

**CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE
BARRACKPORE**

**Annual Report
1967**



INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI

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DIRECTOR'S INTRODUCTION

Acute shortage of food during the post-war period leading to the formulation of a development scheme for scientific studies on Indian fisheries resulted in the formal establishment of the Central Inland Fisheries Research Institute in March, 1947 at Calcutta under the Ministry of Food and Agriculture, Government of India.

The objective of the Institute has been to study and elucidate the scientific principles which could be applied for the utilization of all available inland waters for maximum production of fish as food in the country. This entails evolving suitable fish cultural techniques, investigations on the biology of important food fishes, studies hydrology and ecology of different types of waters, research on fish populations in natural waters like rivers, lakes, estuaries, etc., and management problems concerning both fresh and brackishwater fisheries.

The Institute since June, 1959 is housed in its own buildings at Barrackpore, 23 kilometer north of Calcutta, on the left bank of the river Hooghly and covers an area of about 5.2 ha. A small unit established in December, 1949 at Cuttack (Orissa), to solve the urgent problem of mass mortality of riverine spawn in the nurseries of the State Fisheries Department, has since grown into a sub-station of the Institute and deals mainly with the problems of culture fisheries. Another sub-station was opened at Allahabad in July, 1953, to conduct investigations on the biology and fisheries of the commercially important fishes of the Ganga river system. Besides, several units/centres were also established to expand the activities of the Institute, e.g. Chilka Investigation Unit at Balugaon (Orissa) in 1956; Lacustrine and Hilsa Investigation Units at Calcutta (West Bengal) in August (Lacustrine Unit was later shifted to Tungabhadra Dam, Hospet, in January, 1958) and October, 1956, respectively. The Pond Culture Unit at Joysagar (Assam) and Narbada-Tapti Unit at Hoshangabad on river Narbada in 1957, Krishna-Godavari Unit at Rajahmundry (Andhra Pradesh) on river Godavari in 1958. Sunderbans Unit at Calcutta in 1959, Tank Fisheries Unit at Bangalore in 1962; Coldwater Fisheries Unit at Kangra (Punjab) in November, 1963 and Pulicat Lake Unit at Ponneri (Madras) in January, 1964.

Brackishwater Fish Culture Unit has since been shifted from Cuttack to Kakdwai (West Bengal), Hilsa Unit from Calcutta to Bhagalpur, Lacustrine Unit from Hospet to Konar (Bihar) and Coldwater Fisheries Unit from Kangra to Srinagar (Kashmir). The Pond Culture Unit at Joysagar was closed down in April, 1966 and its staff transferred to Panna in Madhya Pradesh to conduct water retentivity studies at the proposed freshwater central fish farm sites.

A Documentation Unit was established at Barrackpore in 1962 and a new unit, Small Reservoirs Unit, was opened at Rewa (Madhya Pradesh) in June, 1967.

The headquarters of the Estuarine Fisheries Research Sub-station and the Fish Pathology Unit continued to be attached to the Institute at Barrackpore.

Library and documentation

With the library collection expanding rapidly, space has been becoming a problem. An additional shelving of 77 m and 22 m has been provided, respectively for journals and reprints to solve this problem temporarily. The journals and books were rearranged to fully utilize the extra space facilities. However, a large number of unbound back numbers of various journals are still stored in almirahs in a manner which does not make them easily available for reference.

In 1967, the Institute subscribed for 28 Indians and 32 foreign journals and purchased 96 books. Besides, 58 miscellaneous publications, 235 reprints and 165 periodicals were received by the library, a major part of them received in exchange. The Institute has also purchased two microfilms.

The Documentation Unit edited and published two bulletins (No. 10 & 11), one Survey Report (No. 4), one Miscellaneous Contribution (No. 6), Vol. 5 (No. 4) and Vol. 6 (1-3) of the Bibliography of Indian Fisheries. Besides, about 70 technical and non-technical requests were also attended to by the Unit. Considerable back-log of reprints and journals remaining to be indexed, have been cleared.

A list of total library holdings in respect of journals was compiled for the first time and sent to the Indian Council of Agricultural Research for publication. The present library holdings comprise 1971 books, 1222 bound periodicals, 1987 reprints, 881 miscellaneous publications and about 500 titles of journals.

The library also possesses a large number of pamphlets, departmental publications and loose issues of journals. The Institute lent a number of journals to Indian Association of Special Libraries and Information Centre, Calcutta, Central Public Health Engineering Research Institute, Nagpur, and to some State Fisheries Departments. An up-to-date list of the publications of the Institute was also brought out and sent to various organisations in India and abroad.

Distinguished visitors

The following scientists and distinguished persons visited the Institute and its various establishments.

Prof G.M. Gerhardsen	FAO/UNDP/TA, Senior Fisheries Adviser, Ministry of Food, Agriculture, Community Development & Co-operation, Government of India.
Shri M.P. Devasundaram	Assistant Commissioner, Fisheries Division, Ministry of Food, Agriculture, Community Development & Co-operation, Government of India.
Shri Chintamani Panigrahi	M.P., Chairman, Study Group I of the Estimates Committee
Shri Maharaj Singh Bharati	—do—
Shri Y. Gadilingana Goud	—do—
Shri J.M. Imam	—do—

Shri S. Kandappan	M.P., Member, Study Group I of the Estimates Committee
Shri Yashwant Singh Kushwah	—do—
Shri K. Lakappa	—do—
Smt. Sangam Laxmi Bai	—do—
Shri Inder J. Malhotra	—do—
Shri Dhuleshwar Meena	—do—
Shri F.H. Mosin	—do—
Shri Rajdeo Singh	—do—
Shri B.B. Tewari	Deputy Secretary, Lok Sabha
Dr Dorothy Parker	Associate Director, Rockefeller Foundation & Chairman, Indo-American Library Survey & Study Team
Miss A.J. Carabelli	Retired Assistant Director, National Agriculture Library Washington & Member, Indo-American Library Survey & Study Team
Shri S.P. Phadnis	Chief Librarian, Indian Agricultural Research Institute; Secretary, Indo-American Library Survey & Study Team
Shri D.R. Kalia	Director of Public Libraries, Delhi Public Library
Shri S.R. Banerjee	Chief Librarian, Indian Council of Agricultural Research, New Delhi
Dr C. Parker	Weed Research Organisation, Begboke Hill, Kidlington, Oxford, U.S.A.
Dr N.K. Panikkar	Director, National Institute of Oceanography, Council of Scientific & Industrial Research, New Delhi
Prof H.S. Swingle & Dr D.D. Moss	Auburn University, Auburn, U.S.A., USAID Team
Prof P. Sen	Kalyani University, Kalyani
Shri K.H. Alikunhi	Director, Central Institute of Fisheries Education, Bombay
Shri Harihar Patel & Shri M.P. Misra	Hon'ble Minister and Deputy Minister for Industries & Fisheries of Orissa
Dr(Miss) Hamilton	United Kingdom
Shri R.C. Vikal	Hon'ble Minister for Forests & Fisheries, Government of Uttar Pradesh
Dr Y.R. Tripathi	Director of Fisheries, Government of Uttar Pradesh
Shri B.S. Seth	Joint Secretary, Planning Commission, Government of India, New Delhi
Shri Amar Singh	Assistant Chief (Agriculture) Planning Commissioner, Government of India, New Delhi
Dr M.D.L. Shrivastava	Professor & Head of the Department of Zoology, Allahabad University, Allahabad

Dr D.N. Verma

Reader, Department of Zoology, Allahabad University,
Allahabad

Dr A.N. Chattoraj

Reader, Department of Zoology, Allahabad University,
Allahabad**Important events of the year**

The administrative control of the Central Inland Fisheries Research Institute was passed over from the Ministry of Food and Agriculture, Government of India, to the Indian Council of Agricultural Research with effect from October 1, 1967. The Training Section of the Central Inland Fisheries Research Institute was handed over to the Central Institute of Fisheries Education, Bombay and the Sunderbans Exploratory Unit to Deep Sea Fishing Station, Bombay.

The scientific work programme of the Central Inland Fisheries Research Institute was reoriented into 20 priority laid projects. The work programme was also rendered problem-oriented.

A part of the Killa Fish Farm at Cuttack has been converted into a frog farm comprising six nursery (each 0.1 acre) and one rearing pond (0.2 acre). All the frog ponds have been fenced and have an upland feeding ground.

The construction of the laboratory and office buildings and the Brackishwater Fish Farm at Kakdwip (West Bengal) is nearing completion. Excavation of a few test ponds at the Experimental Fish Farm site of Panna (Madhya Pradesh) has also been completed and percolation studies are being performed.

A controlled temperature and illumination chamber has been constructed for experimental culture of fish food organisms at Barrackpore. A separate chamber fitted with ultraviolet lamp has also come into being for isolation purpose. The culture laboratory has been equipped with Kilburn water distillation and Pyrex distillation plants, hot air oven, autoclave, analytical balance, electrical centrifuge, shaking incubator, a high magnification Zeiss research microscope with phase contract attachments and a Zeiss plankton microscope.

A Central Radio Tracer Laboratory was set up in Calcutta to study soil chemistry in relation to productivity of fish ponds using the C_{14} technique. The electronic instruments required for the laboratory were obtained from Trombay Electronics with the help of a grant-in-aid by the Atomic Energy Department (Government of India). These included decade scalers, high tension units, preset timers, quenching units, lead castles, Geiger Muller counters, and radiation survey meter and other accessories. These have been assembled into two radiation testing units. Other non-electronic equipments like Perspex filtering towers, Millipore filters, etc., were also obtained.

Research collaboration with institutes, universities, colleges and other institutions at national level

The Institute took up the work on some of its research projects in close collaboration with various State fisheries departments. Thus investigations on spawn prospecting were carried out with the Departments of Fisheries, Bihar, Uttar Pradesh,

Rajasthan, Andhra Pradesh and Madras. The studies on fat deposition of carp breeders were done in collaboration with the Department of Fisheries, West Bengal.

Fellowships, studentships

Two scholarships for senior research scholars have been awarded by the Ministry of Education to the two workers attached to this Institute. Two more senior research scholarships allotted to this Institute will be filled up shortly.

Advisory services received and provided

A number of private fish farmers were advised on the methods of fish culture and clearance of aquatic weeds from their ponds and were provided with the relevant literature. The Deptment of Fisheries, Mysore, was assisted in the analysis of soil, water, plankton and other biofa of tanks.

Private entrepreneurs in West Bengal and on the west coast were informed about the availability of commercial frog species, their catching seasons, existing transport, storage or shipping facilities and possible frogleg cutting centres.

Private fish farmers were also advised on the methods of controlling *Argulus* infection in large water areas, prevention of fish mortality due to oxygen depletion, control of diseases like fin and tail-rot, dropsy and sporozoan infections.

Extension and nation-building activity

In order to help increase fish production and clearance of aquatic weeds by grass carp, fry of the exotic grass and silver carps, were supplied to various State fisheries departments, public bodies and corporations in India. Besides, a gift consignment was also sent to the Government of Nepal. The details are given below:

<i>Name of the State/organisation</i>	<i>Silver carp</i>	<i>Grass carp</i>
Himachal Pradesh	500	—
Madhya Pradesh	—	3,500
Maharashtra	1,000	1,000
Orissa	—	20,000
West Bengal	4,000	5,000
Punjab Agricultural University	500	—
Indian Co-operation Mission, Nepal	500	500

A total of 57,347 litres of spawn collected during the spawn prospecting investigations in Andhra Pradesh, Bihar, Madras, Rajasthan and Uttar Pradesh was handed over to the respective State fisheries departments in the form of spawn and fry reared in experimental nurseries.

Demonstration and training on induced fish breeding techniques were arranged at various government fish farms in West Bengal. Four sets of rohu (*Labeo rohita*) were induced to spawn at the Berhampore Fish Farm and about 80,000 spawn collected, all of which was made over to the State fisheries department,

An experiment taken up in collaboration with the Orissa Fisheries Department to standardise the method of clearance of water hyacinth by 2, 4-D and to work out the economics resulted in achieving 90 per cent kill of the plants at a total cost of Rs 210/- per hectare as against Rs 387/- per hectare by manual clearance alone.

A private sewage-fed nursery pond and part of the sewage canal and a derelict beel near Calcutta were completely cleared of *Hydrilla verticillata*, *Vallisneria spiralis*, *Ceratophyllum*, *Ottelia* and *Cyperus* by applications of copper sulphate mud pellets at 35 kg/ha, in three to four intermittent doses.

Finance (research funds and expenditure)

The total budget provision sanctioned by the Government of India, Ministry of Food & Agriculture for the year 1967-68 was as under:

1967-68—Budget Estimate (in rupees)

Non-Plan	(Revenue)	17,96,000
Plan	(Revenue)	1,35,000
Plan	(Capital)	13,25,000

Against the above provision for the whole year (1967-68), the expenditure up to 30.9.67 was as follows:

Non-Plan	(Revenue)	10,24,598
Plan	(Revenue)	45,478
Plan	(Capital)	88,968

With effect from 1.10.67 when the Institute was brought under the administrative control of the Indian Council of Agricultural Research, the following budget provision from 1.10.67 to 31.3.68 was sanctioned:

Non-Plan	(Revenue)	7,80,000
Plan	(Revenue)	70,000
Plan	(Capital)	3,00,000

Against the above, expenditure up to 31.3.68 has been worked out as follows:

Non-Plan	(Revenue)	8,28,642
Plan	(Revenue)	83,843
Plan	(Capital)	2,41,532
		11,54,017

PROGRESS OF RESEARCH

The research programme of the Institute conducted hitherto included projects, many of which were having an immediate developmental significance while certain others had only an applied bearing. Some other projects, viz., studies on population

dynamics of natural, wild riverine and estuarine populations of fish in general, cold water capture fishery investigations, etc., which though useful, had only a remote applied value incapable of resulting in increased fish production in foreseeable future. There did not exist a clear cut priority of projects graded in order of their developmental potential.

The research programme of the Institute was, therefore, thoroughly re-oriented to cover investigations on immediate and short-range specific research projects, concurrently laying down priorities, the solution of which is bound to lead to quick fisheries development and increased fish production. However, some projects, though not so short-range ones but bearing potentialities of substantial increase in fish production and capable of fishery development on the basis of regional self-sufficiency e.g., reservoir fishery research, have been included in the re-oriented programme allotting a relatively high priority.

General studies on population dynamics of fish in rivers and estuaries have been completely eliminated for the time being and replaced by corresponding studies in the tamed environment of certain large dams capable of human control. Two projects, viz., fish farm designing and study of economics in fishery research and development, having a definitely direct fishery developmental value but hitherto kept out of the fold of research have been included in the new programme at the appropriate levels.

Another significant feature of the re-oriented research programme is aimed at developing, as the execution of the programme progresses, specialists on a number of subjects and research problems or their components into which the problems may have to be resolved. It is felt that the coming into being of specialists, each an expert in his limited sphere, will lead to quick growth of fishery development.

The various fishery problems have been grouped under 20 research projects, of which 16 were taken up for detailed investigations during 1967. Work on projects No. 7, 10, 11 and 18 will be taken up as soon as the necessary facilities and requisite scientific personnel are available.

- | | |
|------------|--|
| Project 1 | Optimum per hectare production of fry, fingerlings and fish in culture fishery operations |
| Project 2 | Study of induced fish breeding technique |
| Project 3 | Fishery investigations in reservoirs and studies on the dynamics of their fish populations |
| Project 4 | Riverine fish seed investigations and study of population structure and behaviour of spawn |
| Project 5 | Exploratory investigations in Sunderbans |
| Project 6 | Fresh water prawn culture |
| Project 7 | Murrel and other air-breathing fish culture |
| Project 8 | Brackishwater prawn culture in mixed farming |
| Project 9 | Selective breeding and hybridisation in conjunction with induced breeding |
| Project 10 | Research on designing ash farms |
| Project 11 | Study of economics in fishery investigations and development projects |

Project 12	Exotic fish culture
Project 13	Coldwater fish culture
Project 14	Riverine and estuarine fish catch statistics
Project 15	Fish pathology
Project 16	Weed control
Project 17	Frog farming
Project 18	Sewage-fed fisheries
Project 19	Hilsa investigations
Project 20	Water pollution investigations

This report covers the period from January 1 to December 3, 1967 and is the first report being published for a calendar year. Hitherto, the reports of this Institute covered the financial year (from April 1 to March 31 of the subsequent year). It has, however, been decided to publish all future reports for the calendar year.

