

GOVERNMENT OF INDIA

CENTRAL INLAND FISHERIES RESEARCH STATION
CALCUTTA

ANNUAL REPORT FOR THE YEAR 1955-56

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GENERAL

1. There was considerable intensification and expansion of the activities of the Central Inland Fisheries Research Station during the year 1955-56. The Station was called upon to provide technical assistance to some of the State Governments for the improvement of their fish cultural programmes and training of personnel for this purpose. To investigate the fisheries in the Chilka Lake in Orissa, which is believed to be undergoing depletion, a Research Unit was sanctioned during the year. A Research Unit to study the *Hilsa* fisheries of India, a Statistical Unit to assist in the survey of inland fisheries and planning of fishery investigations, a Lacustrine Unit to study the lake and reservoir fisheries and a *Tilapia* Unit to undertake experimental studies on various aspects of *Tilapia* have also been sanctioned during the year. The necessary staff for the Schemes are being recruited.

2. Under the T.C.M. Programme, two jeeps with trailers, a motion picture projector, a generating set, one 35 mm. films strips projector, one epidiascope, one public address set and one trailer for the generator have been obtained during the period to facilitate the research and extension work of the Station. Mr. Paul Ziener, F.A.O. Naval Architect, prepared detailed drawings for an estuarine exploratory fishing vessel which is expected to be obtained for this Station under the T.C.M. Programme.

Technical Assistance to the States of Assam and Bhopal

3. The Fisheries Extension Unit and the Pond Culture Section of the Station jointly conducted experiments and demonstrations on improved methods of carp egg collections and their hatching and rearing in Assam. The Pond Culture Section conducted similar work in Bhopal also during the year. Spawn collection nets were considerably modified to work as floating, self-adjusting nets operated from previously prepared bamboo scaffoldings for collecting carp eggs from fast flowing rivers. By the use of such nets, the cost of collection could be considerably reduced as a series of about 12 such nets could be easily operated by two men from a boat whereas the old Chittagong method of collection required at least three men to operate a single net from a boat. Floating *hapas* were demonstrated to be the most economical device for the hatching of carp eggs in Assam. Hatching opera-

tions were conducted successfully in hatchery tubs in Bhopal. Improved methods of nursery preparation, fry rearing, artificial feeding, etc., were demonstrated and explained to the technical staff of the Fishery Departments. Considerable reduction in the rate of mortality of fry in the nurseries of the two States has been effected by the adoption of the improved methods of culture.

Fish Seed Supplies and Extension work among fish farmers

4. Demand for fish seed from deficit States was much higher during the year than in previous years. The Fisheries Extension Unit organised fish seed supplies by rail and air to the States of Andhra, Assam, Bhopal, Bombay, Coorg, Madras, Madhya Pradesh, Mysore, Vindhya Pradesh and West Bengal and by air to Nepal. Considerable difficulty was experienced during the year in the transport of seed on the South-Eastern Railway on account of the withdrawal of facilities offered last year in pursuance of the directive of the Railway Board. However, a total of 72,16,580 fry and 21½ kunkas of spawn of major carps were despatched during the year. Experimental consignments of fry packed in oxygen-filled plastic bags were sent to Bombay, Mysore and Assam. Mortality of fry in such bags was less than 1%. It has been found that packing of fry in plastic bags is much more easy and the air-freight of consignments would be lower due to reduced weight. The condition of fry can be directly observed through the transparent plastic bag and the bag can be used for transport more than once. It has, therefore, been decided to transport all the air-consignments of fry during next year in plastic bags.

5. The Fisheries Extension Unit gave technical advice to several fish farmers in West Bengal and adjoining States for initiation and improvement of fish culture. The staff of the Unit contacted fish-farmers in selected villages in West Bengal and after ascertaining the status of fish culture in the ponds, suggested easy and cheap means of stepping up production in them. A large number of enquiries received from various organisations, especially State Fishery Departments and Community Development Projects were attended to.

First All-India Fisheries Exhibition

6. With a view to acquainting the public about the progress of fisheries development in the country and to disseminate scientific knowledge acquired by research during recent years, an All-India Fisheries Exhibition was organised by the Station in collaboration with the Fisheries Department of Orissa at Cuttack and the Central Marine Fisheries Research Station. The Exhibition was inaugurated by Shri N. K. Chaudhuri, Chief Minister of Orissa,

on 20-2-1956 and was open till 26-2-1956. Besides the sponsoring organisations, ten other State Fisheries Departments, F.A.O., D.V.C. and a number of private organisations participated in the Exhibition. The Souvenir entitled "Progress of Fisheries Development in India" containing contributions by experts on various aspects of fisheries development in the country, including information on the expanded activities of fisheries development envisaged under the Second Five-Year Plan, was published on this occasion.

Training

7. The Inland Fisheries Training Course was continued during the year. 20 candidates—11 Government deputees, 3 Government Stipendiaries and 6 private candidates—were trained during the year in various aspects of inland fishery work with special reference to fish culture and fishery management.

8. Two officers deputed by the Government of Burma were given special training in the location of fish seed collection centres, techniques of seed collection, hatching, rearing and transport. Four officers of the Philippine Fisheries Department were given a brief special training in inland fisheries work in the Station at Calcutta and the Substation at Cuttack. A batch of officers and fishermen of the Madhya Bharat Government under the charge of a Superintendent of Fisheries, was given facilities to study the work of the Station at Calcutta and the Pond Culture Substation at Cuttack.

Meetings

9. Dr. B. S. Bhimachar, Chief Research Officer, attended the first meeting of the Committee on Standardization of the names of fishes and fishing subjects held at Calcutta in July, 1955 and the second meeting held at Madras in December, 1955. He also attended the meeting of the Research Committee of the Government of India at Delhi in April, 1955. As a member of the West Bengal State Fishery Advisory Board, he attended the meetings of the Board during the year under report.

10. The second meeting of the *Hilsa* Sub-Committee of the Indo-Pacific Fisheries Council was held at this Research Station from 30-6-1956 to 4-7-1955. Dr. B. S. Bhimachar and Dr. T. V. R. Pillay participated in the discussions of the meeting for the formulation of co-operative programme of research on the *Hilsa* fisheries of the Indo-Pacific area.

Deputations

11. Shri K. H. Alikunhi, Research Officer (Pond Culture), was deputed for a period of three weeks as a special instructor at the Third International

Inland Fisheries Training Centre at Bogor, Indonesia, under the auspices of the F.A.O. of the U.N. Shri S. M. Banerjee and Shri B. B. Bose were deputed for a period of three months to study the methods of soil analysis at the Indian Agricultural Research Institute, New Delhi.

Visitors

12. Shri A. P. Jain, Minister for Food and Agriculture, Government of India, visited the Research Station on 15-1-1955. Shri P. N. Thapar, Secretary to the Government of India, Ministry of Food and Agriculture, Shri R. L. Mehta, Joint Secretary to the Government of India, Dr. B. N. Chopra, Fisheries Development Adviser, Dr. D. Bhatia, Deputy Fisheries Development Adviser, Dr. N. K. Panikkar, Chief Research Officer, Central Marine Fisheries Research Station, and Shri K. Chidambaram, Assistant Fisheries Development Adviser, also visited the Research Station during the year under report. Other visitors to the Station were: Dr. W. B. Goodsell, F.A.O. Consultant, Mr. Chimits of the F.A.O., Shri B. R. Tandon, Adviser, Programme Administration, Planning Commission, Mr. Ole J. Heggem, T.C.A. Consultant, Prof. Kenji Nakamura from Japan, Prof. Liu Chung Lo of the Institute of Entomology, Academia Sinica, Peking, Dr. Mirchandani, Director of Soil Conservation, D.V.C., Shri A. Majid, Director of Fisheries, Assam, Shri Kantiraj, Director of Agriculture, Manipur, and Dr. Ghulam Mustafa Malik, Director of Fish Preservation, Kashmir.

