuary, was finalised. On the basis of data collected, the total quantity of fish caught from the Hooghly estuary has been estimated

to be about 42,92,921 lb. Efforts are now being made to improve the accuracy of the estimates. The catch-per-unit-of-effort data were also collected from all the sampling centres.

The year under report witnessed very poor fishing conditions in the Hooghly and Matlah estuaries. The main fishing season in the lower Sunderbans is during winter, when fishermen from the villages from the upper stretches migrate to camps in the Sunderbans for fishing. Due to the destruction caused by floods in West Bengal the fishing camps were set up late in the season. Over 3,000 fishermen with about 560 nets and 220 boats were camping in the Frazergunge and Jambu Dwip area. The catches in bag-nets as well as in other fishing units in the area were exceptionally poor. Shoals of *Hilsa* which used to occur in abundance in the area were conspicuous by their absence during the season. The moderate catches of Bombay duck, prawns, clupeids, etc., obtained in the bag-nets also decreased by the middle of December. Most of the fishermen, therefore, had to migrate to the Orissa coast or return to their villages by the end of December.

Age or size class composition, maturity and feeding of fish stocks

48. To study the age or size class composition, maturity and feeding intensity of fish stocks, samples of commercial catches were studied from selected sampling centres at fortnightly intervals. Salient features of the observations made, are summarised below.

Clupeids

49. The data relating to *Hilsa* caught from the two estuaries are incorporated in the report on *Hilsa* fishery investigations. Other clupeids of major economic importance in the catches from the two estuaries are *Setipinna* spp. and *Anchoviella* spp. *Setipinna phasa* was caught in all the centres of observation throughout the year. The predominant group in the catches belonged to the 0 year group. Mature and maturing fish ranged between 12.0 cm. and 28.9 cm. This species appears to have a prolonged breeding season extending from December to June. No marked variation in the feeding intensity of the species was observed. *Setipinna taty* was caught mainly from the Matlah estuary, where they were available throughout the year, excepting April and May, and in the lower zone of the Hooghly where it was abundant during the winter months. Those caught from the upper stretches of estuaries were mostly immature ones but the fish caught from the lower zones consisted of mature and maturing specimens, ranging between 11.0 cm. and 13.7 cm. in length. Among species of *Anchoviella*,

Anchoviella tri was the most common species in the catches from the middle and lower zones of Hooghly as well as from the Matlah. *Coilia remacarati* and *C. borneensis* were two other important clupeids.

Grey mullets

50. Among the grey mullets *Mugil parsia*, *M. corsula* and *M. cunnesius* were commonly caught from the estuaries. Catches of *M. parsia* were confined to the lower and middle zones. The majority of catches consisted of the 0 year group, except during the winter months when one and two-year old fish also occurred in the catches. *M. corsula* was represented in the catches mainly by the 0 year group ranging from 2-8 cm. in total length. *M. cunnesius* were caught from the middle and lower zones of the estuaries. They all belonged to the 0 year group. From August to October there was a major recruitment of young ones to the fishery.

Perches

51. *Sillago panijus* was the only important perch caught from the estuaries. It occurred in the catches throughout the year. Larger size groups were caught mainly during the winter months. During the month of August and September a large number of young fish with a modal length of about 3.5 cm. were found in the catches. From November to January adult fish in early stages of maturity were found in the catches in the middle zone of the estuaries. Young prawns, prawn larvæ, megalopa larvæ, copepods, isopods, amphipods, etc., and small gobioid fishes formed the main constituents of its food.

Threadfins

52. *Polynemus paradiseus* was caught from the Hooghly and Matlah estuaries almost throughout the year. From May to August maturing and mature fish were caught in appreciable numbers from the upper zone of the Hooghly estuary. During the winter months spent fish were caught in the lower zones nearabout the mouths of the estuaries. Two major size groups are found in the catches, one with a modal length of 5.5 cm. and another 15.5 cm. Prawns formed the main food of the species. The catches of *Eleutheronema tetradactylum* consisted mainly of young ones, except for stray specimens of larger size.