1. Optimum per hectare production of fry, fingerlings and large fish in culture fishery operations

Six problems have been identified under this project.

1.1. *Composite culture of Indian and exotic species for maximum production of fingerlings and large fish.* Earlier studies on the optimum/ha production of fish by mixed farming of compatible Indian and exotic species with a view to fully utilizing the fish food resources of a pond gave a net production of 2478 kg/ha/annum and a survival of 69.5 per cent when stocking was done at 4500 fingerlings/ha with catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*) and gourami (*Osphronemus gourami*) in the ratio of 1.5:5:1:4:3:3:0.3 in a pond measuring 0.4 ha as compared to 2024 kg/ha/annum with a survival of 76.3 per cent produced in another pond (0.133 ha) stocked at the same rate and in the same ratio.

In yet another experiment, a net production of 3494 and 3969.5 kg/ha/annum with a survival of 73.2 and 75.7 per cent, respectively was obtained when stocking was done at 5000 fingerlings/ha but in the same ratio. Manuring with organic and inorganic fertilizers and artificial feeding were resorted to in these ponds. These experiments clearly indicated that composite farming could give high production provided the ponds were well-managed.

Studies conducted during 1967 on the production of large fish in a 0.4 ha pond stocked with fingerlings of catla, rohu, mrigal, silver carp, grass carp, common carp and calbasu (*Labeo calbasu*) at 5000/ha and in the ratio of 2.5:5:2.5:5:2.5:0.5 gave a net production of 3564 kg/ha/annum. The percentage of survival and the average weight of the different species at the end of the year were 98.8/838.04, 96.8/501.83, 93.2/710.42, 95.6/1082.75, 85.0/810.12, 99.2/559.35 and 92.0/312.0, respectively. An additional 3388 juveniles of common carp resulting from its natural breeding in the pond were also recovered. Besides manuring the pond with cowdung and inorganic manures at 25,000 and 975 kg/ha/annum, respectively, the grass carp

was fed with 14,700 kg/ha/annum of fresh aquatic weeds and other fishes with mustard oil cake and rice bran at 3000 kg/ha/annum.

Observations on the replicate of the above experiment and in new experiment in two ponds using the same species but in the ratio of 3 (catla): 4 (rohu): 2.5 (mrigal): 6 (silver carp): 1.5 (grass carp): 2.5 (common carp): 0.5 (*calbasu*) are in progress. Culture of fry of the six species of carps stocked in six 0.08 ha ponds during October 1967 at 100,000/ha in three combinations of 3 (catla): 3 (rohu): 1.5 (grass carp): 2.5 (mrigal); 3 (silver carp): 3 (rohu): 1.5 (grass carp): 2.5: (common carp); and 1.5 (catla): 1 (silver carp): 3 (rohu): 1.5 (grass carp): 1.25 (mrigal): 1.25 (common carp), are in progress in connection with studies on fingerling production.

Studies on the production of fingerlings of Indian and exotic carps under composite culture using other combinations and stocking densities and on production of large fish using additional species of fish, prawns and frogs are envisaged in 1968.

Experiments on the production of large fish by stocking fingerlings of the Indian major carps alone in the ratio of 3 (catla): 4 (rohu): 3 (mrigal) but at different stocking densities of 3750, 5000 and 7500/ha with two replications for each density were concluded in 1967 after a year's observation. Net productions in kg/ha/annum recorded were 606 and 1698 when the stocking density was 3750/ha, 412 and 979.2 at 5,000/ha and 1580 and 2504.6 at 7,500/ha. Since the ponds under stocking rates of 3,750 and 5,000 were privately owned and except in one instance, not properly managed or protected, the results obtained were strictly not comparable.

In a second set of experiments in which fingerlings of catla, rohu and mrigal were stocked at a uniform rate of 3,750/ha but in the ratios 3:5:2 and 3:6:1 with 1 to 3 replications for each ratio, an average net production of 1302 kg/ha/annum was obtained from three ponds in the first ratio. The experiment with 3:6:1 ratio is still in progress.

Comparable experiments to determine the optimum stocking density and species ratio will be undertaken in 1968, subject to availability of ponds.

(Please also see 12.2 and 12.4)

1.2. *Studies on the use of growth promoting substances for enhanced growth of carp fry and fingerlings.* Three preliminary jar experiments, each of 2 to 3 weeks' duration, using the growth promoting substances prolid, eltroxin, macrabin, berin, B-complex, yeast and starch as feed, have indicated that the highest survival and growth in case of rohu fry was obtained with starch followed by yeast. Zooplankton was used as normal feed in all cases.

Confirmatory experiments using rohu and common carp fry/fingerlings and additional growth promoting substances like cobalt compounds, terramycin, amino-acids, etc., pelleted along with normal feed (zooplankton or others) are planned to be conducted both in jars and plastic pools.

1.3. *Relative efficiency of different nitrogenous fertilizers in pond fertilization using production of plankton and fry as indices of response.* Earlier experiments, both in cement-cisterns and ponds using urea, ammonium sulphate, sodium nitrate and calcium-ammonium nitrate had indicated that nitrogenous fertilizers influence the production of plankton significantly after an initial dose of a phosphatic fertilizer.

Laboratory experiments in which three nitrogenous fertilizers, viz., ammonium sulphate, urea and calcium ammonium nitrate, were applied at three rates (20, 50 and 80 kg/ha) to pond soil, kept in glass jars along with distilled water, indicated that the higher rate of application of all the fertilizers, and calcium ammonium nitrate in particular, gave the best result in terms of primary production determined by the dark and light bottle method. Among the medium rates also this fertilizer gave the best result. Lower rates and untreated control showed the least primary productivity. The experiment is still in progress.

1.4. *Exploratory investigations on the fixation of nitrogen by blue-green algae in pond soils with special reference to the productivity of pond water.* Preliminary experiments were conducted to ascertain the magnitude of fixation of nitrogen by blue-green algae along with bacteria occurring in different fish pond soils. Unsterilised pond soils treated with phosphorus and phosphorus+calcium and maintained against a control, with replications for each, indicated growth of blue-green algae accompanied by considerable increase in total nitrogen in 'light' flasks as compared to 'dark' flasks.

The study will be continued in the laboratory and in plastic pools using sterilised and unsterilised soils for inoculation of selected blue-green algae.

1.5. *Culture and utilization of fish food organisms*

1.5.1. CRUDE CULTURE. Statistically designed laboratory experiments on crude culture of diatoms, especially *Nitzschia* sp., have indicated that these could be successfully grown in a medium of boiled, cooled and filtered pond water to which N-P-K. (5:15:3) at 230 ppm and small quantities of weed and soil extracts have been added.

1.5.2. LABORATORY CULTURE AND CULTURE IN THE FIELD. Preparatory cultures of *Chlorella* sp. and *Nitzschia* sp. was done in the culture laboratory on agar plates in Chu No. 10, Bristol's and Soil extract solutions under a controlled temperature condition of $25^{\circ}\text{C} \pm 1$ and 100 lux illumination. It has been observed that *Chlorella* sp. and *Nitzschia* sp. appeared in 7 to 8 and 10 to 15 days, respectively. It has also been observed that *Nitzschia* sp. grows comparatively better in Chu No. 10 solution while *Chlorella* sp. in Bristol's Solution with 1 per cent urea. Unialgal culture of *Chlorella* sp. and *Nitzschia* sp. have been achieved.

1.5.3. ALGAE AS A NUTRITIVE SOURCE OF FOOD TO FISHES. Algae powder, obtained by drying *Oedogonium obtruncatum* Wittrock at 120°C for 3-4 hours, was mixed with different food ingredients and boiled with distilled water on a water bath and made into fine thread-like forms by a hand machine. These were cut into several very small pieces and dried in a hot air oven at 60°C .

The experimental fish, *C. mrigala*, was fed continuously with this feed from 1000 to 1700 hours and then transferred to the excretion jars provided with a fine nylon screen (20 mm mesh) at the bottom. It was observed that the experimental fish increased in body weight even when fed on *O. obtruncatum* as the only source of protein.

Chemical analyses of food and faeces for protein, fat, ash and carbohydrate was done. Further work on crude and laboratory culture of fish food organisms and algae as a source of nutritive food is in progress.

Induced fish breeding

To ensure a reliable source of supply of quality spawn, pioneering work has been done in the Institute to induce the major Indian as well the Chinese carps to breed in captivity by administration of pituitary gland extract. The project has been divided into five problems as given below:

2.1. *Fish breeding experiments under controlled temperature.* With a view to avoiding the dependence on the vagaries of weather for commercial production of fish seed, experiments on induced breeding of fish were planned to be conducted in an air conditioned laboratory by regulating the most important factor, the temperature. However, no work could be undertaken during the 1967 monsoon season as the air-condition unit did not function.

2.2. *Study of fat deposition in fishes, cause, effect and remedy including fecundity.* It has been noticed that an excess of fat deposition in fishes hampers the proper development and maturity of gonads. With a view to studying the index of deposition and its relation with spawning, a large number of samples of rohu flesh have been analysed for fat index, iodine and saponification values, and the males have been observed to have higher values than females in both resorbed condition and in the first stage of maturity.

Thirty-six specimens of major carps (290-800 mm) from four *bheels* (Kulia, Dhokorda, Mathura and Anjana) in West Bengal were also examined for mesenterial fat deposit. Ninety-four per cent of the fish in all the four *bheels* were fatty bearing a high fat value in weight in relation to that of the alimentary canal, ranging in stage of maturity from I to III. Fifteen sets of fish from these *bheels* were administered with pituitary injection with no success. However, five sets of fish procured from a stocking pond by the side of Kulia *bheel* responded to pituitary administration. No cause for fat deposition in the above stated four *bheels* could be found.

2.3. *Inducing early maturity in fishes.* In a field experiment in which 50 individuals of rohu received 13 successive injections of fish pituitary gland at 2 mg/kg wt of recipient at weekly intervals, there was marked increase in length and weight accompanied by appreciable advance in maturity compared to the condition among uninjected fishes.

A fresh experiment on the same lines started in November 1967 is in progress. During 1968 it is proposed to continue the study simultaneously on catla, rohu and mrigal.

2.4. *Use of various synthetic and mammalian hormones for inducing spawning in carps.* Studies on the use of various synthetic and mammalian hormones have indicated that while human chorionic gonadotrophin (HCG), extracted from pregnancy urine by alcohol precipitation method, at 1 mg/kg weight of the recipient fish in combination with a threshold dose of pituitary extract at 2 to 3 mg/kg of body weight could induce spawning in rohu, HCG alone, synahorin, lutocycline or ovocycline did not have any effect at all. However, HCG alone at 1 to 3 mg/kg body weight of the recipient fish induced profuse spawning in common carp. Similarly, oxytocin (extract of the posterior lobe of the bovine pituitary gland) also induced spawning in rohu only when injected in combination with fish pituitary gland.

Experiments with various other synthetic hormones are envisaged to be conducted in the next season.

2.5. *Extraction, preservation and ampouling of pituitary hormone.* Studies on the extraction of pituitary gonadotrophins with 1.5 per cent TCA have indicated that the extraction is not complete even after six hours immersion of the gland as evidenced by the fact that both the TCA extract as well as the extract prepared by macerating the immersed gland could induce spawning in rohu. It was also found that TCA extract preserved in propylene glycol for 75 days retained its potency.

Apart from the above problems, studies on the sex specificity of carp pituitary glands taken up in 1966 and investigations on the disappearance of carp eggs from breeding *hapas* which has been baffling research workers for quite some time and which has been causing considerable economic loss were continued and concluded in 1967. The former study indicated that there is no significant difference between male and female glands in their capacity to induce spawning and as such separate collections of glands from the two sexes are not necessary. In the latter, the discovery and confirmation beyond doubt that common carp present in the ponds where the *hapas* are fixed, has been responsible for the destruction of the eggs by their sucking from outside the *hapas* have helped in solving this problem satisfactorily.

Incidental to various induced breeding experiments, a total of 31.76 lakhs of carp spawn comprising rohu (23.83 lakh), catla (0.43 lakh), mrigal (0.82 lakh), calbasu (1.15 lakh) and common carp (5.53 lakh) were produced.

3. Fisheries investigations in reservoirs and studies on the dynamics of their fish populations

3.1. 2. *Investigations in big reservoirs (under preparation).* *Investigations in small reservoirs.* As practically no information on the management of reservoir fishery in India is available, three different types of reservoirs were selected in Madhya Pradesh for detailed investigations.

3.2.1. QUANTITATIVE AND QUALITATIVE ASSESSMENT OF INITIAL FISH FAUNA AND MAPPING OF BOTTOM CONTOUR AND SCATTER OF TREE-STUMPS. Preliminary surveys of the Devendranagar (200 ha), Loni (320 ha) and Govindgarh (320 ha) were completed and a detailed programme of work has been drawn up. Fish fauna of Govindgarh and Devendranagar reservoirs has been collected and tentatively identified.

3.2.2. EVOLVEMENT OF THE TECHNIQUE FOR THE ERADICATION OF UNWANTED FISHES. The scheme will be taken up only after the results of problem 3.2.1 are available.

3.2.3. ASSESSMENT OF PRODUCTIVE POTENTIAL OF RESERVOIRS. With a view to making the fullest use of all the available food for obtaining the maximum possible fish yield from the reservoirs, studies on the scientific appraisal of the nutrient level and food resources of these reservoirs have been initiated. Preliminary observations on the physico-chemical conditions of Loni reservoir showed that the water was clear with a pH of 8.0, D.O. 7.9 ppm, alkalinity 106 ppm, hardness 100 ppm, nitrates 0.03 to 0.16 ppm, phosphates 0.02 to 0.05 ppm and silicates 6.0 to 8.0 ppm.

Weekly samples of surface water and plankton were collected from four zones

in the Govindgarh reservoir at 6, 12, 18 and 24 hours in December. Analyses of water samples showed that while nitrates and silicates were completely absent, there were considerable variations in phosphates and total alkalinity values in the different zones of the reservoir. Similarly, plankton distribution also showed wide variations in different zones, average plankton production from the four zones being 3,028 units/litre. Phytoplankton (86.6 per cent), represented mainly by *Phormidium* (96 per cent), dominated over zooplankton (13.4 per cent). The latter was dominated by protozoans (61.5 per cent), of which *Ceratium* was the most common form.

Observations on the bottom fauna, collected from the four zones of the Govindgarh reservoir in the third week of November and first and fourth weeks of December 1967, showed that the concentration of bottom organisms was 2,220 units/sq m for the entire reservoir and comprised chironomid larvae (66.2 per cent), nematodes (21.2 per cent) and insect larvae (12.6 per cent). The bottom fauna too showed wide variations in abundance in the different regions.

3.2.4. INVESTIGATIONS ON EXPLOITATION TECHNIQUES, FISH BIOLOGY AND POPULATION DYNAMICS TOWARDS FORMULATION OF MANAGEMENT MEASURES. With a view to developing successful management techniques for these reservoirs, studies on the biology of commercially important fishes and experimental fishing to determine the effectiveness of various mesh-sizes of a particular gear were initiated in November, 1967.

The species constituting the commercial catches of Govindgarh reservoir comprise *Tor tor*, *L. rohita*, *C. mrigala* and *C. catla*. The gut contents of *T. tor* were found to comprise sand and mud (42.7 per cent), digested matter (mostly plants, 39.4 per cent), molluscs (mostly bivalves, 6.0 per cent), fish remains (6.0 per cent), grass, seeds and twigs (4.0 per cent) and insect larvae (1.9 per cent).

Studies on the breeding of carps in the Govindgarh and Loni reservoirs resulted in the location of spawning grounds in the two reservoirs. A breeding ground of major carps was located near the waste weir of Govindgarh reservoir, where breeding of *C. catla* and *L. rohita* was observed and a large number of eggs collected, when the water level of the reservoir reached the 100 feet mark and the water started overflowing. The breeding was observed to take place in a shallow and gradually sloping area, having muddy and sandy soil and wild growth of grass, and the turbidity did not appear to play any role as the carps were found to be breeding in clear water. The eggs collected were reared in nursery pits and the fry obtained were tentatively identified as catla-rohu hybrids.