STUDIES ON POND CULTURE

13. Investigations on the culture of fish in ponds were conducted mainly at the Pond Culture Substation at Cuttack. Besides continuing experimental studies for improving nursery practices, which have been in progress during the last two years, observations were also conducted on *Tilapia* and varieties of the Common carp, *Cyprinus carpio*.

Observations on *Tilapia mosambica*

14. Detailed study of the stomach contents of *Tilapia* of different sizes from different ponds showed that in ponds without macrovegetation, mud and sand constituted 40 to 80 per cent. of the stomach contents of adult specimens indicating bottom feeding to an appreciable extent. Other food items encountered were fish larvæ, phyto and zooplankton, worms, insects and filamentous algæ in the order of abundance. Fingerlings up to 55 mm. in total length were found to have fed heavily on *Tilapia* fry which formed 55 to 75 per cent. of the feed. Adult specimens had also fed occasionally on fish fry. Fry up to 25 mm. in total length had fed heavily on zooplankton which ranged from 25 to 95 per cent. of the stomach contents. In smaller

fry up to 15 mm. in length, the stomach contents invariably consisted of about 95 per cent. zooplankton. In ponds with an abundance of submerged weeds and filamentous algæ, the former constituted appreciable portion of the stomach contents in nearly 25 per cent. of the specimens examined. Filamentous algæ were encountered in the stomach of the majority of the specimens but the fry were feeding mainly on zooplankton. In ponds with algal blooms the smaller fry were feeding on zooplankton; the proportion of planktonic algæ in the stomach contents of adult specimens was appreciable. The quantity of mud and sand in the stomach was also considerable.

Preliminary observations show that growth is rapid in the early stages, averaging 1.5 to 2.0 mm. per day. In ponds with abundance of weeds, the growth of *Tilapia* is not satisfactory as in ponds without weeds. Growth is rapid when artificial feeding with oilcake is resorted to. Growth slows down with attainment of sexual maturity.

Observations on varieties of the Common carp, Cyprinus carpio

15. A variety of the Common carp *Cyprinus carpio* was introduced in the cold upland waters of India in 1939. It has since been found to grow well in our tropical waters in the plains also, but has not been breeding satisfactorily under such conditions. With a view to inducing this quick-growing exotic carp to breed freely in our tropical waters, a consignment of fingerlings was brought from Madras in January 1955. Stocked in ponds at Cuttack the growth of these fingerlings has been remarkably rapid. Stocked at the rate of about 200 per acre they showed an average growth of 6.1 inches and 382.1 g. (over $\frac{3}{4}$ pound) during a period of 6 weeks. Released in a large stocking pond along with *Catla* and *Rohu* the growth of Mirror carps has been satisfactory, averaging approximately 2 inches per month during the first 7 months. The largest specimen had attained a length of 18.4 inches and weighed about 4 pounds. Growth of Mirror carp was observed to be remarkably rapid when abundant submerged weeds were present in the pond. Growth of *Catla* was then not so satisfactory but when the weeds were removed and kept in check, growth of *Catla* improved and that of Mirror carps slowed down.

A preliminary experiment on artificial feeding showed that while Mirror carps consumed daily about one-fifth the body weight of artificial food in the form of mustard oilcake or groundnut oilcake, similar-sized fingerlings of *Rohu* could hardly consume half the quantity. The growth was also better in Mirror carps than in *Rohu*. Within a year the specimens became sexually mature and attained a weight of over 8 pounds.

Carp fry season experiments

16. (a) *Spaced manuring for maintaining high production of plankton.*—That manuring with cow-dung results in increased production of plankton has been demonstrated. This high production is, however, for only a short duration and it was found difficult to maintain high level production for a long period. As the availability of fry depends on rain and flood conditions which vary from year to year, in actual practice it is found difficult to have all the ponds ready with enough plankton when fry are available for stocking. A large-scale field experiment was, therefore, undertaken to ascertain whether spaced manuring at different doses would be of help in enhancing plankton production and maintaining it at a high level for a number of days so that the ponds will have adequate plankton whenever fry are available for stocking. 48 ponds treated in 12 different doses were under observation. Study of plankton collected at bi-weekly intervals from these ponds shows that spaced manuring with 1,000 lb. per acre initial dose of cow-dung followed up 10 days later by 5 more supplementary doses each, of 2,000 lb. per acre every third day, maintains a fairly high level of plankton production. The volume of plankton being almost invariably above 0.5 c.c. in 12 gallons of water. The same quantity of manure applied in a single dose did not maintain similar high production.

(b) *Species segregation of carp fry.*—Two experiments were carried out at the Nawapatna spawn collection centre with about 18,00,000 fry. In the first experiment the fry that came up to the surface were periodically removed in lots; while in the second experiment fresh-water was sprinkled at the surface each time fry were crowding there and when they came up again they were removed in lots. Samples of fry (20,000 to 80,000 from each lot) were stocked in specially prepared nursery ponds and reared to ascertain species composition. The earlier laboratory findings that species could be separated by this method were fully confirmed. Further, it was remarkable to observe that in the second experiment (with sprinkling of fresh-water) the first two lots of fry removed did not contain a single specimen of either *Catla* or *Rohu*. While this method is now demonstrated as workable under field conditions a series of experiments have yet to be carried out before the segregation procedures and timings are standardized for different compositions of fry.

(c) *Oilcakes as pond manure.*—Preliminary experiments to assess the relative utility of oilcakes as manure compared with the commonly used organic manure cow-dung, were carried out in the laboratory. While the study is still in progress it is seen that oilcakes generally produce blooms

of algæ in the first instance and these are followed by zooplankton. In the case of cow-dung, high doses practically assure early production of swarms of zooplankton.

(d) *Survival of fry up to fingerling stage.*—In properly prepared nursery ponds early fry grow to $\frac{3}{4}$ – $1\frac{1}{4}$ inch within 15 days if artificially fed on oilcakes. While the size is ideal for transport, for purposes of stocking irrigation reservoirs and large stocking ponds larger fry and fingerlings, about 3 inches long or larger are required. With a view to working out suitable cultural practices for rearing advanced fingerlings, 25 ponds were stocked with 15 days old fry in different densities of stocking. Some of the ponds were manured with cow-dung, and in others the fry were fed daily with oilcakes in different doses. Fortnightly samples were taken from all the ponds by netting and the feeding schedules were revised on the basis of growth rate observed. The entire experiment was, however, completely spoilt by overflowing resulting from unusually heavy rains. The experiment is, however, being planned to be repeated on a bigger scale during the next season.

(e) *Control of prawns and insects in nursery ponds.*—Mustard-oil-soap-emulsion treatment in nursery ponds was developed to control predatory aquatic insects and derris powder for removing fish. It has also been experimentally shown that water dispersible gammaxene (obtainable under the trade name of Hortex W.P.) in very low doses could kill the notonectids effectively without harming fish fry and with very little harm to fish food organisms.