Catfishes

53. Over 23 species of catfishes were caught from the estuaries out of which about 10 are of greater economic importance. The fishery of almost all the important species of catfishes, in the middle and upper zones

of the estuary, was constituted predominantly by the 0 group fishes. Excepting *Mystus gulio* and *Pangasius pangasius*, which were represented in the catches during almost all the months of the year, the occurrence of the rest of the species was seasonal. Mainly, young ones of the fresh-water species of cat fishes (excepting *N. punctata*) enter the fishery in the upper zone of the estuary, in the monsoon and post-monsoon months, and usually none of these species is represented during the rest of the year. Most of the fresh-water species appear to breed in the riverine region beyond the upper zone, and the young ones come down, to the upper and middle zones for a brief sojourn of 3-7 months, and then return to the river. On the other hand estuarine catfishes like *Osteogeneiosus militaris* and *Tachysurus* spp. enter the fishery of the middle zone in the summer months (February to May). It appears that the species comes up for breeding, and spawning takes place in the month of April. In May the young ones as well as adults disappear from the estuarine area suggesting that after spawning the species descends down to the lower reaches of the estuary.

Three of the estuarine and one fresh-water species, viz., *O. militaris*, *Tachysurus jella*, *M. gulio* and *Nangra punctata*, spawn in the region covered by the survey. *O. militaris* and *Tachysurus jella* breed during April to May in the middle zone in Diamond Harbour-Uluberia region. *M. gulio* and *N. punctata* spawn in the middle and upper zones (Uluberia-Tribeni region), the former during late summer and monsoon months and the latter during monsoon months. *N. punctata* and *M. gulio* appear to mature and spawn for the first time, when they are about a year old.

Attempts are being made to explore the possibilities of estimating age of catfishes from sections of spines.

Bombay-duck

54. The Bombay-duck, *Harpodon nehereus*, formed a major constituent of catches from the Matlah estuary at Port Canning except during the period December to February. In the Hooghly they were caught in the lower zone and the lower reaches of the middle zone. From April to July 1956, the 0 group having a modal value of 7.7 cm. was predominant. New recruits entered the fishery from December 1956 onwards. Maturing and mature individuals were found only in the catches from near the mouths of the estuaries. These ranged from 19.0-29.0 cm. in length. Fish caught in December had the gonads mostly in the I stage of maturity. By January they had reached the III stage of maturity. Most of the fish caught in February had spent gonads. The food of the species consisted of small fishes, prawns and megalopa larvæ.

Ribbonfishes

55. *Trichiurus savala* was the most common ribbonfish in the catches from the estuaries. It was caught from the middle and lower zones of the Hooghly and from the neighbourhood of Port Canning in Matlah. Maturing individuals were found in the catches from Sunderbans area. *T. haumela* were less abundant but were caught from the same areas as *T. savala*. They ranged from 12.7 to 54.3 cm. in length. Maturing individuals were occasionally found in the catches from the lower zones of the estuary.

Jewfishes

56. *Pama pama*, *Sciæna coitor*, *S. vogleri*, *S. glauca*, *S. ossea*, *S. sina*, *S. albida*, *Sciænooides biauritus* and *Otolithus maculatus* were the common species of jewfishes in the catches. Of these *Pama pama* and *Sciæna coitor* were the most common species. *Pama pama* was caught from throughout the Hooghly estuary but was very rare in the Matlah. In the pre-monsoon and monsoon months, the smaller juvenile specimens were abundant in the upper zone, but in the post-monsoon period they were found in large numbers in the middle and lower zones. Majority of the larger size groups were caught from the lower Sunderbans. Three size groups with modal lengths of about 4 cm., 21 cm. and 25 cm. were found in the catches from April to July. From October to February large number of young ones were caught. Fishes above 16 cm. in length were found to be mature. Maturing fish were found in the catches, in small numbers, throughout the year. Spent fish were caught from May to August and November to January. The food of the species consisted of small fishes, prawns and copepods.