Fertilized eggs were also collected near the water-weir of Loni reservoir when the water level crossed the 290 feet mark, and the escape channel started overflowing, and though the efforts were made to locate the areas of carp breeding in the reservoir and the incoming channels, the suspected areas could not be reached due to extremely bad weather. The percentage composition of eggs after rearing was found to be 31 per cent major carps, 65 per cent minor carps and 4 per cent catfishes.

Studies on experimental fishing with multi-meshed gill nets (mesh bar 40, 60, 75, 95, 100 and 155 mm), using floats and sinkers and without sinkers but with master floats only, were initiated in the Loni reservoir during December, 1967. Four pieces,

each of 60×6 m of webbing of different mesh sizes, randomly stocked, were joined together to form a fishing unit with a hanging coefficient of 0.5. Observations on these studies showed that nets without sinkers but with master floats landed better catches than the nets with sinkers and floats. Further yield from deeper zone was better than from the shallower portions of the reservoir.

Observations on commercial fishing with gill nets by the local Fishermen Cooperative Society, conducted throughout the year except from July to October, in the Govindgarh reservoir indicated the percentage composition (by number) of the catches to be *T. tor* (56.8 per cent), *L. rohita* (22.7 per cent), *C. catla* (7.5 per cent), *C. mrigala* (6.8 per cent), *Labeo gonius* (3.4 per cent), *Wallago attu* (2.5 per cent) and *L. calbasu*, *Channa marulius* & *C. carpio* (0.1 per cent each). The total catch landed during the year was estimated to be 5.8 tonnes.

Studies on gear efficiency conducted during November-December, 1967, revealed that the efficiency of gill nets increased with the increase in mesh bar size as shown below:

Mesh bar (mm)	Average catch/net/day (kg)
40-50	0.7269
55-75	0.9614
80-100	0.9501
105-130	1.1812

Studies on gear selectivity are in progress.

3.3. *Tank fishery investigations.* The tank fisheries in peninsular India being a part of the rural economy, investigations on their fisheries were initiated with a view to ensuring the maximum utilization of available food at all trophic levels and assuring maximum quantity of fish yield within the limitations of water utilization in the tank.

3.3.1. *ASSESSMENT OF FISH PRODUCTION POTENTIALITY IN TANKS.* Studies on the primary production of Light and Dark Bottle method indicated the photo-synthetically fixed gross carbon to vary from 173.8-2681, 321.8-1250, 690.0-2294 and 162.5-499.9 mg C/m³/day in the Hutchamankere and Karpur tanks and Side Hoskote and Kadgrahara ponds. Kadgrahara pond had a comparatively high turbidity value.

Studies on biomass production revealed an abundance of epiphytic diatoms ranging from 4 to 11 lakh units/ sq m of weed surface area by numbers while by volume they, along with the settled particulate organic matter, constituted 31-83 ml/sq m. The extent of settled particulate organic matter in a given area and time, as assessed by slide submersion experiment in Hutchamankere tank in December, 1967, has been found to be 0.07 mg/30 sq cm of the slide area.

Observations on plankton density showed the plankton, by numbers, to vary from 64-1533 units/l in tanks and 70-2560 units/l in ponds while by volume it ranged from 0.61-10.2 ml/cu m and 1.2-25.8 ml/cu m, respectively.

The density of invertebrate organisms constituting littoral and benthic fauna was found to range from 148-1787 units/ sq m in tanks and from 60-461 units/sq m

in ponds. Charred weights of these samples indicated carbon content of 1.34-28.59 per cent per sq m in tanks and 2.3-31.8 per cent per sq m in ponds.

Observations were also made on various physico-chemical factors to study the influence of environmental factors on biomass production. The temperature, turbidity, pH, DO, alkalinity, hardness, specific conductivity, nitrates, phosphates, silicates and iron in the water phase of the tanks and ponds were found to vary from 20°.9-33°.05 and 20.8-30°.9C, 100-1475 and 100-1500 ppm, 6.8-9.6 and 6.8-9.6, 4.01-10.1 and 2.94-11.69 mg/l, 48.0-376.0 and 200.0-740.0 mg/l, 24.0-94.0, 32.0-140.0 mg/l, 104-500 and $112-1045 \times 10^{-6}$ ohms, 0.096-1.33 and 0.052-0.88 mg/l, traces to 0.2 and traces to 0.3 mg/l, 9.0-33.0 and 16.6-35.0 mg/l and traces to 24.8 and 0.06-24.8 mg/l, respectively.

Studies on the physico-chemical characteristics of the soil phase of the tanks and ponds showed the pH, calcium, magnesium, phosphorus and ammonia to vary from 6.6 to 8.5 and 7.6 to 8.5, 1000 to 6000 lb/acre, 40 to 120 and 40 to 80 lb/acre, traces to 25 lb/acre and 25 to 100 lb/acre, respectively.

3.3.2. ENHANCEMENT OF FISH PRODUCTION UNDER EXISTING AND IMPROVED CONDITIONS. The fry of Indian major carps was directly stocked in seasonal tanks to eliminate the nursery practice and an yield of about 180 kg/ha was obtained within 10 months from Karpur tank (31.2 ha) while the yield from perennial Hutchamman-kere tank was 800 kg/ha/annum.

The young ones of the freshwater prawn, *Macrobrachium malcolmsonii*, procured from the river Godavari at Rajahmundry were stocked in the following tanks, resevoirs and fish farms in December, 1967.

Name of the tank/reservoir/ fish farm	Number stocked
Sakalwara tank	2634
Bethamangala reservoir	3900
Shantisagar reservoir	3900
Kanwa reservoir	5000
Hessarghatta fish farm	2000
Krishnarajasagar fish farm	2000
Shantisagar fish farm	1200

Preliminary attempts to check the prolific multiplication of forage fish viz., *Puntius ticto*, *P. stigma* and *Gambusia* sp. in Bellandur tank have been made by stocking 300 murrel fingerlings. Possibilities of murrel culture have also been explored and the 'seed' source of *Canna striatus* located.

Scientific methods of murrel culture on a commercial scale; devising of traps for catching murrels, *Clarias* and *Heteropneustes*; investigations on the seed prospecting of *Puntius pulchellus* and *P. dobsonii* in the Cauvery river and *chanos chanos* in the backwaters of Coondapur have been envisaged for 1968.

4. Riverine fish seed investigations and study of population structure and behaviour of spawn

The spawn requirement for the country being almost thrice as much as the present production and the rivers still contributing to about 92 per cent of the total spawn production, all-out efforts with a view to increasing fish seed production through maximum exploitation of the riverine resource are required. To minimise the cost and mortality during transshipment and achieve regional self-sufficiency, location of seed collection centres in the different states of the country had become an utter necessity. Comprehensive investigations, including location of spawn collection centres and assessment of their potentiality in terms of quantity as well as quality, were initiated by the Institute for the first time in 1964 and continued through 1967.

4.1. *Location of new spawn collection centres and assessment of their potentiality at Kulithalai Dharmapuri, Sopari (Tonk), Nethla, Salempur and Dingraghat.* With a view to prospecting new sources of fish seed in the rivers and streams and assessing the qualitative and quantitative potentiality of such centres, a number of possible sites were surveyed during the pre-monsoon season of 1967. On the bases of these surveys, six sites viz., Kulithalai (Tiruchi Dist.) on R. Cauvery in Madras, Dharmapuri (near Karimnagar) on R. Godavari in Andhra Pradesh, Sopari (Tonk) on R. Banas in Rajasthan, Nethla (near Meerut) on R. Yamuna and Salempur (Lucknow Dist.) on R. Gomti in Uttar Pradesh and Dingraghat (Purnea Dist.) on R. Mahananda in Bihar, were selected for detailed prospecting investigations.

KULITHALAI. Spawn was available for 108 hours, of which 68 hours yielded desirable spawn. In the entire season 3162 ml of spawn were collected by about 11 to 13 nets including standard shooting nets, state nets and research nets. Analyses of spawn samples as well as nursery rearing indicated a high percentage of cultivable species in spurt 4, the percentage in the respective samples being 82.76 and 64.5.

In addition, 12 sites upstream of Kulithalai and 13 sites downstream of it were also examined both during the pre-flood and the flood periods for their suitability to operate shooting nets. Of these, Timmachipuram alone, a site upstream of Kulithalai, was found suitable for the operation of shooting nets. Limited areas for the operation of shooting nets were also available at Pattavaithalai and Tirapparathurai, sites downstream of Kulithalai, but the accessibility was very poor and nets could be operated only up to a particular water level. All other sites were found unsuitable for the operation of shooting nets, either because of steep banks or for want of proper approach.

DHARMAPURI. During the period of investigations from 22nd June to 27th August spawn was available in three spurts only for a total period of 10 hours, the total quantity collected being only 20 ml. Spawn was also not available in appreciable quantities at any of the fish seed collection centres of the State Fisheries Department upstream of Dharmapuri in Adilabad, Nizamabad and Karimnagar districts. The major carp content in the spawn was found to vary from 5 to 18 per cent.

SOPARI (TONK). A total of 9,446 ml of spawn were collected by standard and research nets in four spurts lasting for 82 hours, the entire spawn catch being of desirable species. However, the percentage of major carps as revealed by spawn

analyses and nursery rearing, was found to vary from 21 to 76.5 per cent and 16 to 82.9 per cent, respectively. Prospecting investigations conducted at Dubbi, Nigaria, Bisalpur and Rajmahal showed widespread availability of spawn in the stretch.

NETHLA. A total of 32,381 ml of spawn were collected in four spawn spurts during the season lasting for 172 hours. Spawn analyses showed the percentage of major carps to range from 12.8 to 20.8 while results of nursery rearing revealed the major carp content to be only 7.0 per cent.

SALEMPUR. 12,077 ml spawn was collected in two spurts at this centre, of which about 97 per cent spawn was that of desirable species. While spawn analyses revealed the major carp content to range from 17.6 to 22.5 per cent nursery rearing indicated 25.3 to 41.5 per cent major carps. The first spurt was found to be dominated by *C. mrigala* followed by *L. rohita* with no *C. catla*, the second spurt was dominated by *C. catla* followed approximately equally by all the other major carps.

DINGRAGHAT. Of the five floods encountered during the season, only the first flood yielded spawn, the third and fourth floods yielding fertilized eggs and fry, respectively.

506 ml of spawn were collected in two spurts in a total period of 29 hours, spawn analyses and nursery rearing indicating 87.9 and 94.0 per cent of major carp content. Besides, 2010 ml (c 1.01 lakh) of fertilised eggs were collected in 14 hours which on analysis showed to comprise 71.4 per cent major carps. Nursery rearing of this sample indicated 85.8 per cent rohu, the only major carp available.

The fourth flood yielded 605 ml (c 0.16 lakh) of desirable fry in 11 hours during the rising phase and 2205 ml (c 0.55 lakh) of undesirable fry (mainly catfishes and minnows) in 36 hours during the receding phase. The desirable fry had a major carp content of 62 to 66 per cent in different spurts, which when reared was found to contain rohu (69 per cent) only.

Spawn availability at Labha, a site situated 60 km downstream of Dingraghat and exploited by the commercial fishermen, was found to commence three days prior to that at Dingraghat, the spawn comprising 71 per cent rohu and 5 per cent catla indicating thereby that rohu alone spawns upstream of Dingraghat while both rohu and catla spawning downstream of Dingraghat. The breeding upstream of Dingraghat appears to be limited up to Mouzabarighat, a place where lucrative fishery of mature rohu exists in monsoon months. Exploitation of this stretch of the river from Mouzabarighat to Labha is expected to yield very high quality spawn in sizable quantities since commercial collection of spawn at Labha in 1967 stood at 1022 *hundies*, each *hundi* containing about 1,35,000 spawn.

4.2. *Standardisation of spawn collection and measuring techniques at Kulithalai, Dharmapuri, Sopari (Tonk), Nethla, Salempur and Dingraghat.* Though spawn collection from riverine sources has been in vogue in India for a very long time, there has hardly ever been a serious attempt at standardization of the collection and measuring techniques, the data collected, therefore, being not mutually comparable. Analyses of the relative merits of different collection and measuring techniques prevalent in the country is, therefore, necessary to adopt the best method. Based on the experimental work carried out during the 1964 spawn prospecting investigations, the

Central Inland Fisheries Research Institute, adopted the 1/8" meshed Midnapore-type shooting net as the standard net and suggested its adoption all over the country. The Institute also suggested the adoption of certain standard measures in metric system. The above standard net and measures were employed by the Institute during the spawn prospecting investigations in subsequent years.

During 1967, besides nets of different dimensions, which were operated simultaneously with the standard net and state nets to assess their efficiencies, a specially designed double-walled net was also tried at Sopari (Tonk) to estimate the escapement of spawn from the 1/8" meshed net over various turbidity ranges.

Simultaneous operation of nets of three different sizes (5, 7 and 9 m) along with the standard net at Sopari (Tonk) indicated the average efficiencies to be as follows:

Net size	5 m	7 m	9 m
Efficiency	56.6 per cent	47.4 per cent	43.2 per cent

These efficiencies, however, cannot be accepted as reliable indices because random changes in the position of nets, which affect the catching capacities, could not be done as the spawn spurt lasted for a very short period of 14 hours. The escape-ment from 1/8" meshed net, estimated by operating an especially designed double-walled net, was found to range from 28 to 37.5 per cent over the turbidity range of 375 to 700 ppm and current velocities around 1.5 km/hr.

Simultaneous operation of state nets of four sizes (designated as A, B, C & D) and especially designed nets of different sizes at Salempur on R. Gomti in Uttar Pradesh, with a view to comparing their efficiencies with the standard nets, gave the following results.

Net type		Research nets							State nets			
Net size	6 m	8 m	10 m	12 m	14 m	16 m	18 m		A	B	C	D
% Efficiency	47.8	99.2	28.4	186.9	145.1	280.3	224.1		41.8	74.2	54.2	69.5

4.3. *Spawn availability and behaviour in relation to hydrographical and biotic factors at Kulithalai, Dharmapuri, Sopari (Tonk), Hethla, Salempur and Dingraghat.* In spite of the fact that the riverine collection has always constituted the bulk of spawn production in the country, no attempts were made at a scientific appraisal of the exploited resources nor of the effect of the hydrographical and biotic factors on spawn behaviour and availability. Detailed investigations on spawn availability in relation to a variety of hydrographical, biotic and meteorological factors, initiated by this Institute in 1964, have yielded valuable data wherein correlations have been observed with regard to some of the factors. These investigations have revealed that the effects of various factors are not necessarily similar in different river stretches and that they depend largely on the totality of the various factors involved.

Investigations conducted at the six sites during the 1967 monsoon season yielded the following results:

KULITHALAI. All the nine spurts, encountered at this centre, occurred when the water level started rising because of the release from the Mettur reservoir. It is of interest to record that spawn was available between sunset and sunrise, only spurt 1 being an exception. Turbidity in the Cauvery did not appear to have any effect on concentration of spawn at Kulithalai, nor the observed range of turbidity had any effect on the catching efficiency of the standard nets. Similarly, air and water temperatures also did not appear to have any definite effect on spawn concentration at the site. Current velocity below 1 km/hr and above 4 km/hr were not found to be conducive for spawn collection. However, comparatively low magnitude of spawn in the Cauvery could be attributed to low density brood fish population. Moreover, intensive fishing by the lease holders appeared to have adversely affected the breeder population while adverse effects of the increasing population of *Tilapia* on carp spawn also cannot be ruled out. It will be of advantage to the fishery of the Cauvery if the fishing right of the reservoir at Mayanur bed regulator are not leased out and if yearlings of big-sized carps are stocked annually.

DHARMAPURI. Spawn was available only during the receding phases of the floods. However, the poor availability of spawn (20 ml) at this centre may be attributed to one or more of the following factors:

Exceptionally high rate of rise of water level (27 cm/hr) in the second flood adversely affecting the breeding opportunities.

Vacillation of water level around the very high level of 7 m during the receding phase of the second flood for an inordinately long duration of seven days, thereby dispersing and disturbing the spawn flow of whatever breeding success that might have occurred.

Large-scale commercial fishing in recent years which might have substantially impaired recruitment.