Fresh-water prawns, mostly *Palæmon lamarri*, usually abound in nursery ponds and multiply rapidly during the rainy season. They are not killed by derris powder in doses fatal to fish. In carp nurseries they are harmful, in the sense that they compete with fish fry for food and probably prey upon weak and dying fish fry also. They also do considerable harm to fish fry when they are netted and crowded in *hops* or nets. Laboratory and field experiments have shown that water dispersible gammaxene in a very low dose of 0.1 parts in million parts of water could ensure complete kill of the prawns. The effect of this dose on zooplankton is insignificant even at 3 p.p.m. Fish are not effected and even at 0.1 p.p.m. all notonectids and most other aquatic insects are killed.

In continuation of the work carried out earlier with gamma benzene hexachloride for control of notonectids further experiments were carried out with the pure gamma isomer of benzene hexachloride. This compound being insoluble in water was first dissolved in ethyl alcohol and then applied

in various doses in the laboratory aquaria. It was observed that in the pure form the chemical is highly toxic to the insects killing them in about 6 hours at a dose of 0.01 p.p.m. only. Carp fry could tolerate a dose up to 0.05 p.p.m.

(f) *Quietening fish for better transport.*—Earlier experiments with sodium amytal have shown that when dissolved in water this drug can quieten carp fingerlings. The oxygen consumption of the drugged and quietened fish was however not significantly lower than in normal fish but it was felt that the quietened fish will be much less susceptible to physical shock and injury during transport than ordinary fingerlings. A field experiment was carried out to test this. Two equal lots of carp fingerlings (4 inches size) were put in two sets of tin carriers each of about 20 litre capacity. One lot was treated with sodium amytal and the other was kept as control. After about 3 hours run over bad roads the two lots were stocked in separate cisterns. It was found that the survival after four days in the lot treated with amytal was 50% more than in the control lot.

(g) *Studies on fish food organisms.*—Laboratory experiments were carried out to find out the rates of production of the important fish food, *Moina* at different doses of manure (cow-dung) in the same volume of water. Doses of 500, 1000, 2000, 5000 and 10000 lb. per acre were tried. During a period of 15 days it was found that total production increased with the increase in the dose of manure. As the number of *Moina* introduced in each jar was the same, increase in production indicates that breeding capacity of the individuals also increases with the increased availability of nutrients.

Fish Breeding Experiments

17. Preliminary experiments in inducing various fish to breed by pituitary gland injections were carried out. Material for these studies was procured at Mettur, Madras, while some brought from Alabama (U.S.A.) was also used. Intraperitoneal injections of dried pituitary gland suspensions in distilled water induced ovulation in *Labeo bata*. With major carps (*Catla* and *Rohu*) the males became oozing within 24 hours after the injection, but the females did not show any appreciable change, probably because they were not fully ripe. Successful spawning was induced in the common Minnow, *Esomus danricus*. The fishes were injected with *Catla* pituitary glands. Within 4 hours heavy spawning took place and the eggs were fertilised. Injections of *Mystus aor* pituitary gland were administered to the *Singhi*, *Heteropneustes fossilis*. Ovulation took place within 20 hours of the injection but ova could not be fertilised as males were not available. Gold fish injected with carp pituitary readily spawned within 12 to 16 hours. By repeating

the injections it was possible to make them breed whenever required. Similar but intermuscular injections on scale carp (*Cyprinus carpio*) rendered the males oozing, when the injection was repeated at 6-hourly intervals. A female developed loose ova in the ovaries but before spawning could take place the fish died owing to an accident.

Experiments on Pond Fertilization

18. In continuation of the experiments conducted in the previous year 12 nursery ponds were manured with different combinations of inorganic and organic manures in equivalent nutrient basis and in varying doses to study the relative efficiency of these different combinations in maintaining a sufficiency of food in carp nurseries. The manures used were: (1) cow-dung (1.90 per cent. N, 0.80 per cent. P_2O_5 , 0.30 per cent. K_2O), (2) Super-phosphate (20 per cent. P_2O_5), (3) Sodium nitrate (16.00 per cent. N) and (4) Potassium sulphate (48.0 per cent. K_2O).

Regular examination of water and plankton showed practically the same trend of variations as in the previous year. The water remained alkaline with pH generally ranging between 8.0 to 9.0. D.O. was maintained at fair concentration. As regards the essential nutrients there was no proportionate increase in their concentration in the aquatic phase by the added manures and in the ponds manured with organic manures only the phosphate was maintained at a comparatively higher level throughout the period of observation as observed in the previous year.

All the ponds were stocked with equal numbers of early fry, approximately at 4 fry per cubic foot of water. Before stocking, the stock of previous year was completely removed by rotenone treatment and repeated netting. The survival and growth of these fry were estimated by complete netting after about 15 days.

The experiments showed that only organic manure gives the best result as regards yield per acre. Considering also the percentage of survival and the cost of treatment this treatment appears more efficient than others. It may however be mentioned that while manuring on equivalent nutrient basis, the high proportion of nitrogen in the cow-dung has made the combinations with inorganic nitrogen rather more expensive. When comparing the results with phosphates and potassium, this high proportion of nitrogen in organic combination may not be necessary. From the standpoint of cost and yield per acre PK combination appears to rank next to organic manure, and in view of the fact that importance of the phosphatic manures as single fertilisers is well recognised this combination will be studied in detail, in the next year.

Weed Control Experiments

19. (a) *Experiments with hormone weed killer.*—In view of the fact that the different salts and esters of 2-4 dichlorophenoxy acetic acid are recognised as very efficient for controlling broad leafed floating and emergent weeds, experiments were taken up with fernoxone, to study the effect on emergent and rooted aquatic vegetation. It is an I.C.I. product the active constituent being Na salt of 2-4 dichlorophenoxy acetic acid. Aquatic weeds *Hydrilla* and *Ottelia* were grown in cement cisterns, 6'×3' with 2' of water and 6" soil substratum. The doses applied were 19, 15, 20 lb. per acre foot of water. The same treatment was also done in Killa moat area in field plots which had a thick growth of *Hydrilla*, *Ceratophyllum* and *Naias*. Floating and emergent weeds like *Pistia*, *Limnanthemum*, *Ipomea* and *Marsilea* were also present. In both the cases it was observed that the submerged vegetations were little affected by the chemical, though in the latter experiment the emergent weeds were completely killed in about 10 days' time. Probably a much higher dose is necessary for killing the submerged vegetation as the chemical is much diluted by the water, but considering the high price of the chemical the prospect of its being used as a cheap and economic means of controlling submerged weeds is probably very remote.

(b) *Experiments with sodium arsenite.*—In some preliminary experiments conducted under semi-field conditions in cement cisterns with a thick growth of *Hydrilla* grown artificially it was observed that this chemical though not favoured because of its poisonous nature, is very effective in killing submerged aquatics. When applied at 6, 8 and 10 p.p.m. it was observed that with all these doses the weeds completely decomposed and dissolved in 7 days' time. The carp fingerlings introduced in the cisterns could not however resist this dose.

The experiment was repeated under field conditions in a Killa channel which had thick natural growth of *Ceratophyllum* and *Naias* with sparse growth of *Hydrilla*, *Limnanthemum*, *Lagarosiphon* and *Jussiaea*. The dose applied was 5 p.p.m. The plants showed visible signs of decay from the second day and started decomposing from the fifth day, being completely decomposed in about 10 days' time. A few *Limnanthemum* plants had however survived. It is interesting to note that this dose did not prove lethal to the natural stock of fish in the pond, which consisted of *Tilapia*, Murrels, Catfishes and Carps (*Rohu*, *Catla* and *Mrigal*). Some signs of unrest were observed on the 6th day when the oxygen concentration of the water went very low but no fish died.