Sciæna coitor was caught from the middle and lower zones of the Hooghly and from the neighbourhood of Canning in Matlah. From April to June the size group ranging from 7-17 cm. formed the dominant group in the catches, but in subsequent months they were absent. New recruits entered the fishery from August to December. In August and September fishes ranging from 2-5.5 cm. in length formed the predominant group. From April to June maturing and mature fish were represented in the catches. The food of the species consisted of copepods, cladocerans and small prawns.

Miscellaneous fishes

57. Among the large number of species of miscellaneous fishes caught from the estuaries, the gobioid fishes *Glossogobius giuris* and *Odontamblyopus rubicundus* were economically more important. The fishery of *G. giuris* is mainly confined to the upper zone of the Hooghly estuary, where the juveniles predominated in the catches. Maturing and mature fish were caught

from the middle and lower zones during the winter months. *O. rubicundus* formed a considerable part of the catches in the upper zone of the Hooghly during the period, November to March. From the middle zone of the Hooghly and from Port Canning area in Matlah larger size groups were caught. This species appears to have a prolonged breeding season, with the peak period from November to February.

Prawns and shrimps

58. There are about 18 species of commercially important prawns and shrimps in the Hooghly-Matlah estuarine system. In the upper zone of Hooghly, the dominant species contributing to the commercial catches was *Palæmon birmanicus*, the large adult individuals of which were caught in the traps and nets only during the breeding season from May to September. During the remaining part of the year the catches consisted mostly of juveniles. In the middle zone the dominating species was *Palæmon mirabilis*, which was caught in large quantities throughout the year, except during the monsoon months. In the lower stretches *Leander styliferus* and *Metapenæus brevicornis* were the species substantially contributing to the catches, excepting the monsoon period when they migrate to the sea. In bulk, species of *Leander*, *Metapenæus brevicornis* and *Parapenæopsis sculptilis* caught from the lower reaches of Hooghly and from Canning together outweigh all the other species caught from all the other zones. The adult and large individuals of these species were found in large numbers only towards the river mouth, those migrating up the estuary being mostly small ones.

P. mirabilis seems to be endemic in the Hooghly estuary and is found throughout in all the seasons. *P. birmanicus*, though a fresh-water species, penetrates up to Diamond Harbour; but, the fishery is restricted to the upper zone only. The typically estuarine prawn *L. styliferus* ascends up to Uluberia. *Metapenæus brevicornis* is essentially a marine species and its range extends up to the middle zone. *Parapenæopsis sculptilis* though found in the middle and lower zones of Hooghly and at Canning in large numbers, adult mature specimens were taken only from the lower stretches towards the river mouth. *L. fluminicola* was not found in the brackish-water or saline regions. *Palæmon lamarrei* and *P. dayanus*, the two species, which normally do not occur in the river, formed a sizeable fishery during the year under report. They appear to have entered the upper stretches of Hooghly from adjoining ponds and rivulets during the heavy floods of the year.

P. mirabilis breeds throughout the year and hence fresh broods are found recruited to the population almost continuously. Maturing prawns, while migrating slowly to the lower stretches, mature and become berried

by the time they concentrate in the lower stretches. *P. birmanicus* breeds in the upper zone from May to September. It appears to have more than one brood in the same season. In *P. carcinus* females with the ovary in the IV and V stages of maturity were found to congregate in a particular locality in the middle zone from March to May. At the time of breeding many palæmonids were observed to migrate from one habitat to another of different salinity. *Leander styliferus* and *L. tenuipes* migrate to the sea at the time of breeding.