4.4. *Estimation of total spawn catch by commercial fishermen in the eastern sector of Ganga river system.* The importance of collection of proper statistics in case of spawn production from riverine resources cannot be under-rated in view of its importance in determining the fluctuations in its production. The work on the collection of statistics of total spawn quantity collected by commercial spawn collectors from the lower reaches of the Ganga River System between Moghyr and Lalgola was initiated by the Institute in 1964. As bulk of the collection was transported out of the collection centres through the railways, it was considered adequate to collect railway booking figures from all exporting centres to obtain a reliable picture of spawn production in this stretch. This study from 1964 through 1966 indicated that consistent quantity of production is not maintained at a centre between the years and that some of the centres which were reported to give very high yields of spawn during the past years have almost become defunct.

4.5. *Exploratory investigations in Sunderbans.* With a view to ascertaining the

availability of *Hilsa ilisha* and other fish in the Hooghly estuary, six exploratory fishing cruises were undertaken by the departmental vessel M.V. 'Sunderbans'. During all the cruises gill netting, with both drift—and bottom-set nets, was done in the lower reaches of the estuary, around Fraserganj.

Bottom set gill-nets, 200 fathoms in length and $2\frac{1}{2}$ fathoms in width, made out of nylon yarn (Code No varying from 5 to 7), were operated using cement sinkers (1 kg each) and round polythene floats. While the sinkers were tied to the foot rope at a distance of every 3 fathoms, the floats were kept 2 fathoms apart. Manila rope ($\frac{1}{8}$ " in thickness) was used as head and foot rope. The mesh size of the nets operated varied from 4" to 7" and a combination of different mesh sizes was used in different operations.

Drift gill nets used at a time were 600 fathoms in length and $2\frac{1}{2}$ " fathoms in depth and were made of nylon yarn (Code No 1 and 2). Manila rope ($\frac{1}{8}$ " in thickness) was used as head and foot rope and the size of the mesh of nets varied from $3\frac{1}{2}$ ", 4" & $4\frac{1}{2}$ ". While the distance between two sinkers (burnt clay sinkers weighing 500 gm each) in rigged nets was 3 fathoms, polythene floats were tied at intervals of 5 fathoms.

All the nets had a 50 per cent hanging. While the catch of drift gill nets was 1238 kg in 95 hours, bottom set gill netting yielded only 552 kg in 276 hours. *Hilsa ilisha*, *H. sinensis*, *Chirocentrus dorab*, *Pampus argenteus*, *Scomberomorus guttatus* and catfishes dominated the catches of drift gill nets.

As the project was handed over to the Deep Sea Fishing Station, Bombay, further work of the project was stopped with the transfer of this Institute to the Indian Council of Agricultural Research on October 1, 1967.

6. Freshwater prawn culture

6.1 *Culture of freshwater prawns in fish ponds.* Culture of freshwater prawns was initiated in two nursery ponds at the Killa Fish at Cuttack during 1967 with a view to exploring the possibilities and economics of culture of the two important species viz., *Macrobrachium rosenbergii* and *M. malcolmsonii*. Small fingerlings of *M. malcolmsonii*, collected from the Mahanadi and Katjuri rivers, were stocked in the ponds and artificial feeding given in one pond while no feeding was done in the other. Heavy mortality was recorded in both the ponds due probably to low oxygen-content recorded at times.

A source of prawn fingerlings has been located near the Jobra anicut on the Mahanadi river.

Surveys in the nearby rivers to locate additional prawn fry sources and experimental culture in several smaller ponds will be taken up in 1968.

About 40,000 juveniles of the fresh water prawn *M. malcolmsonii*, collected from the Godavari at Rajahmundry were successfully transported to Bangalore. Oxygenation at two stages i.e., initially while packing and then after 6 to 8 hours, enhanced the survival rate.

Attempts to rear the larvae of *M. rosenbergii* and *M. malcolmsonii* during the breeding season from March-July resulted only in partial success as these could be

reared only up to IV mysis stage (7 to 8 days of larval life after hatching).

8. Brackishwater prawn culture in mixed farming

8.1. *Brackishwater fish seed investigations (in the Hooghly estuary)*. Prawn fry and juvenile collection has been initiated in the Hooghly and Rupnarayan rivers. Certain centres for their collection have been located at Nabadwip, Tribeni, Dumurdaha, Naihati, Nawabganj and Barrackpore, in the upper zone of the Hooghly while Diamond Harbour, Kulpi and Uluberia in the middle zone. Kolaghat on the Rupnarayan and Port canning on the Matlah are also centres of considerable potential resource. Detailed investigations on the establishment of various collection centres, methods of collection and transplantation of the seed of brackishwater prawns and identification of stages between post-larval and adult stages of prawns occurring in Hooghly have been planned for 1968.

8.2. *Experimental studies on the survival and growth of prawns in mixed farming*. The survival of *Mugil parsia* fry (20 to 26 mm) collected from Muriganga river at Kakdwip during the low tide periods (salinity, 24 to 28 per cent) from February through April, when acclimatised in various grades of salinity ranging from 15 to 5 per cent for periods varying from 12 to 18 hours, was found to be from 98.20 to 99 per cent. Almost cent per cent survival was recorded when the acclimatised fry were transferred to freshwater as compared to 44.5 per cent in the control.

Observations on the toxic doses of derris root powder (*Derris trifoliata* var. *uliginosa* with 1 to 2 per cent rotenone content) for *Channa punctatus*, *Tilapia mossambica*, *M. parsia* Puntius sp. and *Oxygaster* sp. were found to be 32.5, 39, 11, 14 and 19 mg/litre of water, respectively while that of the root extract were 0.31, 0.45, 0.085, 0.22 and 0.25 ml/litre of water, respectively.

Studies on the relationship between the productivity of *bheris* (brackishwater ponds) and the prevalent hydrobiological conditions, conducted for two years in the Taldi, Rajapur, Belegachi, Bager, Biswas and Daharani *bheris*, indicated optimum production of benthic algae in late summer and monsoon months and minimum during the winter months. Highest benthic production was recorded in the Biswas *bheri* (768 cc/sq m), the lowest being in Daharani *bheri* (24 cc/sq m). Angiosperms were represented by Potamogetonaceae. *Ruppia maritima* was found to record the maximum growth (231 cc/sq m) in Taldi during November, while the growth of *Tribonema bombycinum*, the only species representing Xanthophyceae, was uniformly poor in all the *bheris* throughout the period.

Plankton production followed the same trend as benthic algae, being abundant in the late summer and monsoon months. Maximum phytoplankton production (600 units/l) was encountered in the Biswas *bheri* and minimum (144 units/l) in the Daharani. Zooplankton, which dominated over phytoplankton, was most abundant (1320 units/l) in November in the Taldi *bheri*, the minimum concentration being 504 units/l in the Daharani *bheri* during the same month.

Gastropods, mainly comprising *Cerithedia cingulata*, *Viviparus bengalensis*, *Melanoides tuberculatus* and *Asssiminea* sp., were dominant amongst the bottom macrofauna throughout the period from May to December, the maximum concentra-

tion being 321.76 gm/sq m in Belegachi and the minimum (4.5 gm/sq m) in Daharani.

Observations on the physico-chemical conditions revealed the temperature, pH, DO carbonate, bicarbonate, calcium, magnesium, nitrogen, phosphorus and potassium to range from 19.0 to 33.5°C, 7.0 to 8.0, 3.6 to 16.4 ppm, nil to 47.2 ppm, 27 to 153 ppm, 270 to 675 ppm, 1136 to 2050 ppm, 0.1 to 1.4 ppm, traces to 0.15 ppm and 69 to 216 ppm, respectively.

Investigations on the seasonal fluctuations in abundance and composition of the seed of cultivable species of fish and prawn, initiated in November, 1967 in the feeder canal of the Brackishwater Fish Farm, Kakdwip (West Bengal), showed that it mainly comprised *Palaemon styliferus* (13 to 38 mm) and *Penaeus indicus* (15 to 57 mm), *Metapenaeus brevicornis* (19 to 62 mm), *M. monoceros* (31 to 40 mm), *Parapenaeopsis stylifera* (41 to 42 mm), *Macrobrachium rude* and *Metapenaeus affinis* being the other cultivable prawn species.

8.3. *Brackishwater fish seed prospecting near defunct bheri areas.* Steady decline in the quantity of incoming brackishwater fish seed in many of the *bheri* suggested the prospecting for suitable areas wherefrom fish seed could be collected for stocking the *bheris*. A survey of the terminal stretch of the Kulti estuary near Kharibari, initiated in July, 1967, did not show any larvae of commercial importance during August-October.

8.4. *Biological investigations in Pulicat lake, Ennore backwaters and Adyar estuary.* Investigations on the survival and mortality rates of commercially important fishes of the Pulicat lake were completed. The details are given below.

SPECIES	YEAR	ANNUAL MORTALITY	REMARKS
<i>Mugil cephalus</i>	1967	0.7451	The annual mortality was more in 1967
	1966	0.5603	
<i>M. macrolepis</i>	1967	0.6525	The annual mortality was more in 1967
	1966	0.4702	
<i>M. parsia</i>	1967	0.7116	—do—
	1966	0.5778	
<i>Sillago sihama</i>	1967	0.8320	—do—
	1966	0.6672	
<i>Gerres oyena</i>	1967	0.6325	The annual mortality was very slightly more in 1966
	1966	0.6565	
<i>G. filamentosus</i>	1967	0.7949	—do—
	1966	0.8121	
<i>Nematalosa nasus</i>	1967	0.6261	The annual mortality was more in 1966
	1966	0.8128	
<i>Chanos chanos</i>	1967	0.5002	The annual mortality was very slightly more in 1966
	1966	0.5399	
<i>Elops saurus</i>	1967	0.6571	
	1966	—	

Investigations on the biology of prawns (*Penaeus indicus*, *P. monodon*, *P. semi-sulcatus*, *Metapenaeus monoceros*, *M. dobsoni* and *M. burkenroadii*) and fishes (*Sillago sihama*, *Gerres oyena*, *G. filamentosus*, *Etroplus suratensis*, *Nematalosa nasus*, *Chanos chanos* and *Elops saurus*) were completed.

Observations on the food of *Mugil cephalus* indicated slimy mud, decayed organic matter, dinoflagellats, diatoms, foraminiferan shells, molluscan shells, filamentous algae, gill raker processes and tintinnids to constitute the gut contents. *M. cephalus* in the commercial catches of the lake showed modes at 135, 180, 245, 275 and 365 mm. Maximum size at first maturity was 270 mm for males and 400 mm for females. Sex ratio was male: female : : 1.2:1.0. The food of *M. macrolepis* also comprised almost the same items as that of *M. cephalus*. Three modes at 90, 165 and 245 mm were present in the commercial catches, the size at first maturity for males and females being 145 and 195 mm, respectively. The species seems to have prolonged spawning season as evidenced by the fry entering the lake throughout the year. Ova diameter studies revealed two modes at 78 and 499 μ while the fecundity ranged between 1,54,759 to 78,15,000 in fishes measuring 205 to 336 mm. The entry of *M. parsia* fry in the lake round the year suggests prolonged spawning season for this species. The size at first maturity for *M. parsia* was 140 and 153 mm for males and females respectively. Two modes of ova were present at 78 and 499 μ . Fecundity ranged between 82,803 and 2,34,296 for fish measuring 143 to 241 mm.

Studies on the distribution and abundance of fish eggs, larvae and juveniles with a view to determining the spawning grounds, nursery grounds and collection centres for commercial exploitation have indicated that the eggs of *Thriposocles* sp. are available in the southern and northern sectors during January, March-May and August-November. While the larvae were abundant during March-June and August in the southern sector, post-larvae were available throughout the year at lake mouth, with peaks in March, June and September.

The eggs of *Sardinella* sp. were available in the northern sector in September. Eggs of *M. cephalus* were available in November-December at lake mouth but in very small numbers. However, the fry of *Mugil* species (10 to 25 mm) was available throughout the year at lake mouth with peaks in March-June, September and December. Fry of *C. chanos* (10 to 15 mm) was collected at the lake mouth during March-October with peaks in April-September. Juveniles of *S. sihama* (10 to 40 mm) were found to enter the lake almost throughout the year with peaks in March, June, October and December. While the larvae of *E. saurus* (28 to 30 mm) are available throughout the larvae of *Megalops cyprinoides* (22 to 28 mm) are available at lake mouth during April-October and December, with peaks in April and June. Juveniles of *E. suratensis* were available at lake mouth and in the southern sector during September-January. Annamalaicheri in the southern sector and Irakkam and Pulinjeri in the northern sector seem to form the nursery grounds for juvenile fish. Post-larvae and juvenile fish were more abundant during the new-moon night high tide period.

Hydrographical data collected during August-December 1967 indicated the surface water temperature, transparency, DO, salinity, pH and total alkalinity to range from 25.01-29°.OC, 0 to 94.5 cm, 6.6-20.6 ppm, 4-35 per cent (southern

sector) to above 27.5 per cent (northern sector), 7.4-8.8 and 64-124 ppm, respectively.

9. Selective breeding and hybridisation

9.1. *Studies on the biological and genetical features of some Indian carp hybrids.* F_1 hybrids of catla $\times$ mrigal, mrigal $\times$ catla and rohu $\times$ mrigal were produced with the object of developing improved strains of Indian carps. Detailed studies on their biology in comparison to the parent species were taken up. Structural adaptations/modifications and food and feeding habits of the hybrids were also studied in detail.

12. Exotic fish culture

12.1. *Standardisation of techniques of breeding of grass and silver carps for large scale production of seed.* Despite adverse weather conditions considerable success was achieved in the induced breeding of grass carp and silver carp resulting in the production of 1.61 lakhs fry of the former and 2.6 lakhs of the latter. The effective dose of hormone usually ranged from 12 to 14 mg/kg wt of males in both the species. However, in one instance, a dose of 5 mg/kg wt was enough to induce spawning in grass carp. Natural spawning occurred on several occasions in injected grass carps and once in silver carp.

Trials with the synthetic hormone 'synahorin' and experiments under controlled temperature in the air-conditioned laboratory are envisaged in 1968.

12.2. *Optimum per hectare production of exotic carps to obtain increased production of fingerlings and yearlings.* In an experiment on optimum/ha production of fingerlings in which fry of grass, silver and common carps were stocked in the ratio 3:4:3 at 60,000 and 90,000/ha, each with two replications, average survival percentages of 76.1 and 80.5 were recorded in three months' rearing. In an experiment on yearling production in which fingerlings of the three species were stocked in the ratio 4:2:3 at 3,700/ha, with two replications an average production of 2909 kg/ha/annum with survival of 88.2, 94.3 and 82.3 per cent was obtained.

Fingerling production at the same rates of stocking of fry but in the ratio 4:3:3 and yearling production at stocking rates of 3700 and 5000/ha and species ratios of 4:2:3 and 3:1:2 will be attempted in 1968.

12.3. *Food preferences of grass carp.* Preliminary observations on the use of grass carp for weed control gave encouraging results, hence detailed investigations on the food preferences of the species were planned with a view to determine the optimum size and rate of stocking of the species for effective control of various aquatic weeds.

In field experiments grass carp of varying sizes were observed to control weeds like *Hydrilla*, *Najas*, *Ceratophyllum*, *Nitella* and *Spirodela* effectively and exercise a check on the growth of *Utricularia*, *Nehamandra*, *Vallisneria* and *Salvinia*. In feeding experiments in the laboratory, juveniles of the fish consumed *Potamogeton pectinatus*, *Halophila ovata* and *Myriophyllum* and, sparingly, cut bits of *Eichhornia*. Tender shoots of *Jussiaea* were not taken. Even in the field, cut bits of *Eichhornia* were consumed by the juveniles only sparingly even when supplied regularly.

12.4. *Investigations on compatibility of catla and silver carp.* To determine the proper ratios in which catla and silver carp could be stocked in composite culture,

observations were carried out in a set of eight ponds stocked with uniform-sized fingerlings of both silver carp and catla at 2,500/ha but in four different ratios of 1:2, 2:1, 1:4 and 4:1, each with two replications. Silver carp recorded better growth than catla in all the ratios, even though growth of silver carp was poor in the winter months, thereby suggesting that in the competition for food between the two species catla suffers. Studies with one to two-year old fishes and at different stocking densities and ratios are proposed to be taken up in 1968, subject to availability of ponds.

Besides the above problems, the intensive culture of tilapia along with a limited number of Indian and exotic carps which was taken up in 1965 was continued in 1967 and a total harvest of 3425 kg of tilapia and 791 kg of other fishes were obtained during the year, the gross production working out to 3513 kg/ha/annum.