(c) *Experiments with black dye Nigrosine G 140.*—The black dye nigrosine G 140 was applied at 10 lb. and 20 lb. per acre in two cement cisterns heavily choked with *Hydrilla verticillata*. It was observed that though this dye imparted a deep colour to the water in experimental cisterns, this deep colouration could be maintained for a long period only in the absence of weeds.

(d) *Weed control with organic manures.*—It has been commonly observed that application of a heavy dose of cow-dung turns the water deep or chocolate brown in colour within 2-3 days and this colour is maintained for a number of days. Experiments were conducted to ascertain whether these changes in the colour of water will adversely affect the growth of submerged weeds. At the rate of 9 tons per acre cow-dung when applied in the form of a liquid made a thick brown layer which completely shut off all submerged weeds from view. Normal diffusion of sunlight was obviously affected and in one of the ponds at the end of the month after treatment practically all weeds (*Naias* spp.) had disappeared and the water was still brown in colour. The results were not so remarkable in other ponds. It is possible that the extent of weed growth and the depth of water above the weeds may have some bearing on the success of this method which will be tried in other ponds also.

(e) *Weed control by manual labour.*—To see how the cost of chemicals compared with manual labour a field plot of 1/16th of an acre was cleared of a thick growth of *Hydrilla*, *Naias*, *Ceratophyllum* and a number of emergent aquatic weeds by manual labour. It took 16 man-hours to clear the area completely, that is at a cost of about Rs. 48 per acre. However, it was found that the submerged weeds came up again in fairly large numbers after a fortnight, almost choking the water within a period of about 6 to 10 weeks. This means that manual labour has to be used once in 2 or 3 months to keep the water clear of vegetation.

Preliminary studies on the autecology of higher aquatic plants and their control in fish ponds were undertaken at Calcutta also. It was found that the seeds of *Limnanthemum cristatum* would germinate under favourable conditions without undergoing any long dormant period. Experimental studies showed that *Hydrilla verticillata* is predominantly a rooted aquatic and would thrive only in sub-strata containing not more than 50% of sand. Results of experiments in earthenware tubs showed that *Hydrilla verticillata* would completely decay within a period of 3 months if its surface is kept covered by a thick layer of *Azolla*. It was observed under both laboratory and field conditions that treatment with 500 p.p.m. superphosphate will

uproot the rooted submerged *Hydrilla* plants within about 18 days without adversely affecting the fish population in ponds.

STUDIES ON RIVERINE FISHERIES

20. Fishery investigation of the Ganga River System including quantitative study of fish landings, their species and size compositions; fishing village survey and observations on catches per unit of effort; prospecting for new sources of major carp seed; study of general fishery biology of several commercial species of fish, notably those of *Mrigal* and *Mystus* and study of stream pollution were the major investigations carried out on riverine fisheries at the Riverine and Lacustrine Substation at Allahabad.

Fishery Investigations of the Ganga River System

21. The purpose of this investigation was to acquire knowledge of the relative predominance of different species of fish and their sizes in the commercial catches in different sections of the Ganga river system; to evolve a method of estimating total fish production in the river system and to study fish abundance. For this purpose a rapid fishery survey of several important fish production centres in Uttar Pradesh and Bihar was made in 1955 and quantitative studies of fish landings at Allahabad and Buxar were continued.

(a) *Fishery of Bihar*.—The centres surveyed included Patna, Bhagalpur and Sahibganj in South Bihar and Katihar, Hassanpur Road, and Khagaria in Northern Bihar. The principal areas of fish production in Bihar lie in Northern Bihar where river Kosi and its numerous channels, which form a network in that part of the country, are the main sources of fish. Katihar, Hassanpur Road and Khagaria are the main assembly centres. River Ganges does not yield appreciable quantities of fish in Central and Eastern Bihar except for *Hilsa*. Other fish harvested in Ganges are mostly locally consumed. The fishery of Southern Bihar is mostly culture fishery and river fish found in Patna, Bhagalpur, etc., are largely those received from Northern Bihar. The source of fish seed in Southern Bihar is mainly the Ganga. Most of the riverine species of fish harvested are available all the year round. Their relative abundance alone varies from season to season. *Labeo rohita* followed by *Mrigal*, *Catla* and *Wallago attu* constitute the dominant riverine catches in Northern Bihar in the season autumn to spring. *Hilsa* and Prawns are abundant in the period June-September at Katihar and Hassanpur Road. There are about a dozen other species of commercial value found in the area the trade of which is lucrative but they are comparatively secondary to the species named above. The annual export of fish from Katihar in 1954 was 40,253 maunds. In the three main assembly

centres named above in Northern Bihar, the approximate landings per day in March were observed to be 142 maunds and in April 173 maunds. Khagaria and Hassanpur Road are more important assembly centres, in the order stated, than Katihar. The catches in autumn and winter months, particularly in the latter, are reported to be of far greater magnitude than those observed in spring and summer.

Fishery of Central, Eastern Uttar Pradesh and part of Western Uttar Pradesh.—The centres surveyed included Benaras, Mirzapur, Kanpur, Etawah and Agra. Benaras and Mirzapur on Ganges have similar fisheries which share certain common characteristics with those of Buxar situated in Western Bihar. Here again a large number of species enter the commercial catches and most are available all the year round. Their relative abundance varies from season to season. *Hilsa* occurs most dominantly in September and October, *Pangasius* in June-August, *Mystus* in March-July and major carps in April-June. Approximately 17,730 and 5,000 maunds of fishes were exported from Benaras and Mirzapur respectively in the year 1954. About 15 to 20 per cent. of the fish produced is locally consumed at Benaras. The entire catches at Mirzapore are exported.

The abundance of *Hilsa* progressively decreases as one proceeds West. At Allahabad, *Hilsa* catches are considerable but at Kanpur *Hilsa* doesn't constitute a fishery of any consequence. Similar is the case at Etawah and Agra. *Mrigal* is by far the most dominant fish at all these 3 centres all the year round. Amongst major carps, *Mrigal* is definitely known to be dominant both at Buxar and Allahabad. The zone of dominance of *Mrigal* appears to commence in Western Bihar and continues right up to Agra. The relative importance of other indigenous fishes somewhat varies at these centres; while *Catla* is the next dominant fish at Etawah, it is replaced by *Mystus* both at Kanpur and Agra. At Buxar and Allahabad also *Mystus* is the next dominant fish. *Calbasu* also forms an important fishery at Agra and Etawah but not at Kanpur. *Wallago attu*, *Silonia*, *Pangasius* and *Rohu* constitute lucrative fisheries but are not so important as *Mrigal* and *Mystus*. Both Etawah and Agra are large centres of fish production and assembly. In 1952, 8,370 maunds, in 1953, 14,438 maunds and in 1954, 12,439 maunds of fish were exported from Etawah. In 1953, 17,876 maunds in 1954, 23,759 maunds of fish were exported from Agra.

(b) *Fish landings at Sadiapur, Allahabad.*—A total of about 8,308 maunds of fish have been estimated to have been landed at Sadiapur, Allahabad, in the 12 months of the year 1955.

The maximum catches during the year were made in the month of October and the minimum in August, when the average landings per day were 40.2 and 9.9 maunds respectively. The period September to January may be considered as the season when the heaviest catches are made by the fishermen.

The status of each species of fish in the commercial catches has been precisely determined. Considering the over-all picture of the year, *Hilsa*, *Mrigal*, *Mystus* and *Wallago* formed the most important fisheries, in the order of dominance stated, together contributing about 72 per cent. of the fishery at Allahabad. *Hilsa* alone formed 36.7 per cent. of the fishery and was available in greatest abundance in October and in least in May. *Mrigal* was available in almost equal abundance in September and March (207 and 206 maunds respectively), which was the maximum of the year, and in least in February. *Mystus* was comparatively more dominant in April and *Wallago* in November.