Most of the palæmonids mainly subsist on the bottom debris; other recognisable food items are larval fish, small crustaceans, insect remains, plant tissues, gastropod shells and diatoms. *P. mirabilis* is unique, as it feeds on planktonic crustaceans such as copepods and ostracods. Diatoms formed a considerable portion of the diet of *Acetes indicus* and *Metapenæus brevicornis*. Filamentous algæ occurred very frequently in the stomachs of *Palæmon birmanicus*. During the late monsoon season, most of the prawns were found to be feeding intensively on the megalopa of *Varuna litterata*, myriads of which occurred throughout the estuary at this time.

Hydrobiological observations of the Hooghly and Matlah estuaries

59. Hydrobiological observations of the two estuaries were conducted to examine the correlation between the fluctuations in the abundance of fish stocks in the estuary and the density of plankton in them. The surface temperature of the water in Hooghly ranged between 32.5° C. and 21.6° C. from August 1956 to March 1957. During the monsoon season, the salinity was trace, both in the upper and middle zones. The salinity steadily increased during the post-monsoon period in the middle zone, ranging between a trace & 16.5‰. In the Matlah estuary, the surface temperature ranged between 31.8° C. and 22.0° C. from August 1956 to March 1957 and the salinity ranged between 9‰ and 29.5‰. The water in the Matlah estuary never became fresh during the year.

60. The plankton data collected so far indicated a general decline in its density in Hooghly after a sudden fall in June. In Matlah the sudden fall in plankton density in June was followed by a sharp increase from July to August. But from November to December there was again a general decline in the zoo- and phytoplankton populations. This was followed by another increase in January to February 1957. As has been observed previously, the upper zone of the Hooghly showed greater production of plankton than the middle and lower zones, throughout the year. Port Canning area in the Matlah estuary is more productive than any area in the Hooghly. Relatively very low production of plankton was observed in the lower Sunder-

bans during the winter months which form the main fishing season in the area. This appears to be correlated with the very low catch of *Hilsa* and other plankton feeding fishes recorded in the area during the year.

Investigation on the Hilsa fisheries of India

61. Investigations on *Hilsa* fisheries of India were conducted in the Hilsa Investigation Unit, established in the section at the close of October 1956. The investigations initiated by the Unit closely followed the lines suggested by the Hilsa Sub-Committee of the Indo-Pacific Fisheries Council (at its meeting in Calcutta in July 1955). The programmes of work undertaken were as follows:

- (a) Continuation and intensification of the investigations on the population structure of *Hilsa*, already in progress in the Estuarine Section.
- (b) Processing and collation of catch statistics on *Hilsa* collected in the Estuarine Section from the Hooghly and Matlah estuaries.
- (c) Studies on length-frequencies of *Hilsa* catches from the major fishing centres for the purpose of assessing recruitment, mortality, strength of year-classes and growth trends.
- (d) Studies on the maturity and feeding of *Hilsa* stocks.
- (e) Initiation of larval and young fish surveys in the Hooghly estuary.

Population structure of Hilsa in Indian waters

62. Investigations on the racial status of *Hilsa* in the River Ganga and River Karmanasa, a tributary of the Ganga, by morphometric comparison of samples collected from them, showed significant differences in respect of head length, indicating thereby the possibility of the stocks in these two rivers belonging to two distinct racial stocks. Similar comparison of morphometric data of the *Hilsa* of the River Godavari with those in the Hooghly, showed that the *Hilsa* in these two rivers formed separate racial stocks, differing from each other in the relative height of body, length of caudal peduncle and diameter of eye.

Comparison of meristic and non-meristic characters of *Hilsa* samples collected from Brahmaputra and Barak Rivers in Assam indicated that the stocks of these two rivers are different. Comparison of these with the morphometrics of *Hilsa* from the River Hooghly showed that they are distinct from the Hooghly *Hilsa*. The *Hilsa* fisheries in Assam bear on the stocks found in the fresh-water zones of the two rivers and on the analogy of the tentative conclusion that the stock of *Hilsa* in the upper reaches of Ganga is distinct from that in the estuarine zones, it appears probable that the

Hilsa stocks in the rivers of Assam are distinct from those of River Meghna in East Pakistan) which the two rivers join.