13. Coldwater fish culture

Experimental work with a view to increasing the present rate of survival, initiated at the Achabal Trout Farm, Kashmir, showed that application of modern techniques in trout culture operations increased the rate of survival of eggs, alevins and fry from the green eggs to fry stage in the case of brown trout (*Salmo trutta fario*) to 49.3 per cent as against 22.5 per cent obtained by the State Fisheries Department. Similarly, in case of rainbow trout (*S. gairdnerii gairdnerii*), application of the same techniques increased the percentage survival from the green egg to fry stage from 17.0 to 39.3.

In order to carry out detailed investigations on the trout hatcheries of Jammu and Kashmir State, the headquarters of the Unit have been shifted from Kangra to Srinagar.

14. Riverine and estuarine fish catch statistics

A comprehensive report on the fisheries of the R. Ganga, based on studies made from 1954 through 1966 and a very detailed analysis of the statistical data collected were completed during 1967. Statistics of monthly market landings of various species of fish at eight selected centres on the Ganga river system was used to elucidate the annual and seasonal fluctuations in the fisheries of various zones and the fisheries of various species illustrating their trends.

Studies on the fishery biology of important species, completed during the eight-year period, with special reference to the juvenile fishery and legal status of the same, have been reported. The status of the present stage of Ganga fishery has been discussed with measures for improvement, and further scientific studies to be undertaken enumerated.

Investigations on the fish production of riverine enclosed waters (backwaters or oxbow lakes) of R. Ganga were continued from 1964 through 1966. The riverine enclosed waters were found to be a regular source of fish supply during the major part of the year between the recession of monsoon floods in October and the commencement of the succeeding monsoons in June. Altogether 45 enclosed water bodies were found to supply fish regularly to the Bhagalpur fish assembly centre. Fifteen backwaters were found to be the most productive, accounting for 81.8 per

cent of the total landings from this source. Highest yields were obtained from Mahadevpur, Lattipur, Sonbarsa, Ghogha, Pirpainti and Matroja backwaters. *H. ilisha* was not represented in the catch from this source. 94.01 per cent of the total major carp production was landed by fifteen backwaters among which Mahadevpur, Sonbarsa, Lattipur, Matroja, Pirpainti, Hilsamari and Mathurapur were most important. Post-monsoon months presented low production of major carps. An examination of the size groupwise distribution of the desirable species revealed that while these sources provided a flourishing fishery for the juvenile carps, other size groups accounted for maximum landings of the catfishes.

A preliminary report on the main findings on the problem of possible depletion of the fishery in the Godavari river was completed.

Studies on the fisheries of the Narbada river were wound up in March, 67 and subsequently the Narbada Tapti Unit was transferred to Rewa.

Investigations on the fisheries of Chilka lake were concluded during 1967. The total production of the lake from January to June was estimated at 1547 tonnes, of which prawns formed 24.32 per cent, perches 18.77 per cent, clupeoids 15.64 per cent, mullets 10.12 per cent, catfishes 8.95 per cent, threadfins 6.12 per cent, sciaenids 4.86 per cent, beloniformes 1.20 per cent and miscellaneous fishes 9.65 per cent.

14.1.1. RIVERINE FISH CATCH STATISTICS—GANGA SYSTEM. Specieswise monthly estimates of fish landings at eight assembly centres on the rivers Ganga and Yamuna were continued (Appendix 1 & 2). The estimated landings at six fish assembly centres on the Ganga were 473.57 tonnes as against 462.43 tonnes during 1966. *H. ilisha* which accounted for 20.21 per cent of the total landing was the dominant species followed by *Mystus aor* (7.18 per cent), *M. seenghala* (5.98 per cent), *Wallago attu* (4.82 per cent), *C. catla* (4.45 per cent), *C. mrigala* (3.53 per cent), *L. rohita* (3.24 per cent), *Rita* (2.08 per cent) and *L. calbasu* (0.60 per cent).

200.13 tonnes of fish were landed by the commercial fishermen at the two-fish assembly centres on the Yamuna as against 244.57 tonnes during 1966. Unlike the Ganga, major carps dominated the Yamuna landings with a contribution of 50.27 per cent to the total, while catfishes and hilsa, respectively contributed 27.35 and 7.0 per cent, *C. mrigala* (27.68 per cent) was the dominant species, followed by *L. calbasu* (10.74 per cent), *M. aor* (9.83 per cent), *M. seenghala* (8.73 per cent), *H. ilisha* (7.01 per cent), *L. rohita* (6.57 per cent) *W. attu* (5.52 per cent) and *C. catla* (5.28 per cent). Miscellaneous fishes accounted for 15.37 per cent of the annual estimates.

The estimated annual landing at Lalgola on the Padma during 1967 was recorded to be 12.45 tonnes as against 12.88 tonnes in 1966, registering a decline by 3.34 per cent. Comparative study of the monthly pattern of landings indicated that this decline was due to the lower yield during the monsoon and post-monsoon months. Of the eight desirable species, only *H. ilisha* (3.70 tonnes) was represented in the landings, the remaining 8.75 tonnes being that of miscellaneous species of fish. The factors that contributed to the lower production in the year were observed to be the total absence of major carps and catfishes in the landings and a decline in the yield of *H. ilisha*.

A survey to elicit information on the present practice of riverine catch disposal, markets and landings *ghats* utilized, magnitude of catch, etc., was carried out in the vicinity of Allahabad, from Kalakankar to Mirzapur, on the Ganga, a stretch of about 200 km, and 75 km stretch of the Yamuna from Rajapur to its confluence with R. Ganga. A total of 66 villages on river Ganga were surveyed, which feed a total of 23 landing *ghats*. On the Yamuna, a total of 51 villages were surveyed and only one landing *ghat* was reported. The catch disposal techniques gathered were generally in conformity with those collected earlier. Based on the data gathered, it is proposed to start a pilot survey of landing centres for estimation of fish landing variability pattern for developing a suitable design for estimation of total fish landings from this stretch.

Biological investigations on *M. seenghala* and *M. aor* were conducted through 1967.

MATURITY AND FECUNDITY STUDIES ON *M. seenghala*. Detailed analysis of the data on ova diameter measurements to study the growth of the intraovarian eggs of *M. seenghala* was completed and 10 different stages depending upon the size of most mature group of ova were demarcated. Accordingly, the size of ova in the early mature stage ranged between 0.900 to 0.996 mm. In the ripe ovaries, the ova size was found to be 1.190 mm and above.

A close relationship expressed by the equation $\log Y = 0.02956 + 0.65960 \log x$, ($r = 0.79328$) between the progression of the two right hand modes in the ovaries in advanced stages of maturity, indicated that the smaller groups of ova also grow to maturity and mature in their turn within the same spawning season. The multiplicity of the model groups of ova and a high correlation between the modes of successive group of ova ($r = 0.7932$ at $P < 0.05$) provide enough evidence to suggest that an individual *M. seenghala* spawns more than once during a breeding season.

The relationships between the fecundity and length and weight of fish were found to be :

$$Y = -3.95763 + 2.92484 \log T.L. \quad (T.L. = \text{Total length}) \text{ and} \\ Y = 1.05863 + 0.98573 \log W \quad (W = \text{Weight of fish}), \text{ respectively.}$$

Other relationships between the length of fish and length of ovaries and testes were also established and found to be :

$$Y = -1.60013 + 1.24784 \log T.L. \\ Y_t = -0.83435 + 1.02726 \log T.L.$$

respectively and it was found that the ovaries grow at a slightly faster rate than the testes.

The relationship between the weight of ovary and the number of ova spawned can be expressed as :

$$Y = 3.11675 + 0.92753 \log \text{weight of ovary.}$$

The total fecundity of fish during one spawning burst was found to vary between 39,000 ova to 1,20,000 ova in the size range of fish from 850 to 1110 mm in total

length, the weight of fish ranging between 4 to 10 kg.

BREEDING SEASON OF *M. seenghala*. Immature specimens of *M. seenghala* were recorded almost throughout the year with their majority being encountered in September to November and February. Majority of mature ovaries in advanced stages of maturity, i.e., F.G.H. and I, were recorded in the months March to June and July. The spent ovaries were also encountered during the months March to June and also in August. The breeding season of *M. seenghala* like *M. aor* appears to extend during the period March to August. Early larval stages of *M. seenghala*, which were collected during this period, from the breeding, pits, also supported the above conclusions.

MORTALITY AND SURVIVAL RATES OF *M. aor* & *M. seenghala*. Estimation of annual mortality and survival rates of *M. aor* for the year 1967, based on age frequencies, were made and the results are as under:

Instantaneous mortality rate	=0.650
survival rate	=0.537
mortality rate	=0.463

In case of *M. seenghala*, the mortality and survival rates are as under :

Instantaneous mortality rate Δ	=0.509
survival rate S	=0.603
mortality rater	=0.397

The studies on various aspects of biological investigations of *M. aor* and *M. seenghala* have been completed and the results of investigations are being finalised in the form of technical papers.

14.1.2. INVESTIGATIONS ON THE REPORTED DEPLETION OF FISHERIES IN THE GODAVARI. Observations on the catch/effort estimates of the Godavari were continued during 1967. The total landing being 161.9 tonnes in 1967, the rise of over 31 tonnes over 1966 is attributed to the record landings of prawn 97.7 tonnes (about 26 tonnes rise) and a slight increase by 6 tonnes over previous year of all major catfish of the river. Landings of *H. ilisha* declined while those of major carps and miscellaneous fish remained comparatively stable. The overall pattern of monthly and zonal landings showed only minor variations.

The total catch against total effort expended and the catch per-man-hour 'however' indicated continued fall in density of large-sized fish populations as shown by the gill-nets. For 409.8 thousands of man-hours expended by this net, the yield was only 28.8 tonnes and catch-per-man-hour was 0.07 kg. In the seines, viz., *Alivivala* and *Jaruguvala*, the effort, yield, and C/M/H, all the three values increased over the previous year due to increased yield of juvenile fish in the former and prawns in the latter. The general trend indicated that despite rise in total yield, the symptoms of overfishing are continuing in the river with no signs of improvement. Landings in terms of market values paid and the fluctuations and trends were maintained for a second year in succession.

A preliminary study on marking with the biological stain, Trypan blue, on the

prawn, *M. malcolmsonii* of the river (using nearly 3000 prawns) indicated that the; (a) mark is retained for more than 90 days at a stretch, (b) that the movements of the prawns are very much localized to the spot of release even after 2 months, (c) that there is considerable initial mortality, i.e., within 2 to 3 days after marking, after which the mortality due to marking is practically absent, and (d) that this marking is quite suitable for short term growth and behavioural studies. Further study has been planned for 1968.

It was established that the mortality of juvenile *M. malcolmsonii* at anicuts caused by catching with improvised methods is considerably increased during the year and is detrimental to regular commercial fishing of larger size groups.

14.1.3. ESTIMATION OF PRIMARY PRODUCTIVITY

14.2. *Estuarine fish catch statistics.* HOOGHLY ESTUARY. The total catch from the Hooghly estuary for the period December, 1966 to November, 1967 was 7839.3 tonnes as against 6474.5 tonnes of the corresponding period of 1966 (Appendix 3). Bulk of this catch was obtained from zone III, which showed a slight decrease in the percentage contribution but an increase in the actual catch. *H. ilisha* dominated the catches, followed by *Harpodon nehereus* and prawns. There was an increase in the landings of *H. ilisha*, *Pama pama*, *S. cinereus*, *Pangasius pangasius*, *Sciaena miles*, *Hilsa toli*, *Ilisha elongata*, *Setipinna taty* and *S. phasa* and prawns as compared to that of 1966 while the landings of *H. nehereus*, *Tachysurus jella*, *Sciaena bauritus*, *Coilia ramcarati*, *Trichiurus savala* and *T. haumela* (Appendix 4). Zone III was the most productive of all zones (Appendix 5). Of the gears employed, bagnets as usual contributed the maximum landings, followed by large seines, small seines, drifts, hooks and lines, set gills, etc. (Appendix 6).

PULICAT LAKE. The total estimated landings from the lake during 1967 were 1133.81 tonnes, showing a rise of 11.07% over that of last year, the increase being mainly due to increased prawn landings. *P. indicus* was the dominant prawn and *M. cephalus*, the dominant fish (Appendix 7). The catches from the southern sector were heavier than from the northern, the fishery of the former being dominated by prawn while that of the latter by mullets. Catch/net/day was the maximum in case of *badivalai* (129.41 kg) than the other nets (Appendix 8).

15. Fish pathology

Studies on the spoilage of fish in Calcutta fish markets and surrounding industrial belt, conducted jointly by this Institute and the Department of Microbiology, All India Institute of Hygiene and Public Health, Calcutta, to determine (a) the microflora in a variety of fish, *Cyprinus carpio* var. *communis* and (b) to consider the possibilities of these bacteria being associated with the spoilage of this variety of fish after death were completed.

Thirty-two strains of bacteria were isolated from the pond-water (habitat of the fish), surface of freshly caught live fish, fish intestine and the fluid from the rotting fish. Of the 32 strains obtained in pure culture, 6 were able to produce conditions considered to be 'spoilage' of fish. The degree of spoilage was marked in 2 of the strains at $\frac{1}{2}$ dilution. Experiments were conducted with all the six strains which

cause rotting within 24 hours. It was found that a bacterial load numbering 10^7 to 10^{10} /ml was responsible for causing fish 'spoilage'. Bacteria isolated from several sources, while examining the microflora of *C. carpio*, were found to belong to Micrococci (yellow and white), *Proteus* spp., *Corynebacterium* spp., *Klebsiella* spp., *Vibrio* spp. (belonging to Heiberg I), *Achromobacter* spp., *Pseudomonas* (group III & IV) *Escherichia coli*, and Enterobacteriaceae.

15.1. *Investigations on the parasitic diseases of cultivated fishes.* Detailed investigations in ten nursery ponds in the Hooghly and 24-Parganas districts of West Bengal revealed that though the carp fry, hatched in June, 67, were all free from the infection of protozoan and helminth parasites, infestation started in these ponds in early July, almost simultaneously in the ponds of both the districts. The fry were found to be infested with *Dactylogyrus* sp. at a very early stage (9 to 10 mm). However, the infection of *Gyrodactylus* and other protozoan parasites was recorded when the fry were more than 40 mm in size. Considerable variation in the degree of infestation with the above mentioned parasites was observed from pond to pond as mentioned below.

Pond No.	Locality	No. of fish examined	Rate of infection with				
			<i>Tricho-</i> <i>dina</i>	<i>Myxo-</i> <i>bolus</i>	<i>Theloha-</i> <i>nellus</i>	<i>Gyrodac-</i> <i>tylus</i>	<i>Dactylo-</i> <i>gyrus</i>
1.	Barasat	25	36	36	4	44	—
2.	„	28	—	3.5	—	67.8	—
3.	Baidyabati	105	80	75	—	—	—
4.	„	57	10.5	15.5	—	50.8	1.7
5.	„	90	30	12.2	—	85	1
6.	„	87	2.2	6.8	—	84	4.5
7.	Sheoraphuli	65	30	23	—	64	14
8.	„	29	10.3	20.6	—	72	3.4
9.	„	40	25	7.5	57	45	—
10.	„	177	12.4	20.7	32.7	92.6	1.6

Mass mortalities were encountered in most of the ponds. It was found that the factors common in cases were over-crowding (over 50,000 fry in 0.1 acre) and retardation in growth and weakness.

Studies on the development of control and prophylactic measures revealed cent per cent mortality at 3 per cent and 2 per cent sodium chloride within 10 to 15 and 30 to 40 minutes, respectively when the size of fish varied between 77 and 100 mm.

Fry of catla, rohu and mrigal were used in the toxicity tests of potassium dichromate, a chemical control agent of fish diseases. 100 per cent mortality and 100 per cent survival of the test animals were noticed within 36 hours' time limit in a dose

of 1:7000 at 34°C and 24°C, respectively. This experiment needs elaboration before conclusive results are obtained.