(c) *Capture Fishery Statistics at Buxar (Bihar).*—During the year under report analyses of data gathered on the capture fisheries at Buxar for the years 1952–54 were completed. Including fresh-water tortoises and prawns total catches in Buxar in the years 1952 (May onwards), 1953 and 1954 were 2,693.0, 4,207.8 and 11,994.4 maunds respectively. *Hilsa* catches were made in far greater abundance in 1954 and were mainly responsible for the enhanced landings of 1954. They constituted 31.3 per cent., 25.0 per cent. and 78.5 per cent. of the total fisheries for the years 1952, 1953 and 1954 respectively. Major carps formed 19.7 per cent., 21.4 per cent. and 5.4 per cent. of the total catches in the years 1952–54 respectively. Eight species of catfishes, including the major and minor forms, constituted 23.8 per cent., 32.9 per cent. and 7.8 per cent. of the catches in the year 1952–54 respectively. The availability of *Hilsa* in 1954 was 900 per cent. higher than in 1953. On account of the easy availability of *Hilsa*, there was less intensive fishing for other species in 1954. Although *Hilsa* is available all the year round, the period July–December constitutes the main season of its fishery, the peak generally falling in the month of October or November. 81 per cent. and 97 per cent. of the total catches of *Hilsa* in 1953 and 1954 respectively were made in the latter half of these years and 50 per cent. of the total annual catches were made in November, 1953, the peak month of production that year. In 1954 nearly 65 per cent. of the total catches for that year were made within only 2 months, viz., October and November.

Hilsa formed the most dominant fishery in the Buxar area in 1955. Its availability in monthly catches varied between 12.2 to 93.5 per cent. It was most abundant in the months of September and October and least in

April. Catfishes (in which *Mystus* was most dominant) formed the next dominant fishery and were abundant during winter and spring seasons.

(d) *Fishing villages survey*.—A survey of the fishing villages around Allahabad was initiated. To date, a total of 26 villages, 11 of which are located on the river Ganga and 15 on river Jumna, have been surveyed. These villages have a total population of 1,755 active adult fishermen who possess a total of 260 units of different types of gear and 696 fishing boats.

Investigations on the availability of major carp seed

22. With a view to locating new sources of major carp seed in Meerut and Bulandshahr Districts of U.P., an investigation was conducted in July and August in which trial fry collection nets were operated at 9 sites connected with Ganga or Jumna or their tributaries. As a result of this investigation two new and very productive sources of major carp seed have been discovered at Baghpat in Meerut District, and Rajghat Narora in Bulandshahr District. A third site of comparatively lesser value has been discovered at Dankaur in Bulandshahr District. At Baghpat about 45 lakhs fry (of which about 80 per cent. were determined by rearing to be major carps), and about 17½ lakhs of major carp fingerlings were collected in the season. The collection site near ferry Ghat at Baghpat is gradually sloping and is ideal for simultaneous operation of over 100 fry collection nets. The State Government of Uttar Pradesh was informed of the productivity of the site at Baghpat and in this very season the State personnel started its commercial exploitation. At Rajghat Narora about 10¼ lakhs of fry, of which 70 per cent. were determined by rearing to be major carps, and about 1½ lakhs of major carp eggs were collected in the season. At this site also about 100 fry collection nets can be simultaneously operated and spawn collected with the help of one or two boats. Dankaur yielded about 3 lakhs of carp fry and 1,500 carp fingerlings.

Surveys conducted during the year enabled the location of the spawning grounds of major carps in the Kosi River in Saharsa District, in Burhigandak in Muzaffarpur District, and in Ganga at Sakrigalighat.

Investigations on the biology of commercial species

23. (i) *Cirrhina mrigala*.—The size classes of *Mrigal* which formed commercial catches at Allahabad in 1955 are given in the table on the next page.

It may be seen from it that 23–30 inches size range forms the most commercially exploited size of *Mrigal*.

Class	Size of Range	Per cent. in <i>Mrigal</i> fishery of 1955
I	Up to 12"	7.4%
II	13"-22"	24.9%
III	23"-30"	43.1%
IV	31" and above	24.6%

Progress was maintained in the scale studies of *Cirrhina mrigala*. It was tentatively inferred that *Mrigal* scales are reliable indices of the age of the fish. Approximate size and weights attained by *Mrigal* at various years of its life have been biometrically computed to be 12 inches, 20 inches, 25½ inches, 29½ inches, 32½ inches, 34½ inches and 35¾ inches in the first 7 years of its life respectively. Otoliths, vertebrae and opercular bones are also being studied for age determination but no conclusions have yet been drawn.

Gut contents of samples belonging to 4 different size groups were examined. 62.8 per cent. of the gut contents consisted of decayed organic matter, 13.7 per cent. sand, 19.8 per cent. mud, 2.8 per cent. planktonic food and 0.9 per cent. semi-digested organic matter. Amongst the planktonic food 49.2 per cent. consisted of diatoms, 22.8 per cent. of chlorophyceae, and the rest of Myxophyceae, Euglenae, Zooplankton, Fungi, etc. The period December to February is the time of active feeding of the fish. From March onwards the number of empty guts considerably increases.

(ii) *Mystus aor* and *M. seenghala*.—Study on these fishes was commenced in November 1955. Fishes of the size range 15-30 inches and 31 inches and above together formed 96 per cent. of the total *Mystus* catches in 1955. Sex ratio of *M. aor* in March was 54.5 per cent. males and 45.5 per cent. females and in *M. seenghala* 56.5 per cent. males and 43.5 per cent. females. Both the species mostly feed on other species of fish, insects and crustaceans.

(iii) *Eutropiichthys vacha*.—*Vacha* forms a valuable fishery during the period December to May. The fish grows by about 165 mm. in the first year and 110 mm. in the second year of its life. It subsists mainly on aquatic and terrestrial insects and teleosts. It is a marginal surface feeder and feeds actively in the period April to July and September to November. Males

mature at a smaller size (185–195 mm.) than females (210–225 mm.). Fecundity ranges between 45,643 to 3,88,260. Males are heavier than the females in the earlier stages but after the length of 180 mm. is reached the females turn heavier. Sex ratio in 1954 was 32 per cent. males and 68 per cent. females.

(iv) *Chupisoma garua*.—Examination of stomach contents showed that 41.3 per cent. of the feed consisted of terrestrial and aquatic insects, 8.5 per cent. animal flesh, bones, etc., 2.9 per cent. fish, 1.0 per cent. bivalve molluscs, 1.0 per cent. crustacea, etc.

(v) *Ailia coila*.—The fish mainly feeds on aquatic and terrestrial insects which form 38.9 per cent. of the diet. Ostracods form 2.9 per cent. and semi-digested and mostly unidentifiable animal matter about 23.9 per cent. of the diet. Sand, mud, mucus and other incidental food items found in the stomach together make up about 34.3 per cent. of the gut contents. The fish appears to be a bottom marginal feeder.

(vi) *Pangasius pangasius*.—Studies on the food and growth of *Pangasius pangasius* were continued during the period. The natural food of the species in the tidal rivers was found to consist mainly of refuse matter thrown from boats, faecal matter, prawns and crabs. Experiments on the culture of this species along with carps were continued during the period.

(vii) A quantitative study of the stomach contents of 4 economic species of catfishes collected at Buxar showed that *S. silondia* subsists mainly on crustacea and other fishes, *Pangasius* on bivalve molluscs and gastropods, and *Bagarius* and *Wallago* almost exclusively on other fishes. The precise status of each item of food in fish diet have been determined.