Length-frequency studies

63. Length-frequency distributions of *Hilsa* in the commercial catches in the Rivers Hooghly, Ganga, Karmanasa, Godavari, Brahmaputra, Barak and Padma were studied during the year. Adult *Hilsa* in the commercial catches in all these rivers comprised of year-classes above $1\frac{1}{2}$ years age. The studies conducted during the year under report showed that the dominant year-classes in the commercial catches of *Hilsa* in the Ganga, the Hooghly and the Padma were the $3\frac{1}{2}$ and the $4\frac{1}{2}$ year-classes, while in the Brahmaputra, the Barak, the Godavari and the Karmanasa the $2\frac{1}{2}$ and the $3\frac{1}{2}$ year-classes formed the bulk of the catches.

Young *Hilsa* of 0 age-group, measuring from about 2.0 cm. to 7.0 cm. length, were caught in fairly large numbers in the Hooghly during the months November–December–January and in much smaller numbers during the other months.

Winter fishery for Hilsa in the Sunderbans

64. The usually intensive fishery for *Hilsa* in the Sunderbans, during the winter months, was a complete failure during the winter of 1956–57. The high turbidity of the water in the area at the time, and the scarcity of plankton in the water, appear to be significant; but since related data for the previous years are not available for comparison, the conclusions drawn at present are only tentative.

Studies on the feeding and breeding of Hilsa stocks

65. Samples of adult *Hilsa* collected in June from Rivers Brahmaputra and Barak, from River Ganga at Allahabad in April, May, June and October, and at Buxar in June and August were examined for a comparative assessment of their feeding intensity, composition of food, gonadal maturity, sex composition, etc. It was found that all the samples except that collected at Buxar in June, consisted of a large proportion of fish with empty stomachs, the remaining fish showing a poor intensity of feeding, with sandgrains present in fairly large quantities in their guts. All these samples showed a high proportion of males over the females and were in the later stages of maturity, ranging between stages IV and V, except those collected at Allahabad in May to June and at Buxar in June. The *Hilsa* from the Assam rivers collected in July were all in stages IV and V of maturity. Those collected from the Ganga at Allahabad in April were in stage V, and in May and June were in stages II and IV, while those collected from the same place

in October showed V and spent stages. The samples collected at Buxar in June had gonads in II stage of maturity, and in August, in the V stage. There appears to be hardly any correlation between the stage of maturity and the intensity of feeding in the sample examined, as, except in June sample from Buxar, all the others showed poor feeding intensity, though they differed in maturity from the III to the spent stages.

About 30–60% of the food of adult *Hilsa* examined consisted of green algæ of the order Zygnematales. Copepoda, Cladocera, Ostracoda and insect larvæ came only next in abundance, together constituting 22–43% of the gut contents. Diatoms formed only 2–3% of the gut contents of adult *Hilsa*. Other miscellaneous items such as rotifers, fungal hyphæ, roots of plants and other unidentifiable matter formed about 5% of the gut contents.

Young *Hilsa* of the 0 age class, showed great variation in feeding intensity between individuals, varying from empty to 'gorged'. Copepods, cladocera, algæ such as *Microcystis*, *Oscillatoria*, *Skeletonema*, *Cosmarium*, *Spirogyra* and algal spores, diatoms (mainly *Coscinodiscus*) and rotifers formed the chief items of food. One remarkable feature frequently noticed was the presence of only one or two of these organisms in very large numbers in the guts of individual fish, to the almost complete exclusion of the other organisms.

Initiation of larval and young fish survey

66. Preliminary experiments were made in the use of two-metre tow nets and the commercial bag-nets in the Hooghly for the quantitative assessment of the larval and young *Hilsa* present in the river. The techniques of collection and assessment are under experimentation.