In order to evolve cheap and efficient methods to prevent and control fish diseases, toxicity tests of the following chemical control agents are proposed to be made :

Acriflavine
Formalin
Methylene blue
Potassium dichromate
Malachite green

16. Weed control

16.1. *Standardization of control of water hyacinth with 2,4-D.* Work on standardization of control of water hyacinth with sodium 2,4-D and other formulations, with the object of working out precise minimum doses of the weedicide and other additive and evolving suitable techniques for effective treatment of diverse categories of water hyacinth infestations and for economic follow-up management measures, was taken up during 1967.

In a field experiment with "Taficide-80" (80 per cent sodium salt of 2,4-D) at 6 kg/ha with 0.25 per cent detergent (surf) at 1 kg/ha and kerosene at 4 litres/ha, when uniformly sprayed on a thick infestation of 33 plants/sq m of water hyacinth weighing 21 kg/sq m, 94 per cent clearance was obtained in 12 weeks' time without adverse effect on fish or fish food organisms at a cost of Rs 210/ha. However, results of these and of yard experiments indicate that a dosage of 8 to 12 mg acid equivalent of sodium 2,4-D/kg wt of live plant may be needed to achieve a total kill. The problem of approach of dense infestations where boats cannot be plied for spraying has been successfully solved and improvements are being worked out. Clearance of water hyacinth with 2,4-D appeared far more feasible and economical than manual clearance.

16.2. *Control of aquatic grasses and sedges.* In field experiments, it was found possible to achieve total kill, clearance and prolonged control of even mature *Cyperus* infestations by foliar spraying with 2,4-D sodium salt at 8 kg acid equivalent per hectare. However, younger stages of the plant were more susceptible to the weedicide. Manual cutting resulted in quick regeneration. Field studies on *Cyperus* and *Panicum* indicated maximum growth density during June-July in the former and during August-September in the latter.

Laboratory experiments conducted with a view to study the behaviour of bound copper, when copper sulphate mud pellets are applied to the bottom soil for control of submerged weeds, have shown that the maximum rise of Cu^{++} concentration was 0.6 ppm, six hours after the fourth application at 35 kg/ha. Addition of concentrated sulphuric acid at a maximum of 5000 litres/ha increased the concentration of Cu^{++} from 0.04 ppm to 1.6 ppm in the water at the soil-water interface after 24 hours which indicates that even if an enormous quantity of the acid is added to the soil treated with copper sulphate mud pellets, the concentration of Cu^{++} would not be fatal as a

concentration of 2 pp,m of Cu^{++} is permissible in drinking water according to the WHO standards. However, no rise in the concentration of Cu^{++} was noted on the addition of 2N potassium hydroxide solution.

Application of copper sulphate mud pellets at 35 kg/ha in three intermittent doses, to the bottom soil of a sewage-fed nursery pond (312 sq m) and part of a canal (185 sq m), through which the sewage flows, controlled *Vallisneria spiralis* and *Hydrilla verticillata*, and *Eichhornia* and *Cyperus* which were choking the pond and the canal respectively. No regrowth of these weeds has been observed. Fish life in the pond was not affected at all.

Further field trials with copper sulphate mud pellets in a derelict bheel (c. 55 ha), completely covered with a floating mat comprising *Eichhornia*, *Salvinia*, *Pistia*, *Spirodela*, *Colocasia* and *Lemna* and fully choked with *Hydrilla verticillata*, *Ceratophyllum demersum*, *Ottelia alismoides* and *Nymphaea* spp., where three areas were selected for experimental treatment, have indicated that application of the pellets at 35 kg/ha, in four intermittent doses, is more effective when the floating mat (*Eichhornia*, etc.) of vegetation is removed 24 hours before the treatment than in cases where the mat is either not removed or removed 4 months before the treatment. Both the acid and water soluble copper in the soil showed an increase of 0.2 mg/100 gm of soil, after the treatment with copper sulphate.

However, a very significant observation has been that the plants (*H. verticillata*) up-rooted by the application of copper sulphate do not die but continue to survive in a floating state and develop new branches from the axils of the decaying leaves and roots also show development from the base of the new branches. On the unhealthy floating plants formation of green turions was also very common.

Studies on the autecology of *Vallisneria spiralis* and *Ceratophyllum demersum* and the utilitarian aspects of *Spirodela polyrrhiza* are in progress.

16.3. *Evolution and evaluation of new weedicide formulations.* In laboratory and yard tests on four weedicides, while B.V. 201 (1-3-4) dichlorophenyl 1 3-methyl, 2 pyrolidinone) at 3 to 6 ppm gave total kill and prolonged suppression of *Nechamandra*, Tok E-25 (2-4 dichlorophenyl 4 nitrophenyl ether) at 3-6 ppm gave effective kill but only temporary suppression of *Hydrilla* and *Vallisneria* but the granular form of the same weedicide at 1 to 3 ppm was not effective against *Najas*. Gramoxone (1:1 dimethyl 4:4 bipyridilium) at 10 ppm was effective against *Hydrilla*, but at 5 ppm or more was toxic to tilapia and carp fingerlings. Phenoxylene plus (Methyl chlorophenoxyacetic acid) at 3 kg/ha gave effective kill of bulk of water hyacinth.

For preparing water soluble weedicides for ground application an easy granulation technique, in which the weedicide dissolved/emulsified in starch was impregnated with fine sand, dried and broken to original size, has been worked out.

Further studies with the weedicides tested as well as new ones, and evaluation of the combined role of ammonia as an aquatic weedicide and fertilizer for large scale field use are envisaged during 1968.

17. Frog farming

The frog-leg industry of India being a lucrative source of foreign exchange

various attempts to boost the industry are being made. However, it must be realised that the natural resources are bound to get depleted, if proper conservancy and developmental measures are not adopted. A scheme on frog farming has, therefore, been initiated at this Institute with a view to develop methods of commercial frog farming and frog-cum-fish culture. In this connection, a part of the Killa Fish Farm at Cuttack has been converted into a frog farm comprising six nurseries of 0.1 acre each and one rearing pond of 0.2 acre with all round wire net fencing together with upland feeding grounds for frogs in each pond on one side. Further fencing work and electrification of the farm ponds in order to attract insects for feeding the frogs will be taken up shortly.

Besides, a survey of frog resources of various states for commercial exploitation was also conducted and areas for exploitation of *Rana tigrina* and *R. hexadactyla* were located in the Howrah and 24-Parganas districts of West Bengal and for *R. tigrina* in the Cuttack and Puri districts of Orissa.

Twenty live specimens of American bull frogs (*Rana catesbeiana*) were introduced into the country for the first time during April-October 1967 in the form of gift consignments by Prof. W. Frank Blair of the University of Texas, U.S.A. *R. hexadactyla*, hitherto not available in Orissa, has been introduced in that state from West Bengal during August-September, 1967.

17.1. *Tadpole rearing and raising small frogs.* Raising of tadpoles from fertilized eggs obtained through induced breeding of *R. tigrina* and natural breeding of *R. hexadactyla* and rearing them to early/small frog stages were done during July-October, 1967, in the laboratory and field nurseries. 1072 early frogs could be raised from 3000 fertilized eggs of *R. tigrina*. Hatching of eggs was better in Holt-freter solution than in pond water. Assessment of various life-history stages and survival were not found feasible in the field by netting.

Laboratory, yard and field experiments for raising tadpoles and small frogs and their assessment in the field are envisaged in 1968. Culture of a few live frog food organisms will also be attempted.

17.2. *Culture of frogs and study of productivity in frog farming.* Early frogs of *R. tigrina* stocked in a well-fenced nursery at 2,000/ha showed slightly retarded growth during a four month observational period compared to its growth in nature, whereas *R. hexadactyla* under the same conditions showed normal growth during a 2 month observational period. The retarded growth of the former was obviously due to non-availability of adequate supply of insect food in the pond.

Analysis of the gut contents of 163 individuals at various life-history stages revealed that in contrast to the vegetarian habit (feeding on *Spirogyra*, *Oedogonium* and tender leaves of *Hydrilla*) of tadpoles of *R. hexadactyla*, those of *R. tigrina* feed on tubifex and mosquito larvae. From frog-let to small frog stages *R. tigrina* feeds on worms and insects and their larvae while *R. hexadactyla* feeds mostly on aquatic insects and spiders.

17.3. *Investigations on fish-cum-frog culture.* Field experiments in five (0.04 ha) ponds (suitable manured/planted with seeds for *R. hexadactyla*) have been initiated by stocking together early frogs of *R. hexadactyla*/*R. tigrina* at 2,000/ha

and fingerlings of catla, rohu and mrigal at 3,750/ha in the ratio 3:4:3:, to study the cultural possibilities of these frogs in association with the Indian major carps, the growth of both frogs and fish appears to be satisfactory.

In induced breeding experiments carried out during 1967 with homoplastic pituitary gland extracts, 62 per cent success was obtained in *R. tigrina* during July-September and cent per cent in *R. hexadactyla* during the non-breeding period (May) with a priming dose of progesterone.

19. Hilsa investigations

19.1.1. STUDIES ON THE SPAWNING SUCCESS OF *Hilsa ilisha* AND ITS BEARING ON HILSA FISHERY IN THE UPPER REACHES OF THE GANGA RIVER SYSTEM. The reasons for the wide fluctuations in the hilsa fishery of the Ganga river system still remain to be answered. Recent studies by this Institute have, however, indicated the existence of three distinct resident subpopulations of hilsa in the Ganga. Since it is known to migrate over long distances, the extent of the breeding and feeding grounds of the various resident populations of hilsa assumes special importance in the context of the development of river valley projects. Earlier work on the delimitation of spawning grounds of hilsa in the Ganga has indicated that it breeds practically all along the stretch, with concentration in certain regions.

During the 1967 monsoon season, collections of hilsa larvae were made at nine selected centres on the 134 km stretch from Mahewa Patti on the Yamuna (above its confluence with the R. Ganga) to Chunar on the Ganga (below the confluence) in the upper sector and from four sampling centres between Cologong to Dhulian in the lower sector of the Ganga. 1/16" meshed shooting nets and ½ m tow nets were used for sampling throughout. In the upper sector, hilsa larvae appeared at all the centres and continued appearing till mid-November. Sindhoraghat, Mandaghat, Mahewa, Chunar, Vindhyachal and Bhatauli centres accounted for the bulk of the catch. Sindhoraghat recorded maximum catch (800 ml) in a day with the help of shooting net, the collection comprising 100 per cent hilsa larvae. The concentration of larvae was higher between Sindhoraghat and Chunar stretch. The breeding commenced sometimes in September and lasted till mid-November with the peak in October.

Of the four centres viz., Cologong, Sakrigalighat, Farakka and Dhulian in the lower sector, no concentration was found at the former two but a large concentration was observed at the latter two centres. The size of the larvae varied between 5 to 7 mm in July, 5 to 11 mm in August and 5 to 16 mm in September, indicating that the breeding continued during these months. The maximum concentrations were observed in the surface and subsurface collections in the shallow reaches of the river where the total depth did not exceed 2 m. The concentrations appeared to be higher during evenings and the intensity of spawning appeared to be more at Dhulian.

Observations on the pattern of intermingling between the subpopulations of hilsa in a 100 km stretch of the Ganga between Sultanganj and Sahibganj indicated that the three populations intermingle in varying magnitudes during all the seasons of the year. 'Slender' variety dominated in the stretch throughout the year, the

percentage varying between 60.20 during monsoon season to 92.17 in winter. While the 'broader' variety was represented in appreciable percentage (27.76 per cent) during monsoon only, fish belonging to 'broad' variety were available in preponderance during monsoon (12.04 per cent) and post-monsoon months (15.04 per cent).

19.1.2. INDUCED BREEDING OF *Hilsa ilisha* (HAM). Since the fishing at Dowleiswarm anicut on R. Godavari failed once again during the 1967 monsoon season for the third year in succession due to the failure of floods, only a few trials to breed hilsa by inducement could be conducted. Difficulties in keeping the fish alive for a sufficiently long period to enable pituitary administration and spawning to occur was the main cause of the failures. Attempts are being made to get suitable nets to catch live fish without injury to enable further experimentation during the 1968 monsoon season.

19.2. *Estuarine hilsa investigations.* Investigations on the spawning success of hilsa in the Hooghly estuary were initiated in July, 1967. Analyses of tow-net ($\frac{1}{2}$ hour) and shooting net (2 hours) collections made at six centres viz., Nawabganj, Jubilee, Bridge, Damurdaha, Balagarh, Medgachi and Datrigram between Barrackpore and Nabadwip during each tide at weekly intervals, have revealed the occurrence of *H. ilisha* larvae during the months July to September.

20. Water pollution investigations

20.1. *Water pollution investigations in Hooghly estuary.* A survey of the 90 km stretch of the Hooghly estuary from Dumurdaha to Birlapur was initiated in May, 1967 with a view to studying and characterising the industrial effluents with reference to the assessment of pollution load in the estuary.

Analyses of industrial wastes collected from (1) Western India Match Co. Ltd., Alambazar (match and paper); (2) Angelo Brothers Ltd., Cossipore (shellac); (3) Shalimar Paints Ltd. (paints and varnish); (4) Metal and Steel Factory, Ichapur; (5) Tribeni Tissue Private Ltd. (paper); (6) Kesoram Rayons near Iribeni, indicated that except the Wimco wastes (pH, match wastes 4.2; paper wastes 6.9), all the other wastes were alkaline in nature. All the wastes except 'Metal and Steel' waste were organically rich, with high reducible substances. Dissolved oxygen was nil in shellac waste, 0.8 ppm in Tribeni Tissue wastes, 3.4-5.2 ppm in other wastes resulting in fairly high oxygen demand (C.O.D. of shellac wastes, 2720 ppm; Wimco wastes, 1564 (match) and 204 ppm (paper); Tiribeni Tissue wastes, 378 ppm and Kesoram Rayon wastes, 278 ppm).

Analyses of the water of the estuary indicated an alkaline reaction (pH 8.0-8.3) with organic pollution during August (Oxygen consumption value, 32-70.8 ppm) and December (O.C., 11.2-27.2 ppm). Biochemical activity was poor, as the B.O.D. was always below 5.0 ppm. No difference was observed between polluted and non-polluted area in chemical constituents with regard to pollution.

PUBLICATIONS

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EXTENSION

Results of immediate practical application

The finding that the pituitary glands collected from the male and female fish do not differ significantly in their capacity to induce spawning suggests that there is no need to collect them sexwise.

Observations on the destruction of carp eggs by the sucking action of common carp suggest that the breeding hapas used for induced breeding should not be fixed in ponds stocked with common carp.

The method adopted for the clearance of thick infestations of water hyacinth with 'Taficide' at 6 kg/ha at a total cost of Rs 210/- per hectare could be utilised for large scale field demonstration.

Demonstration and training in induced breeding of major carps were given at various fish farms of the Government of West Bengal.

The location of very promising spawn collection centres, capable of producing sizable yields of high quality spawn, especially in Rajasthan and Madras where riverine spawn collection was hitherto unknown, has opened up new vistas for tapping this natural resource towards meeting their fish seed requirements to a large extent from within their own states. The results obtained on R. Mahananda in Bihar and on R. Yamuna in Uttar Pradesh have similarly indicated promise of intensification of seed collection activities in areas erstwhile unexploited or little exploited. The training imparted for collection of spawn on scientific lines is expected to be of immense benefit to workers in this field.

Huge frog resources of *Rana tigrina* and *R. hexadactyla* have been located in the 24-Parganas and Howrah districts of West Bengal and of *R. tigrina* alone in the Cuttack and Puri districts of Orissa for commercial exploitation.

Results likely to be useful to the farmers but needing further trials

Experiments carried out in weed infested ponds indicate that the Chinese grass carp effectively control weeds like *Hydrilla*, *Najas*, *Ceratophyllum*, *Nitella*, *Spirodela* and exercise a check on the growth of *Utricularia*, *Nechamandra*, *Vallisneria* and *Salvinia*, the extent of control and the time taken for the same depending on several factors like type and density of weed infestation, size of the fish stocked and the season. Size of the fish stocked further depends upon the density of the infestation

and the presence of absence of predators. However, further work is needed to give the exact size and stocking rate of the fish for particular type of infestation.

Field experiments conducted so far have indicated that it is possible to raise 2500 to 3500 kg, or even more, of fish in an year from a hectare of well managed fish ponds by composite culture of catla, silver carp, rohu, mrigal, common carp and grass carp, when stocked with 5000 to 6000 fingerlings/ha and manured with cowdung and inorganic manures and fed artificially with equal proportions of all cake and rice bran daily, besides regular feeding the grass carp with aquatic weeds at 10,000-15,000 kg/ha/annum. However, further experimentation on a statistically designed pattern is necessary.