Stream Pollution Studies

24. Pursuant to reports from Uttar Pradesh Department of Fisheries a survey of 11 mile stretch of river Suvaon in Balrampur, from Railway Bridge to Sundar Baag (near Chanda taal), was made in January to February 1955 to study the effects of Sugar Mill wastes on the fishery of the Suvaon. The results showed that the fishery in the 3-mile stretch from the effluent outfall is adversely affected by the Sugar Mill wastes discharged into it. The wastes are predominantly organic in composition and deplete available oxygen of the water in the affected zone, resulting in heavy fish mortality. In the sampling stations upstream of outfall over 45 species of fish were collected of which major carps (0 year class) and *Wallago attu* formed the bulk. Minor carps, minnows, small-sized catfishes were very abundant. The dissolved oxygen in this section ranged between 5.3 to 6.2 p.p.m., with very low B.O.D., and O.C. values. Immediately below the outfall only 12 species were

taken of which *Amblypharyngodon mola*, *Rasbora daniconius*, *Puntius saphore*, *Ophicephalus murulus*, *Pseudeutropius atherinoides* were quite common, the rest occurring stray or rare. These forms are all small-sized and insignificant as commercial species. Major carps were totally absent. D.O. value was 2.2 p.p.m. with B.O.D. 740 p.p.m. and O.C. 360 p.p.m. Further downstream in the zone of mortality near "Nahar Bridge" pool, 28 species were available of which *W. attu* was the most predominant form. *P. saphore*, *Mystus punctatus* and *M. seenghala* were also fairly common and the rest occurring stray or rare. Major carps were totally absent. The fishes in this stretch appeared to be emaciated. D.O. values were nil to 0.1 p.p.m. with high B.O.D. and O.C. values.

Downstream of "Nahar Bridge" pool, species composition was also of a specialised type. Further downstream the number of species generally increased till at Sunder Baag, 8 miles downstream of the effluent outfall, 30 species were available. The D.O. value was 0.6 p.p.m. at Janjhari, 3 miles downstream of effluent outfall, from where the recovery commences and 2 miles further downstream the value was 6.0 p.p.m. which was maintained in all the downstream stations.

STUDIES ON ESTUARINE FISHERIES

25. Studies on grey mullets, *bhekti* and prawns; a general fishery and hydrobiological survey of the Hooghly; and hydrobiological observations in a *bheri* at Taldi were carried out in the Estuarine Section till the end of September 1955. The programme of work of the section was then reorganised and the following three investigations were initiated from the month of October 1955.

- (1) Investigations on the fisheries and fish populations of the Hooghly-Matlah estuarine system.
- (2) Studies on the racial composition of *Hilsa* in Indian waters.
- (3) Survey of the productive potential of *bheris* in the Sunderbans and pot culture experiments to study the conditions favourable for the growth of benthic biota in *bheris*.

Experiments on the survival, feeding and temperature tolerance of fry of M. parsia

26. Experiments were conducted with a view to developing methods for increasing the survival of fry of *M. parsia* after collection. Aquarium observations have shown that holding of fry in 1 per cent. saline water for about an hour after collection, increased their survival rate very considerably.

Even fry which were injured due to handling or jolting during transport, revived under this treatment. Comparative studies conducted in the laboratory showed that while the addition of small quantities of both sodium chloride and calcium chloride in the medium increased survival rate, the latter was more quickly effective.

Fry of *M. parsia* 10 to 20 mm. in length when subjected to gradual rise in temperature of the medium, from about 28° to 40° C. in about 2½ hours, showed signs of acute distress and died within ¾ hour after reaching the critical temperature of 40° C. This observation is of special significance in connection with the culture of mullets in shallow ponds where the water temperature increases considerably during the hot months.

Studies on the age determination of the Bhetki (Lates calcarifer)

27. With a view to examining whether the scales or opercular bones of *bhekti* can be used for determining its age and growth, samples obtained from the market were studied. It has been found that there are growth rings on the scales as well as opercular bones and that they afford reliable estimates of its age. From the studies carried out, it appears that these rings are formed once a year, most probably as a result of the metabolic strain of spawning. Successive growth rings are estimated to have been formed on the scales and opercular bones when the fish had attained, on an average, 24.8 cm., 44.1 cm., 62.6 cm., 77.9 cm., 84.7 cm., and 88.5 cm., total length. The age at which the first growth ring is formed, is under investigation.

Investigations on Prawns

28. Observations on the biology of *Leander styliferus* were continued during the year. The juveniles of this species occur in abundance in the Hooghly estuary in the rainy months. They inhabit the estuary till they became sexually mature when they migrate to the sea for breeding.

Studies on the food and feeding habits of *Palæmon birmanicus* have shown that it feeds mainly on bottom debris. The stomachs of mature females were found to be empty, indicating that there is probably a cessation of feeding in the species till the eggs are extruded.

Investigations on the prawn fisheries of the Hooghly estuary have shown the occurrence of over 31 species in the commercial catches, out of which 22 are important. In the upper zone of the estuary dominated by fresh-water, *Palæmon birmanicus* and *P. mirabilis* formed the dominant species, the former constituting 45 per cent. of the catches and the latter 18 per cent. During the summer months there is a relatively greater preponderance of

P. mirabilis. In the middle zone of the estuary *P. mirabilis* and *Parapenaeopsis sculptilis* were the dominant species, which form 53 per cent. and 15 per cent. of the catches respectively. During the summer months *P. sculptilis* is found in greater abundance. *Leander styliferus* and *Metapenæus brevicornis* are the most dominant species in the lower zone, forming 27 and 17 per cent. of the catches respectively. During winter and summer *P. mirabilis* forms as much as 17 per cent. of the catches. During the monsoon months, *M. monoceros* and *Parapenaeopsis sculptilis* are found to ascend the estuary and *M. brevicornis* and *L. styliferus* to descend towards the sea. The breeding season of the larger Palæmonids starts by about April and continues up to October. Berried females of *Palæmon carinus* occur in the middle zone of the estuary from the end of March to the onset of monsoons.

Survey of the fisheries of Hooghly Estuary

29. A preliminary survey of the fisheries of the Hooghly Estuary started in 1953 was completed in June 1955. Useful data on the fishing methods, fishes caught by the fishermen, the seasonal variations in the occurrence of economically important fishes in the estuary and the general features of the fishery, have been collected during this survey.

Hydrology of the Hooghly Estuary

30. Studies on the hydrological conditions of the Hooghly estuary which were started in 1951 were concluded during the year under report. The data collected so far have enabled the elucidation of the general hydrological characteristics of the estuary which would be of help in understanding the behaviour of fish populations in the area. Three salinity zones, one dominated by brackishwater (the stretch extending from Kakdwip to Falta), another dominated by freshwater (the stretch extending from Calcutta to Nawadwip) and a third showing transitional features (the stretch extending from Falta to Calcutta) are recognisable in the estuary. No appreciable vertical gradient in salinity was observed. The water temperature fluctuated between 18° and 33° C. and there was no marked thermal stratification in the estuary.