Studies on the productive potential of brackish-water bheris

67. Soil conditions and ecological features of six typical *bheris* in different parts of Sunderbans were studied during the year to elucidate their correlation with the abundance of benthic flora. It has been found that shallow waters produce larger quantities of algæ, especially *Myxophyceæ*. *Ruppia* thrives in deep waters. Water temperature in the *bheris* ranged between 17.5° C. and 34.5° C. All the *bheris* had low concentration of phosphates in the water which was moderately hard. The salinity figures fluctuated very widely but did not seem to affect the production of algæ in any appreciable manner. Some of the soil properties appear to be closely correlated with the abundance of benthic algæ. Of the various physical properties studied, moisture at sticky point, water-holding capacity

and volume expansion of bottom soil have been found to be higher in more productive *bheris*. Pore space, specific gravity and apparent density did not, however, indicate any correlation with productivity. Studies on the chemical composition of the soil showed that high values of organic content, and specially a combination of high available phosphorus and nitrogen, favour better growth of benthic algæ. No differential influence of potassium and manganese on algal abundance was observed.

Pot-culture experiments to study the requirements of benthic algæ

68. With a view to determining the optimum range of salinity required for the growth and multiplication of benthic algæ, a series of pot-culture experiments were conducted with *Oscillatoria*. The experiments indicated that a salinity between 10‰ and 15‰ is most suitable for the growth and multiplication of the algæ. It has been further observed that the growth of *Oscillatoria*, even in the favourable range of salinity, was negligible during winter. Comparative laboratory experiments show that low temperatures below 28° C. are not conducive to the growth of the alga.

Culture of brackish-water fishes in paddy fields

69. The indigenous practice of culturing brackish-water fishes in paddy fields, in certain areas of Sunderbans, was studied in some detail during the year. It was observed that a production of 100–200 kg. per hectare of paddy field was obtained in the area with very little additional outlay, as proper embankments and canals have to be maintained in the fields even when fish culture is not undertaken. The common species cultured are Mulletts, Bhekti, Prawns and the Catfish, *Mystus gulis*. All these species grow faster in the paddy fields than in the open estuaries. An account of the investigation was prepared for presentation at the 7th meeting of the Indo-Pacific Fisheries Council at Bandung.

CHILKA INVESTIGATIONS UNIT

70. The research programme of the Unit consisted of surveys of the fisheries of the lake, study of the fishery biology of the lake fishes and hydrobiology of the lake. Appreciable progress has been made in the fishery survey programme and the compilation of information on the nature, location, lease values, etc., of the existing fishing grounds of the lake; compilation of fish export statistics from Chilka area and general observations on species and size composition of catches in different parts of the lake have been started. Considerable progress has also been made in studies on the maturity of the important fishes of the lake,

Fishing grounds of the lake and statistics of export

71. The lake has been divided by the State Government into 228 fishing grounds for the purpose of collection of revenue. Of these there are 93 enclosed trap fisheries called *Janos*, 40 prawn fisheries largely exploited by trapping; 24 open lake fisheries exploited by netting and 71 so-called "Dians" which are isolated pools and are exploited by various modes of capture. Full information on their lease values, which give some clue as to their productivity, has been compiled. Day-to-day fish export statistics for the year 1953-56 have been collected from the South Eastern Railway records for Rambha, Khallikota and Balugan Railway Stations.

Fisheries of the Chilka Lake

72. For the purpose of fishery survey the lake has been divided into 4 sectors, viz., Northern fresh-water sector, Central brakish-water sector, Southern saline and the outer channel. The salient features of the lake fisheries are described below sector-wise.