Publicity activities

Laboratory and field demonstrations on important aspects were arranged for the benefit of (i) distinguished visitors, (ii) a party of 40 secondary school teachers and college lecturers attending the summer school of biology at the Regional Institute of Education Bhubaneswar, (iii) Mr. Richard K. Mc Williams of U.S.A. who was interested in observations on the culture of common carp, at the Cuttack Sub-Station of the Institute.

Conference and symposia

The Director attended the following conferences and symposia during 1967.

March 3	Symposium on 'Oceanography and fisheries' organised by the National Institute of Sciences, New Delhi.
March 27	Meeting of the Advisory Board of the Indian Council of Agricultural Research at New Delhi.
April 17, 18 and October 30	Two meetings of the Scientific Panel for Fisheries Research of the Indian Council of Agricultural Research at New Delhi.
July 3	Meeting of the Fisheries Development Committee of the Tungabhadra Board at Bangalore.
August 17 to 19	Meeting of the Directors of Research Institutes of the Indian Council of Agricultural Research at New Delhi.
October 6 to 8	Symposium on 'Science & India's Food Problem' jointly sponsored by the National Institute of Sciences of India and the Indian Council of Agricultural Research at New Delhi and presented three papers.

SUMMARY OF THE REPORT

The scientific work programme of the Institute was redrawn into 20 priority-laid and problem-oriented projects, of which 16 were taken up for detailed investigations.

Composite culture of Indian and exotic carps in manured ponds with a regular supply of artificial feed gave a net production of 3564 kg/ha/annum while the pro-

duction from ponds stocked with Indian carps alone which were similarly managed was only about 1300-2500 kg/ha/annum.

Laboratory experiments suggest that starch and yeast supplied along with zooplankton serve as a profitable feed for rohu fry. Laboratory experiments suggest that calcium-ammonium nitrate at 80 kg/ha is the best artificial fertilizer for fish ponds.

Crude culture of *Nitzschia* and unialgal culture of *Chlorella* sp. and *Nitzschia* sp. have been achieved. A culture laboratory and a central radio tracer laboratory have been set up at Barrackpore and Calcutta, respectively.

Male rohu showed a higher fat index, iodine and saponification value than females during the resorbed condition and first stage of maturity. No cause for fat deposition in the *bheel* fishes could be assigned though it was noticed that the gonads of such fishes were not fully ripe.

Weekly injections of pituitary extract were found to enhance the growth and maturity of rohu, while chorionic gonadotrophin alone, extracted from human pregnancy urine, did not induce spawning in rohu, positive results were obtained when it was administered along with a threshold dose of pituitary extract.

Extraction of pituitary gonadotrophin with 1.5 per cent TCA was incomplete even after six hours' immersion of the gland in the acid. No significant difference in the action of pituitary glands extracted from males and females was observed in their capacity to induce spawning in carps.

A remarkable discovery was made when common carp were found to be the cause of destruction of carp eggs kept in breeding hapas in the ponds by their sucking action on the outside of these hapas.

26.23 lakhs of major carp spawn/fry was produced during the induced breeding experiments, bulk of which was supplied to the Orissa Fisheries Department.

Preliminary surveys of Devendranagar, Loni and Govindgarh reservoir in Madhya Pradesh were completed and a detailed programme of fishery developmental work was drawn up. Spawning grounds of major carps have also been located in the Loni and Govindgarh reservoirs.

The juveniles of the freshwater prawn, *M. malcolmsonii*, procured from the river Godavari were stocked in various fish farms, tanks and reservoirs of Mysore State.

On the bases of pre-monsoon surveys, six sites, viz. Kulithalai on R. Cauveri in Madras, Dharmapuri on river Godavari in Andhra Pradesh, Sopari (Tonk) on R. Banas in Rajasthan, Nethla on R. Yamuna and Salempur on R. Gomti in Uttar Pradesh and Dingraghat on R. Mahananda in Bihar were selected for detailed spawn prospecting investigations. A total of 57.347 litres of spawn were collected, the respective contributions of Nethla, Salempur, Sopari, Kulithalai, Dingraghat and Dharmapuri being 32,381, 12,077, 9,446, 3,162, 506 and 20 ml.

Spawn escapement from a 1/8" meshed net, estimated by operating an especially designed double-walled net, was found to range from 28 to 37.5 per cent over the turbidity range of 375 to 700 ppm and current velocities around 1.5 km/hr.

Statistics of total spawn collected by commercial fishermen from the lower

reaches of the Ganga river system between Moghyr and Lalgola indicated that consistent quantity of production is not maintained at a centre between the years and that some of the centres which gave very high yields of spawn in past have almost become defunct.

Six exploratory fishing cruises by the 'M.V. Sunderbans' landed a catch of 1238 kg in 95 hours by drift gill nets and 552 kg in 276 hours by bottom set gill nets. The project has been handed over to the Deep Sea Fishing Station, Bombay.

A source of prawn fingerlings has been located near the Jobra anicut on the Mahanadi river in Orissa. In the Hooghly, centres for the collection of prawn fry have been located at Nabadwip, Tribeni, Dumurdaha, Naihati, Nawabganj, Barrackpore, Diamond Harbour, Kulpi and Uluberia. Kolaghat on the Rupnarayan and Port Canning on the Matlah river are potential centres.

F₁ hybrids of catla × mrigal, mrigal × catla, and rohu × mrigal have been produced with the object of developing improved strains.

Grass and silver carp were induced to spawn by fish pituitary hormone resulting in the production of 1.61 lakhs fry of the former and 2.6 of the latter. Natural spawning occurred on several occasions among injected grass carps but only once in silver carp. An average production of 2909 kh/ha/annum was obtained when fingerlings of grass carp, silver carp and common carp were stocked in the ratio of 4:2:3 at 3,700/ha. 6,500 fry of silver carp and 30,000 fry of grass carp were supplied to various State Fisheries Departments and the Government of Nepal.

Grass Carp of varying sizes were observed to control weeds like *Hydrilla*, *Najas*, *Ceratophyllum*, *Nitella* and *Spirodela* effectively and exercise a check on the growth *Utricularia*, *Nechamandra*, *Vallisneria* and *Salvinia*. However, cut bits of *Eichhornia* and tender shoots of *Jussiaea* were not taken by the juveniles in the laboratory and in the field.

Application of modern techniques in trout culture operations increased the rate of survival of eggs, alevins and fry from the green eggs to fry stage in the case of brown trout (*S. trutta fario*) to 49.3 per cent as against 22.5 per cent obtained by the State Fisheries Department and from 17.0 to 39.3 per cent in case of rainbow trout (*S. gairdnerii gairdnerii*).

Investigations on the fisheries of Chilka lake were concluded during 1967. The estimated landings at six fish assembly centres on the Ganga and two on the Yamuna were 473.57 and 200.13 tonnes respectively. An estimated landing of 261.9 tonnes were recorded from the lacustrine stretch of the Godavari.

Preliminary studies on the marking of prawns with Trypan blue have been made.

The total catch from the Hooghly estuary from December, 66 to November, 67 was 7839.3 tonnes and that of Pulicat lake 1133.81 tonnes.

Studies on the spoilage of fish in Calcutta fish markets have revealed only six of the thirty-two strains of bacteria isolated from the fish and its habitat to be responsible for causing spoilage when the bacterial load was in the range of 10⁷ to 10¹⁰/ml. Mass mortalities in over-crowded ponds were recorded.

'Taficide-80' at 6 kg/ha was used in combination with a detergent (surf) and

kerosene to achieve cent per cent clearance of water hyacinth in about 3 months at a cost of Rs. 210/- per hectare.

Copper sulphate mud pellets at 25 kg/ha were used in 3 to 4 intermittent doses to eradicate *Hydrilla*, *Eichhornia*, *Vallisneria* and *Cyperus* from a sewage fishery and *Hydrilla*, *Ceratophyllum*, *Ottelia* and *Nymphaea* from a derelict bheel. However, *Hydrilla* plants uprooted by the application of copper sulphate survived in the floating stage giving out new branches from the axils of the decaying leaves and roots.

Experiments on systematic frog culture have begun for the first time in India and a part of the Killa Fish Farm at Cuttack has been converted into a small Frog Farm. *Rana catesbeina*, the American bull frog, has been introduced into India and the indigenous *R. hexadactyla* from Bengal into Orissa where it was hitherto not available. Both *R. catesbeina* and *R. hexadactyla* seem to have acclimatised themselves to local conditions.

Raising of tadpoles from fertilized eggs obtained through induced breeding of *R. tigrina* and natural breeding of *R. hexadactyla* and rearing them to early/small frog stages were done during July-October, 1967, both in the laboratory and the field. Frog-cum fish culture has been initiated by stocking together early frogs of *R. hexadactyla*/*R. tigrina* at 2,000/ha and fingerlings of catla, rohu and mrigal at 3,750/ha in the ratio of 3:4:3 to study the cultural possibilities of these frogs in association with the Indian major carps.

Administration of pituitary gland extract resulted in the ovulation of 62 per cent *R. tigrina* during July-September and cent per cent *R. hexadactyla* during the non-breeding period (May) with a priming dose of progesterone.

Concentration of hilsa larvae was higher between Sindhoraghat and Chunar stretch in the upper sector and at Farakka and Dhulian in the lower sector of the Ganga. Observations on the pattern of intermingling between the sub-populations of hilsa in a 100-km stretch of the Ganga between Sultanganj and Sahibganj revealed the three populations to intermingle in varying magnitudes during all the seasons of the year. Attempts to induce hilsa to breed by the administration of pituitary extract resulted in failure.

Industrial wastes from Western India Match Co. Ltd., Alambazar (match and paper); Angelo Brothers Ltd., Cossipore (Shellac); Shalimar Paints Ltd. (paints and varnish); Metal and Steel Factory, Ichapur; Tribeni Tissues Private Ltd. (paper) and Kesoram Rayons indicated that except for the Wimco wastes (pH, match wastes 4.9), all the other wastes were alkaline. Analyses of the water of the estuary revealed organic pollution during August and December.

PERSONNEL

PROMOTIONS AND TRANSFERS

During 1967, the appointments to the following posts have been regularised by the Union Public Service Commission :

Dr V.G. Jhingran as Director

Dr A.K. Mondal as Frog Research and Development Officer

Shri A.C. De as Administrative Officer

The following persons were promoted during 1967:

Shri T. Ramaprabhu, Senior Research Assistant as Assistant Research Officer

Shri D.V. Pahwa, Senior Research Assistant as Assistant Research Officer

Shri B.V. Govind, Senior Research Assistant as Assistant Research Officer

The following research workers were transferred during 1967:

Dr A. David, Senior Research Officer From Tungabhadra Dam to Bangalore

Dr A.K. Mondal, Senior Research Officer From Barrackpore to Cuttack

Shri S.M. Banerjea, Research Officer From Cuttack to Calcutta

Dr (Miss) E. Mitra, Research Officer From Cuttack to Calcutta

Shri R.D. Chakrabarty, Research Officer From Barrackpore to Cuttack

Shri A.V. Natarajan, Research Officer From Balugan to Konar Dam

Shri S.J. Karamchandani, Research Officer From Hoshangabad to Rewa

Shri K.L. Sehgal, Research Officer From Kangra to Srinagar

Shri M.A.V. Lakshmanan, Assistant Research Officer From Cuttack to Panna

Dr C.S. Singh, Assistant Research Officer From Cuttack to Barrackpore

Shri Y. Rama Rao, Assistant Research Officer From Ponneri to Rajahmundry

HONOURS AND AWARDS

Shri A.G. Jhingran, Assistant Research Officer, was awarded the degree of Doctor of Philosophy by the University of Allahabad on his thesis entitled 'Studies on the biology and fisheries of the clupeoids, *Setipinna phasa* (Ham.) and *Gadusia chapra* (Ham.) in the Ganga River System.'

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Dr V.G. Jhingran, M.Sc.Ph.D. (Stanford)

Deputy Director

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Central Inland Fisheries Research Sub-Station, Cuttack (Orissa)

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Dr M.T. Philipose, M.A., Ph.D.

(Alabama), Ph.D.

(On deputation to Burma)

Dr A.K. Mondal, M.Sc., Ph.D.

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Shri V. Ramachandran

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Assistant Research Officers

Shri R.M. Bhowmick

Shri K. Raman

Shri K.H. Ibrahim

Shri S. Patnaik

Shri G.N. Saha

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Shri T. Ramaprabhu

Senior Research Assistants

Shri A.K. Banerji

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Research Assistants

Shri A.C. Nandy

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LIBRARY & DOCUMENTATION UNIT, BARRACKPORE

<i>Research Officer</i>	Shri S.D. Tripathi
<i>Senior Artist-Photographer</i>	Shri P.K. Kapoor
<i>Artist-Photographer</i>	Shri J. Ghosh
<i>Reference Collection Assistant</i>	Shri P.K. Chakraborty
<i>Librarian</i>	Miss A. Ghosh
<i>Research Assistant Artist</i>	Shri R.R. Khan
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APPENDICES

APPENDIX I

MONTHWISE LANDINGS (IN TONNES) AT VARIOUS ASSEMBLY CENTRES ON THE RIVERS GANGA AND YAMUNA IN 1967

Centre	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
<i>River Ganga</i>													
Kanpur	3.12	3.08	2.33	2.03	1.36	2.48	2.91	0.95	1.22	1.93	3.06	1.62	26.09
Varanasi	8.76	8.02	8.98	6.39	11.35	16.72	31.03	7.61	7.02	20.04	8.32	6.96	141.20
Buxar	0.96	0.65	1.68	1.01	1.20	1.30	5.17	2.44	3.87	21.09	5.36	2.53	47.26
Bullia	1.13	1.09	1.50	0.79	1.79	2.54	3.91	2.98	2.41	10.48	8.90	3.00	40.52
Patna	11.40	8.45	8.72	9.93	11.25	9.15	6.99	6.59	5.59	7.60	6.64	10.17	102.48
Bhagalpur	—	—	—	—	—	—	—	—	—	—	—	—	116.02
Total	25.37	21.29	23.21	20.15	26.95	32.19	50.01	20.57	20.11	61.14	32.28	24.28	473.57
<i>River Yamuna</i>													
Agra	1.69	2.87	2.31	10.27	4.78	4.05	5.17	0.26	1.36	1.28	0.86	0.80	35.70
Sadiapur	13.74	12.16	18.34	12.05	12.59	12.79	15.67	8.52	11.37	17.37	15.46	14.36	164.42
Total	15.43	15.03	20.65	22.32	17.37	18.84	20.84	8.78	12.73	18.65	16.32	15.16	200.12
Grand Total	40.80	36.32	43.86	42.47	44.32	49.03	70.85	29.35	32.84	79.79	48.60	39.44	673.69

APPENDIX II

SPECIESWISE ANNUAL LANDINGS (IN TONNES) AT VARIOUS ASSEMBLY CENTRES ON THE RIVERS GANGA AND YAMUNA IN 1967

Centre	<i>C. mrigala</i>	<i>C. catla</i>	<i>L. rohita</i>	<i>L. calbasu</i>	<i>M. our</i>	<i>M. seenghala</i>	<i>W. attu</i>	<i>R. rita</i>	<i>H. ilisha</i>	Misc.	Total
<i>River Ganga</i>											
Kanpur	4.14	0.97	2.67	0.73	3.33	2.39	6.49	0.28	—	5.09	26.09
Varanasi	0.63	1.40	0.51	0.11	15.84	7.35	1.86	9.27	35.60	68.63	141.20
Buxar	0.09	0.20	0.27	0.02	1.38	0.50	—	0.08	34.16	10.56	47.26
Ballia	0.71	3.04	0.72	0.10	2.65	3.25	1.22	0.21	15.78	12.84	40.52
Patna	4.73	3.73	4.90	0.46	11.34	10.28	1.84	—	5.15	60.05	102.48
Bhagalpur	5.96	11.78	5.84	0.94	2.63	4.56	10.99	—	4.56	68.76	116.02
Total	16.26	21.12	14.91	2.36	37.17	28.33	22.40	9.84	95.25	225.93	473.57
<i>River Yamuna</i>											
Agra	10.50	0.58	4.05	5.39	1.92	6.20	4.68	0.37	—	2.01	35.70
Sadiapur	44.87	9.98	9.09	16.12	17.77	11.28	6.38	6.16	14.04	28.73	164.42
Total:	55.37	10.56	13.14	21.51	19.69	17.48	11.06	6.53	14.04	30.74	200.12
Grand Total	71.63	31.68	28.05	23.87	56.86	45.81	33.46	16.37	109.29	256.67	673.69

APPENDIX III

ZONWISE QUARTERLY LANDING (IN TONNES): HOOGHLY-MATLAH ESTUARY
(DECEMBER 1966-NOVEMBER 1967)

Zones	Quarters	Dec- Feb.	March- May	June- Aug.	Sep- Nov.	Total	Percentage
I.	Nabadwip-Calcutta	231.3 (262.0)	179.9 (186.4)	129.7 (131.8)	229.9 (227.8)	770.8 (808.0) —37.2	9.8 (12.5)
II.	Calcutta-Diamond Harbour	36.8 (20.3)	61.1 (32.6)	94.2 (30.2)	163.7 (36.5)	355.8 (119.6) +236.2*	4.5 (1.8)
III.	Lower Sunderbans	2688.1 (2377.6)	142.6 (186.2)	805.1 (286.7)	2177.2 (2147.0)	5813.0 (4997.6) +815.5*	74.2 (77.2)
IV.	Rupnarayan	106.2 (94.2)	112.2 (113.2)	247.4 (51.8)	288.7 (111.8)	754.5 (371.0) +383.5*	9.6 (5.7)
V.	Port Canning	38.4 (54.9)	35.8 (38.1)	35.1 (42.5)	35.9 (42.9)	145.2 (178.4) —33.2*	1.9 (2.8)
	Total	3100.8 (2809.0)	531.6 (556.5)	1311.5 (543.0)	2895.4 (2566.0)	7839.3 (6474.5) *1364.8.	100.0 (100.0)
	Percentage	39.6 (43.4)	6.8 (8.6)	16.7 (8.4)	36.9 (39.6)	100.0 (100.0)	

N.B. Figures within brackets relate to the corresponding period of the previous year.