Hydrobiological observations in a Bheri in Taldi (West Bengal)

31. Observations on the hydrobiological conditions prevailing in a typical brackishwater *bheri* in Taldi, were conducted for a period of 12 months. Benthic algæ, both blue-green as well as green, were found to grow profusely on the *bheri* bottom. The most abundant planktonic organisms were diatoms. The seasonal variations in the biota were studied and correlated with the hydrological changes. Salinity in the *bheri* ranged between

10.76 and 31.96 per thousand, water temperature between 21.98° and 32.02° C., and pH between 7.02 and 8.7. The silicate content of water was maximum during July when it was 3.5 p.p.m. and minimum in January, viz., 1.4 p.p.m. Phosphate and nitrate contents were rather low throughout the year. The total yield of fish during the period from the *bheri* which is about 156 acres in area was about 307 maunds, besides over 2,500 crabs. Prawns and Shrimps weighing over 128 maunds, *Bhekti* over 105 maunds and Mulletts over 55 maunds were caught from the *bheri*. The total production thus works out to about 160 lb. per acre.

Studies on the fisheries and fish populations of the Hooghly-Matlah estuarine system

32. With a view to estimating the magnitude of fish populations in the Hooghly-Matlah estuarine system and elucidating the factors that are responsible for the fluctuations in the fisheries bearing on them, the preparation of an inventory of the fishing units in the area and a sampling programme for studying commercial catches were initiated in the month of October 1955.

Inventory of fishing units

33. During the period under report a total of 171 fishing villages having a population of 5,072 working fishermen were covered. In view of the complex nature of operational practices, it has been found that net/trap manpower combinations would serve as suitable sampling units. 1,13,256 fishing units of 49 different types are under operation in these villages.

Catch statistics

34. Pending the completion of the inventory of fishing units, sampling of commercial catches is at present done from 8 fishing centres distributed in the 3 zones of the Hooghly estuary (stratified on the basis of existing fishery conditions) and one centre on the Matlah estuary. The data necessary for assessing the total production and catch per unit of effort were collected from these sampling points. Samples of commercial catches were also obtained from these centres for detailed examination.

Analysis of Commercial catches

The analysis of catch samples obtained during the period September to December 1955 was completed. The salient features of the data collected are indicated below.

Hilsa

35. *Hilsa ilisha* was caught in the upper zone of the Hooghly estuary till about October. The catches consisted of all age-groups with a

predominance of IV year class and they consisted of maturing, fully mature and spent fish, showing a rather low intensity of feeding. The catches of bag nets, both in the upper and middle zones of the Hooghly as well as Matlah estuaries, contained 0 year class fish throughout the period of observation. In the lower zone of the Hooghly estuary, especially near the seacoast, *Hilsa* of all age groups were found to occur. They were either spent or maturing fish, the former being evidently those that have returned after spawning in the upper reaches of the estuary and the latter, those that were ready to migrate up-river for spawning in January to February.

H. toli was also caught in large quantities in the lower zone in November to December. Majority of them belonged to the 20–25 cm. size group.

Other Clupeoids

36. *Setipinna* spp., *Setipinna phasa* and *S. taty* were caught from the Hooghly estuary in fairly large numbers. While the former was available in the whole stretch of the estuary, the latter occurred in the catches in the lower zone only. Majority of *S. phasa* caught, ranged between 15 and 24 cm. in length and were found to have maturing and fully mature gonads. The predominant size group of *S. taty* ranged between 7 and 10 cm. in length. Majority of them were immature, but a few were found to have maturing gonads.

Ilisha spp., immature individuals of *Ilisha motius*, *I. indica* and *I. elongata* were caught in small numbers mainly from the lower zone of the Hooghly.

Anchoviella spp.—A small number of immature *Anchoviella tri*, *A. comersoni* and *A. indicus* were found in the catches mainly in the lower zones. They ranged between 2 and 9 cm. in length.

Coilia spp.—Three species of *Coilia*, viz., *C. ramcarti*, *C. reynaldi* and *C. borneensis* were represented in the catches from the middle and lower-zones of Hooghly and from Port Canning area in the Matlah. Except for a single specimen of *C. ramcarti*, all the fishes examined were immature. The majority of *C. ramcarti* belonged to the length range 5.5 to 11 cm., *C. reynaldi* to the range 6 to 9.5 cm. and *C. borneensis* to the range 3.5 to 8.5 cm.

Corica soborna.—This species, caught only from the upper zone of the Hooghly estuary, was represented by mature individuals ranging from 25 to 45 mm. in length.

Gonialosa manmina.—Individuals of this species ranging from 5 to 10 cm. in length were caught in small numbers from the upper zone of the Hooghly estuary.

*Grey Mullet*s.—*Mugil parsia*, and *M. corsula* were the two species of mullets caught from the Hooghly. From Matlah *M. cunnesius* was also caught. Majority of the mullets in the commercial catches were of the 0 year class. During October-November small quantities of I and II year old *M. parsia* were also present in the catches in the middle zone of Hooghly and at Port Canning in Matlah. They were found to be in a fairly advanced stage of maturity. *M. corsula* were caught only from the upper zone of the Hooghly.

Perches.—*Sillago panijus* was the important species of this group caught from the estuary. A wide range of size groups of this species was caught from all the zones of the Hooghly and from the Matlah. The majority of them belonged to the group with a modal length of 4.5 cm. Specimens above 23 cm. which were caught only from the lower zone, were found to have maturing gonads in stages I and II.

Threadfins.—*Polynemus paradiseus* occurred in the catches in small numbers in all the zones of the Hooghly estuary. They ranged between 6 and 20 cm. in length. The majority of them were immature, but a few were found to be in the first and third stages of maturity. Immature *Eleutheronema tetradactylum* ranging between 6 and 17 cm. in length were caught from the Matlah estuary only. Young ones of *Polydactylus indicus* (6 to 13 cm.) were also caught in very small numbers from the Matlah. Larger ones over 38 cm. in length with maturing gonads were caught in the lower zone of the Hooghly in December.

Catfishes.—The catches of *Silonia silondia* mainly belonged to 2 groups, one ranging between 2.5 to 4.0 cm. and the other 10 to 21 cm. The bigger size group was available in all the centres of observation, whereas the smaller size group was found in the upper zone only.

Pangasius pangasius was generally abundant in the middle and lower zones of the Hooghly estuary. The catches in the middle zone consisted of two groups, one ranging from 3–10 cm. and another 10 to 27 cm. In the lower zone, only bigger size groups ranging from 10 to 27 cm. were obtained in the catches. All the fish examined had immature gonads.

Mystus gulio was caught mainly from the middle and lower zones of the Hooghly and from Port Canning in the Matlah. They were all immature and belonged to the size range of 5 to 16 cm.

Chupisoma garua, belonging to the size range of 8 to 23 cm., were caught in abundance in the upper zone of the Hooghly estuary. They were all immature.

Ailia coilia were also caught in the upper zone of the estuary only. They ranged between 4.8 and 11.5 cm. in length and had immature gonads.

Eutropiichthys vacha and *Pseudeutropius atherinoides* occurred only in the upper zone of the estuary. *E. vacha* belonged to the size range 6 to 14 cm. and *P. atherinoides* to the range 4 to 6.5 cm.

Jew fishes.—Among the Jew fishes caught in the estuaries the most predominant one was *Pama pama*, the others being *Sciæna coitor*, *S. ossea*, *S. sina*, *Otolithus maculatus* and *Sciænoides* sp. The majority of *P. pama* caught were immature and belonged to the 0 year class. Adults (20 to 25 cm. in length) in the II to V stage of maturity have also been found to occur in small numbers in the catches in the middle zone.

Bombay Duck (*Harpodon nehereus*) was caught in appreciable quantities from the middle and lower zones of the Hooghly estuary and at Port Canning in the Matlah. Majority of the fish caught were immature and ranged between 5 to 10 cm. in length. Maturing fish above 20 cm. in length have been observed to occur in the lower zone during the month of December.