Jano fishery

73. The most outstanding feature of the Chilka fishery in the period under review was the installation, late in November of this year, as in other years, of enclosure traps, called *Janos*, which annually yield vast quantities of fish. The *Janos* were operated successfully in 1956 in the month of December after which the catches declined appreciably. The most productive *Janos* are situated in the central part of the lake. 60% of the catches consisted of mullets in which the most dominant species was *Mugil cephalus* followed by *Liza caruleomaculatus* and *Liza troschelli*. These species constituted about 35%, 11% and 7% of the total catches made in this sector, *Mystus gulio* was next to *Mugil cephalus* in the order of abundance contributing about 15% of the fishery of this sector. The perch *Gerres oyena* formed about 10.5% of the fishery of the central sector. Similar observations in other sectors of the lake revealed that in the month of January 1957, the most dominant forms in the north-east sector were the mullet, *Mugil subviridis*, *Mystus gulio*, *Mugil cephalus* and *Pseudosciana albida* stated in the order of abundance. The mud shad *Nematalosa nasus*, *Hilsa ilisha*, *Mugil cephalus*, *Caranx* sp. and *Gerres oyena* were the more dominant forms in the *Jano* catches of the south-east sector of the lake stated in the order of abundance.

Fishery of the north-east sector

74. Mullet dominated the catches in this sector in October 1956, forming 68.6% of the fishery followed by *Hilsa* (6.3%), *Osteogeneiosus*

militaris (5.8%) and *Lates calcarifer* (5.04%). In November 1956, *Bekti* formed the most important fishery (37.36%) followed by mullets (33.28%) and *Osteogeneiosus militaris* (10.71%). Throughout the period January to March *Mystus gulio* formed the most dominant fishery contributing 38.2%, 24.7% and 43.57% respectively of the fisheries of this sector of the lake. This was followed by *Osteogeneiosus* (11.3%) and *Eleutheronema tetradactylum* (11.2%) in January, by *Lates calcarifer* (23.04%) and *Eleutheronema* (11.14%) in February, and by prawns in March 1957. Prawns constituted about 28.82% of the fishery of this sector in March 1957.

Fishery of north-west sector

75. Mulletts dominated the fishery of this sector throughout the period of observation, viz., October 1956, to (except in January 1957, when *Bekti* was more dominant) March 1957, contributing from about 36% in November 1956, to about 60% in December 1956. *Mystus gulio* (19.8%) was the next dominant in October 1956, *Bekti* (27.0% and 22.9%) in November 1956 and February 1957, respectively and *Wallago attu* in March 1957. The third in the order of abundance was *Bekti* in October 1956, *Osteogeneiosus militaris* in November 1956, *Thrissocles* sp. in January 1957, and *Mystus gulio* in February and March 1957.

Fishery of south-west sector

76. Mulletts dominated the catches of this sector in the months of October (43.14%) and November (49.90%) 1956. These were followed by *Eleutheronema tetradactylum* (25.14%), *Osteogeneiosus militaris* (11.99%) and *Thrissocles* sp. (11.14%) in October 1956 and by *Thrissocles* sp. (10.76%), *Gerres oyena* (8.47%) and *Eleutheronema tetradactylum* (8.37%) in November 1956. *Thrissocles* (34.56%) followed by *Lates calcarifer* (27.80%) and Mulletts (10.76%) formed important fisheries in January 1957. *Hilsa ilisha* (35.97%) was the most dominant form in February 1957, and *Nematalosa nasus* (64.16%) in March 1957.

Fishery biological studies

77. With a view to determining whether the fishes of the lake breed in the lake or outside and the exact extent of their breeding seasons, relevant studies were commenced with regard to the following eleven commercially important species of fish: (1) *Nematalosa nasus*, (2) *Hilsa ilisha*, (3) *Thrissocles purava*, (4) *Mystus gulio*, (5) *Arius caelatus*, (6) *Plotosus canius*, (7) *Osteogeneiosus militaris*, (8) *Pseudosciaena albida*, (9) *Eleutheronema tetradactylum*, (10) *Gerres oyena* and (11) *Sparus sarba*. Environmental studies were also commenced with a view to correlating breeding seasons deter-

mined by the study of ovarian eggs with the occurrence of developing eggs, larvæ, fry, etc. In a tow-net haul made in March in the outer channel Carangid eggs and Clupeid eggs (*Thrissocles* sp., *Sardinella fimbriata*, *Kowala coval* and *Nematalosa nasus* stated in the order of abundance) were encountered. The post-larvæ of *Ambassis* sp. and *Cynoglossus* sp. were also found.