*These figures relate to the differences between the totals of current year and the previous year.

APPENDIX IV SPECIESWISE QUARTERLY LANDINGS (IN KG) HOOGHLY-MATLAH ESTUARY

Species/Quarters	Dec. Feb.	Mar- May	June- Aug.	Sept- Nov.	1967		1966		Difference (a-b)
					Total (a)	% Percentage	Total (b)	% Percentage	
1. <i>M. tade</i>	2825	1651	1888	2773	9137	0.1	7372	0.1	1765
2. <i>M. parvia</i>	10223	8053	9432	22759	50467	0.6	45393	0.7	5074
3. <i>L. calcarifer</i>	3764	4219	4084	8582	20649	0.3	24823	0.4	4174
4. <i>S. panijus</i>	10022	2624	3755	10228	26629	0.3	23805	0.4	2824
5. <i>P. paradiseus</i>	1047	6335	7701	10661	31744	0.4	40320	0.6	8575
6. <i>P. indicus</i>	75018	2357	2629	15120	95124	1.2	87078	1.3	8046
7. <i>E. tetradactylum</i>	10696	2525	3669	6530	23420	0.3	16763	0.3	6657
8. <i>S. bauritus</i>	49341	7946	3052	22924	83263	1.1	118256	1.8	34993
9. <i>S. miles</i>	25576	637	343	2417	28973	0.4	6187	0.1	22786
10. <i>P. pama</i>	295355	17023	14745	62695	389818	5.0	139862	2.2	249956
11. <i>H. ilisha</i>	513406	22532	794580	460642	1791160	22.8	635944	9.8	1155216
12. <i>H. toli</i>	9164	99	11052	5508	25823	0.3	6185	0.1	19638
13. <i>I. elongata</i>	65095	3819	4836	23848	97598	1.2	78837	1.2	18761
14. <i>C. ramcarati</i>	30127	5170	8904	34690	78891	1.0	89593	1.4	10702
15. <i>C. borneensis</i>	15684	654	1433	—	17771	0.2	18398	0.3	627
16. <i>S. phasa</i>	198898*	38740*	23067*	155140*	415845*	5.3*	375218*	5.8*	40626*
17. <i>S. taty</i>	—	—	—	—	—	—	—	—	—

Continued—APPENDIX IV

18. <i>P. pangasius</i>	12977	8221	7191	47838	76227	1.0	48913	0.9	27314	—
19. <i>T. jella</i>	126661	334	11245	106176	244416	3.1	290594	4.5	—	46178
20. <i>O. militaris</i>	8953	88	179	2452	11672	0.1	7084	0.1	4588	—
21. <i>P. canius</i>	1373	932	1415	1902	5622	0.1	13922	0.2	—	8300
22. <i>T. savala</i>	62748*	819*	3788*	100568*	167923*	2.1*	246812*	3.8*	—	78889*
23. <i>T. haumela</i>										
24. <i>H. nehereus</i>	361339	74625	91639	819466	1347069	17.2	1604388	24.8	—	257319
25. <i>S. cinereus</i>	25948	2414	13226	24007	65595	0.8	8639	0.1	56956	—
26. Prawns	349374	134759	154099	458887	1097119	14.0	1068123	16.5	28996	—
Miscellaneous	829188	185060	133623	489553	1637424	20.9	1472027	22.7	165403	—
Total	3100802	531636	1322575	2895366	7839379	99.8	6474530	100.0	1364849	—

* The figures relate to the combined figure of *S. phasa* & *S. taty* and *T. savala* & *T. haumela* respectively.

APPENDIX V

SPECIESWISE LANDINGS (IN KG) IN DIFFERENT ZONES: HOOGHLY-MATLAH ESTUARY
(DECEMBER 1966-NOVEMBER 1967)

Species/zones	I	II	III	IV	V	Total
1. <i>M. tade</i>	—	—	8748	—	389	9137
2. <i>M. parsia</i>	—	771	46013	63	3620	50467
3. <i>L. calcarifer</i>	—	—	18296	2099	254	20649
4. <i>S. panijus</i>	1844	602	15856	7978	349	26629
5. <i>P. paradiseus</i>	9901	869	11394	9275	305	31744
6. <i>P. indicus</i>	—	—	94746	—	378	95124
7. <i>E. tetradactylum</i>	35	233	22729	317	106	23420
8. <i>S. biauritus</i>	—	6779	74447	—	2037	83263
9. <i>S. miles</i>	—	360	26351	—	2262	28973
10. <i>P. pama</i>	7113	1757	359691	19317	1940	389818
11. <i>H. ilisha</i>	149786	188820	1193366	259142	46	1791160
12. <i>H. toli</i>	7	—	24924	91	801	25823
13. <i>I. elongata</i>	—	131	97335	21	111	97598
14. <i>C. ramcarati</i>	2299	1389	62311	10120	2772	78891
15. <i>C. borneensis</i>	253	—	120	16944	454	17771
16. <i>S. phasa</i> }	42476*	2533*	355393*	10978*	4465*	415845*
17. <i>S. taty</i> }						
18. <i>P. pangasius</i>	10392	4684	33340	25224	2587	76227
19. <i>T. jella</i>	—	—	244416	—	—	244416
20. <i>O. militaris</i>	9	—	11377	251	35	11672
21. <i>P. canius</i>	—	59	5411	121	31	5622
22. <i>T. savala</i> }	—	390*	160741*	22*	6770*	167923*
23. <i>T. haumela</i> }						
24. <i>H. nephereus</i>	4188	47952	1154341	74336	66252	1347069
25. <i>S. cinereus</i>	—	—	65595	—	—	65595
26. Prawns	262423	49911	619101	134974	30710	1097119
Miscellaneous	280056	48567	1106947	183195	18659	1637424
Total	770782	355807	5812989	754468	145333	7839379

*The figures relate to the combined figure of *S. phasa* and *S. taty* and *T. savala* and *T. haumela* respectively.

APPENDIX VI
GEARWISE QUARTERLY LANDINGS (IN KG) HOOGHLY-MATLAH ESTUARY
(DECEMBER 1966-NOVEMBER 1967)

Gears/Quarters	Dec- Feb.	March- May	June Aug.	Sept- Nov.	1967			1966			Difference (a-b)
					Total (a)	percentage	Total (b)	percentage	Total (b)	percentage	
						×		×		×	
1. Trawl	92457	6173	3661	29879	132170	1.7	123777	1.9	8393	—	—
2. (a) Large seine	783002	—	459554	129977	1372533	17.5	686284	10.6	686249	—	—
(b) Small "	637506	97945	52484	225191	1013126	12.9	341622	5.3	671504	—	—
3. Purse	11748	10	1265	7548	20571	0.3	22565	0.3	—	1994	—
4. Drift	144109	3508	339911	437808	925336	11.8	143937	2.2	781399	—	—
5. Lift	23373	17304	14878	35845	91400	1.2	51798	0.8	39602	—	—
6. Cast	1337	20505	5011	5644	32497	0.4	17071	0.3	15426	—	—
7. Bag	1158745	300239	354377	1780077	3593447	45.8	4285186	66.2	—	691739	—
8. Set-gill	93566	15446	14888	41228	165128	2.1	147530	2.3	17598	—	—
9. Set-barrier	39575	23687	27397	47249	137908	1.8	188269	2.9	—	50361	—
10. Traps	—	—	15660	28604	44264	0.6	23474	0.4	20790	—	—
11. Hooks and Lines	92484	30147	12628	113664	248923	3.2	273225	4.2	—	24302	—
12. Unknown & Unclassified	22891	16672	9861	12652	62076	0.8	169792	2.6	—	107716	—
Total	3100802	531636	1311575	2895366	7839379	100.1	6474530	100.0	1364849	—	—

APPENDIX VII

SPECIESWISE LANDING (IN KG) OF FISHES, PRAWN AND CRABS FROM PUBLICAT LAKE (1967)

Name of fishes	Southern sector	Percentage	Northern sector	Percentage	Total	Percentage	Total landings of last year	Fall or rise percentage
Prawns								
<i>P. indicus</i>	298,780	41.43	89,244	21.63	388,024	34.22	314,502	+ 23.38
<i>P. monodon</i>	45,128	5.26	19,444	4.71	64,572	5.70	37,699	+ 71.28
<i>P. semisulcatus</i>	24,450	3.39	6,252	1.52	30,702	2.71	25,455	+ 20.61
<i>M. monoceros</i>	74,034	10.27	6,060	1.47	80,094	7.06	55,912	+ 43.25
<i>M. burkenroadii</i>	5,793	0.80	30	0.01	5,823	0.51	29,925	+ 80.54
<i>M. dobsonii</i>	52,093	7.22	3,275	0.79	55,368	4.88	41,980	+ 31.89
<i>M. affinis</i>	560	0.08	—	—	560	0.06	—	—
Other prawns	9,184	1.27	226	0.05	9,410	0.83	4,337	+ 129.87
Total	510,022	70.72	124,531	30.18	634,533	55.97	509,810	+ 24.47
Mulletts								
<i>M. cephalus</i>	31,190	4.33	110,083	26.68	141,273	12.46	158,253	— 10.74
<i>M. macrolepis</i>	14,204	1.97	9,168	2.22	23,372	2.06	28,852	— 18.99
<i>M. parsia</i>	676	.08	271	0.07	947	0.09	7,477	— 87.34
<i>M. tade</i>	1,555	0.22	11,645	2.82	13,200	1.16	14,921	— 11.54
<i>M. cunnesius</i>	10,604	1.47	12,843	3.11	23,447	2.07	17,508	+ 33.92
Total	58,229	8.07	144,010	34.90	202,239	17.84	227,021	— 10.92
Perches								
<i>S. sihamia</i>	30,604	4.24	3,102	0.75	33,706	2.97	31,543	+ 6.86
<i>G. ovata</i>	1,981	0.27	3,605	0.87	5,586	0.49	19,504	— 71.36
<i>G. fialmentosus</i>	405	0.06	3,219	0.78	3,624	0.32	—	—
<i>G. limbatus</i>	194	0.03	2,968	0.72	3,162	0.28	16,698	— 59.36
<i>Sparus</i> spp.	1,885	0.26	15,607	3.78	17,492	1.54	3,800	+ 368.32
<i>C. indicus</i>	304	0.04	—	—	304	0.03	—	—
<i>Teuthis</i> spp.	399	0.06	553	0.13	952	0.08	1,129	— 15.68
<i>E. suratensis</i>	54	0.01	161	0.05	215	0.03	—	—
<i>L. calcarifer</i>	9,741	1.35	7,012	1.70	16,753	1.48	4,225	+ 296.52
Other perches	973	0.13	1,561	0.38	2,534	0.22	5,362	— 48.73
Total	46,540	6.45	37,788	9.16	84,328	7.44	82,261	+ 2.51

Continued—APPENDIX VII

Clupeids									
<i>N. nasus</i>	24,945	3.46	17,310	4.19	42,255	3.73	33,923	+ 24.56	
<i>C. chanos</i>	352	0.05	6,182	1.50	6,554	0.58	11,818	— 44.71	
<i>E. saurus</i>	915	0.13	1,878	0.46	2,793	0.24	7,716	— 63.80	
<i>Thrissoles</i> sp.	588	0.08	6,456	1.56	7,044	0.62	8,313	+ 43.82	
Other clupeids	516	0.07	4,395	1.07	4,911	0.43			
Total	27,316	3.79	36,221	8.78	63,537	5.60	61,770	+ 2.86	
Catfishes									
<i>P. canius</i>	2,217	0.31	2,790	0.68	5,007	0.44	7,670	— 34.72	
<i>Tachysurus</i> sp.	24,247	3.36	26,445	6.41	50,692	4.47	16,415	+208.13	
Other catfishes	52	0.01	862	0.20	914	0.08	793	+ 15.26	
Total	26,516	3.68	30,097	7.29	56,613	4.99	24,914	+127.23	
Threadfins									
<i>E. tetradactylum</i>	2,301	0.32	—	—	2,301	0.20	255	+802.35	
<i>P. indicus</i>	10,078	1.40	1,258	0.29	11,336	1.00	1,411	+703.40	
Total	12,379	1.72	1,258	0.29	13,637	1.20	1,666	+718.55	
Sciaenids									
	7,599	1.05	13,640	3.31	21,239	1.87	12,165	+ 74.59	
Belontiiforms									
	1,034	0.15	13,232	3.21	14,266	1.26	18,639	— 23.46	
Crabs									
<i>Scylla serrata</i>	13,405	1.86	2,869	0.69	16,274	1.44	42,494	— 61.70	
<i>Neptunus pelagicus</i>	3,702	0.51	3,452	0.84	7,154	0.63	2,685	—166.44	
Total	17,107	2.37	6,321	1.53	23,428	2.07	45,179	— 48.14	
Miscellaneous									
	14,409	2.00	5,561	1.35	19,970	1.76	37,391	— 46.59	
Total	721,151		412,659		1133,810		1020,856	+ 11.07	

APPENDIX VIII
GEARWISE CATCH/NET/DAY (IN KG) (1967): PULICAT LAKE

Name of gear	Prawns	Mulletts	Perches	Clupeids	Catfishes	Threadfins	Scianids	Belonti- forms	Crabs	Misc.	Total (kg)
Suthuvalai	17.81	—	—	—	—	—	—	—	0.05	—	17.86
Kattuvalai	22.53	—	—	—	—	—	—	—	—	—	22.53
Panthavalai	1.75	5.43	1.51	1.17	0.74	—	0.12	0.17	0.04	0.68	11.61
Badivalai	8.13	23.07	3.72	52.19	2.22	0.84	1.19	0.06	1.13	36.86	129.41
Oivalai	—	17.44	0.34	2.28	0.04	—	0.10	0.06	—	0.41	20.67
Periakondavalia	1.10	1.22	0.47	0.69	0.11	0.02	0.11	0.43	0.02	0.09	4.26
Sillappuvalai	0.04	2.26	0.37	1.17	0.04	—	0.10	0.06	0.01	0.06	4.11
Siruvalai	—	6.94	0.40	0.03	—	—	—	—	—	0.36	7.73
Kondavalai	5.36	0.26	0.16	0.36	0.04	—	0.01	0.0	—	0.49	6.72
Kalvalai	19.50	—	—	—	—	—	—	—	—	—	19.50