Ribbon fish.—*Trichiurus savala* was the main ribbon fish caught in the estuary and they were caught in the middle and lower zones of Hooghly as well as Canning in the Matlah. Most of them were immature and belonged to size range of 15 to 29 cm. A few specimens caught near the mouth of the Hooghly estuary were found to be in an early stage of maturity.

Miscellaneous fishes.—The main miscellaneous fishes caught in the estuaries consisted of *Cybium commersoni*, *Scatophagus argus*, *Ambassis* spp., *Caranx affinis*, *Leiognathus equulus*, *Stromateus sinensis*, *Glossogobius giuris* and *Odantamblyopus rubicundus*. The first 4 species are largely caught in the lower zone. *Glossogobius giuris* form the most abundant goby in the catches.

Besides the above species, a large number of fresh-water fishes belonging to the genus *Barbus*, *Chela*, *Labeo*, *Cirrhina*, *Notopterus*, *Platycephalus*, *Ophicephalus*, etc., were also found to occur in the catches.

Prawns.—*Palæmon mirabilis*, *Metapenæus brevicornis*, *Leander styliiferus*, *Leander tenuipes*, *Palæmon birmanicus*, *Leander fluminicola*, *Palæmon carcinus*, *Palæmon rudis*, *Metapenæus monoceros*, *Acetes indicus* and *Parapenæopsis sculptilis* were the predominant species of prawns (in the order of abundance) caught in the estuaries during the period under report.

Majority of *Palæmon mirabilis* in the catches belonged to the 16 to 45 mm. length group. Most of the females were found to be either berried or with ripening ovaries.

Metapenæus brevicornis were caught only from the lower and middle zones of the Hooghly and from Canning in the Matlah, two size groups, viz., 31 to 35 mm. and 66 to 70 mm. were found to occur in the catches. Except for a single specimen collected from near the mouth of the estuary, in which the thelycum was found covered with spermatophore, all the specimens examined were immature.

Leander styliferus belonging to the size groups 46-50 mm. and 81 to 95 mm. were predominant in the prawn catches, in the lower and middle zone of the Hooghly as well as Matlah. Most of the females of 81 to 95 mm. size were found to be berried, with eggs in late stages of development. Females dominated in the catches.

Majority of *Leander tenuipes* caught in the lower and middle zones of the Hooghly and in the Matlah were females and belonged to the size group 46 to 55 mm. A few maturing individuals were also found in the catches and near the seacoast stray berried individuals were caught.

Palæmon birmanicus were caught mainly from the upper zone of the Hooghly. During October a few large berried females were found in the catches at Tribeni.

Leander fluminicola were caught from the upper and middle zones of the Hooghly. They belonged to the size group 21 to 30 mm. A few individuals between 33 and 42 mm. were found to be berried or with ripe ovaries in the upper zone of the Hooghly.

Most of the *Palæmon carcinus* which were caught in the upper and middle zones of Hooghly ranged between 90 and 140 mm. in length. All of them were immature.

Two size groups (50 to 70 mm. and 15 to 30 mm.) of *Palæmon rudis* were found in the catches from the upper and middle zones of the Hooghly as also Matlah. A few berried individuals were found in the catches at Canning in the Matlah and in the lower zone of the Hooghly.

All the *Metapenæus monoceros* caught in the lower and middle zones of Hooghly as also Matlah were immature and ranged between 16 and 80 mm. in length. *Acetes indicus* were caught from the lower zone of Hooghly and consisted of immature individuals between 12 and 18 mm. in length. *Parapenæopsis sculptilis* were also obtained from the lower zone of Hooghly and were all immature.

Survey of the Winter fisheries in lower Sunderbans

37. During December, a general survey of the fisheries in the lower Sunderbans in the neighbourhood of Frazergunge and Jambudwip was

made on board M.L. "Rohita". Fishing in the area near the mouth of the estuary was largely for *Hilsa*. The catches of each "Sawar" of Kochal Jal or Jangli Jal (former consisting of 6 boats and one net and the latter 5 boats and one net) ranged between 200 and 400 maunds per day which were being transported preserved in ice to Kakdwip and Diamond Harbour in carrier boats. The catches of bag nets were mostly sun-dried in special fishermen's camps in Frazergunge and Jambudwip. The catches of bag nets largely consisted of prawns, Bombay duck, Catfishes, Ribbon fishes and Anchovies.

Abundance of Hilsa in West Bengal during 1955

38. There was an abnormal abundance of *Hilsa* in West Bengal waters during the monsoon season of 1955. Railway bookings of *Hilsa* from some of the assembly centres were observed to be as much as 10 to 11 times the normal bookings. The analysis of available data from 1952 onwards indicates that this abundance was probably the result of a very successful spawning during the monsoon season of 1950. The offspring of that year's breeders appeared in abundance in the winter season of 1952 and this age class could be traced as a predominant class in the catches of subsequent years. Examination of length frequency data of catches from the River Padma also indicated a similar phenomenon.

Studies on the racial composition of Hilsa stocks

39. Abnormally large and deep specimens of *Hilsa* were caught in the Hooghly estuary from September to October which aroused the general belief that they belonged to a different stock. Morphometric studies revealed significant differences between these and the samples studied from the estuary during previous years, in the relative depth of body. Comparison of morphometric data of samples studied from the River Padma at Lalgolaghat showed that they were homogeneous with *Hilsa* examined from Hooghly during previous years and were significantly different from those that were studied from Hooghly during the period under review.

Study of samples from near the mouth of the estuary near Frazergunge failed to reveal the presence in this area of representatives of the stock of deep-bodied *Hilsa* observed in the upper reaches during September-October.

Studies of the productive potential of brackishwater bheris

40. During the period under report 15 brackishwater *bheris* in lower, middle and upper Sunderbans were surveyed. On the basis of data collected during the survey a rough classification of the *bheris* has been made on the basis of their distance from the sea, quality of soil, salinity conditions

and benthic growth. Typical *bheris* have been selected for detailed study of the density of algal growth, seasonal changes in soil nutrients, etc., with reference to their capacity for maintaining bottom feeding fishes like the mullets.

Pot culture experiments in culturing benthic algæ

41. With a view to ascertaining the optimum salinities for the growth of benthic algæ which form the food of cultivated brackishwater fishes such as Mulletts, pot culture experiments were conducted using both estuarine mud as well as ordinary sand as substrata. Comparison of the growth of the blue green algæ, *Oscillatoria* spp. in salinities ranging from 0‰ to 40‰ in the first series of experiments showed that their growth was not profuse in salinities ranging between 10‰ and 15‰. Generally better growth of algæ was obtained on muddy substrata.

STUDIES ON FISH PATHOLOGY

42. Four ponds in which epidemics of fish mortality used to occur every year were kept under observation during the year under report. The hydrological and biotic features of the ponds were studied. From the data collected so far, it may be inferred that mortality of fishes was caused mainly by the reduction in the oxygen concentration in which the bottom mud played an important role. The reduction in oxygen took place mainly during the period March-June and September. The humus content and oxygen-consuming capacity of the mud in ponds where fish mortality had occurred were higher than in ponds where the fish were thriving in a healthy condition. The density of bottom fauna in ponds where fish mortality occurred was low and general observations show that the contents of benthic fauna could be utilised as an indicator of the degree of organic pollution in the ponds.

Experiments were conducted for the control of parasitic copepods and predatory insects in nursery ponds by the application of Gammaxene in concentrations of 0.5 to 0.75 p.p.m. Gammaxene was found to be very effective in controlling this. The density of plankton was reduced by 18 to 40 per cent. by this treatment but within about a week, the density returned to the original level.

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