The stomach contents of *Nematalosa nasus* varying in size from 100–252 mm. were found to be largely decaying organic material supplemented by foraminifera, diatoms, copepods, molluscs and algæ. The stomach contents of juveniles of *Therapon jarbua* were mostly found to be amphipods; those of *Sillago sihama* to be copepods, insects, crustacean larvæ, etc., of *Hemirhamphus gaimardi* to be lamellibranchs, copepods and gastropods and those of *Mugil cephalus* to be copepods supplemented by diatoms, foraminifera, etc.

LACUSTRINE UNIT

78. A general survey of the lakes and reservoirs of India was undertaken immediately after the establishment of the Lacustrine Unit in August 1956, with a view to collecting preliminary information on the lacustrine fishery resources and selecting lakes and reservoirs for detailed investigations. During the period under report, surveys were completed in Andhra, Madhya Pradesh, Manipur and Rajasthan. Information regarding the area exploited and depth of reservoirs were collected from the Central Water and Power Commission and from the respective State Fisheries Departments. 108 reservoirs, about which information is available, cover a total area of 2,599.77 sq. miles out of which only 672.33 sq. miles (25.9%) is under exploitation. At present the production of fish from this area is estimated to be approximately 81,000 maunds per year. From the survey conducted it has been found that most of the artificial reservoirs are being exploited besides some of the large natural lakes of Andhra and Manipur State. The maximum depth of reservoirs ranged between 50 and 150 feet. The commercial catches from the reservoirs in Madhya Pradesh and Rajasthan consist of 50% of carps, 40% of Siluroids and 10% miscellaneous species. In Andhra *Labeo fimbriatus*, *Catla catla* and *Labeo calbasu* formed nearly 40% of the catches, Murrels, Siluroids and small *Barbus* formed the remaining 60% of the catches. In the shallow Collair lake and the lakes of Manipur, the catch consists mainly of air-breathing fishes and other Siluroids. In all the States the reservoirs and lakes are leased out to private parties for exploitation. Departmental fishing is done in a couple of reservoirs in Madhya Pradesh and in three reservoirs in Hyderabad. Fishing licences are issued to fishermen in Andhra for catching fish from reservoirs.

In all the reservoirs gill-nets having a mesh of 2"-4" and a height of 4'-50' are used for fishing. Accurate statistics of fish catches from reservoirs and lakes are not available. In Madhya Pradesh reservoirs are sometimes stocked with carp seed obtained from Bengal. In the Telangana area of Hyderabad also, the reservoirs are stocked periodically. In most of the reservoirs in Madhya Pradesh, Rajasthan and Hyderabad, it is reported that the fishes breed in the upper reaches or in the rivers joining the reservoirs. It would appear that these reservoirs get naturally stocked with fish seed every year. Submerged and floating weeds grow profusely in many of the reservoirs, especially in those in the State of Madhya Pradesh. For the proper exploitation of these reservoirs suitable measures for controlling the growth of weeds would appear essential. Restriction on size of mesh of gill-nets, on the size of fishes caught and the period of fishing are in force in most of the States to prevent uneconomical exploitation. The areas, where fish breed in the reservoirs, have been declared sanctuaries in the State of Madhya Pradesh.

CENTRAL INLAND FISHERIES
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List of scientific papers based on the work done at the Research Station that were published during 1956-57:—

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2. ———. 1956. If you have water grow fish. *Indian Farming*, May 1956.
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