



CENTRAL INLAND FISHERIES RESEARCH INSTITUTE  
BARRACKPORE

**ANNUAL REPORT**

for the year

**1970**

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE  
(Indian Council of Agricultural Research)  
BARRACKPORE, WEST BENGAL  
INDIA

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This report includes unprocessed or semiprocessed data which would form the basis of scientific papers in due course. The material contained in the report, therefore, may not be made use of, without the permission of this Institute, except for quoting it for scientific reference.

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# ANNUAL REPORT OF THE CENTRAL INLAND FISHERIES RESEARCH INSTITUTE, 1970

## I. DIRECTOR'S INTRODUCTION

*History* : The Central Inland Fisheries Research Institute, established in March, 1947 in Calcutta, under the Ministry of Food and Agriculture, Government of India, is since June, 1959, housed in its own buildings at Barrackpore on the left bank of the Hooghly river.

*Object* : The objectives of the Institute are to elucidate the general scientific principles which can be applied for the utilization of the available inland waters for maximum production of fish for food in the country. With this end in view, three substations, one each at Barrackpore, Cuttack and Allahabad, have been established to deal with problems of estuarine, pond culture, and riverine and lacustrine fisheries respectively.

*Organisational structure* : The three above stated substations of the Institute with their units and survey centres, the Reservoir Fisheries Unit at Hazaribagh, the Coldwater Fisheries Unit at Srinagar, the Sunderbans Survey Unit at Kakdwip and the Tank Fisheries Unit at Bangalore continued to function as in the previous year. Work on fish pathology, culture of fish food organisms, live fish culture and sewage fed fish culture was continued at Barrackpore. There was no change in the organisational set up of the Institute during the year.

*Library and Documentation* : During the year 77 books, 192 reprints, 110 miscellaneous publications and 1,267 issues of periodicals were added to the library. The Institute subscribed 35 Indian and 43 foreign journals. It obtained, either as free gift or in exchange 47 Indian and 128 foreign journals. The present library holdings inclusive of the year's arrivals, comprise 2,332 books, 1,473 bound periodicals, 2,727 reprints and 1,226 miscellaneous publications excluding the stock of loose issues of journals, pamphlets, maps and departmental publications etc. Besides maintaining exchange relationship with c. 190 institutions and organisations, 25 new exchange relationships were established during the year. Quarterly accession lists for July-December, 1969 and January-June, 1970 for the benefit of the staff of the Institute were brought out and circulated.

62 technical and non-technical inquiries from India and abroad were attended to by the Documentation Unit. The Institute supplied publications to Osmania University (Hyderabad), Central Public Health Engineering Research Institute (Nagpur) and Institute of Library Information Service (Calcutta) on inter-library loan basis.

During the year, 116 reports (including mimeographed reports) on progress of research, were compiled and sent to Indian Council of Agricultural Research while some were also sent to the Departments under mailing list. "Bibliography of Indian Fisheries" Vol. 8(4) of 1969, Vols. 9(1) and 9(2) of 1970 with cumulative index for Vol. 5(1-4) were brought out. The annual reports of the Institute for the years 1968 and 1969 were compiled, edited and published in the printed form. Besides the above, 188 sketches, diagrams, 18 charts/posters and 446 photo copies on research findings were prepared. Preliminary action has been taken to print the proceeding of the "Seminar on Quality Fish Seed for Fish Culture".

*Honours, Awards etc.* : Dr. V. G. Jhingran, Director of the Institute led the Indian delegation to the 14th session of the Indo-pacific Fisheries Council, held in Bangkok from November 18 to 28, 1970. As a nominated member of the Working Party on Fisheries Economics set up by the Food & Agriculture Organisation of the United Nations, he attended the meeting which was held in Bangkok from November 13 to 17, 1970.

Dr. V. Gopalakrishnan, Fishery Scientist, was chosen a Discussion Leader for the session "Aquaculture technique—culture of vertebrates" during the symposium on coastal aquaculture held from November 18 to 21, 1970 under the auspices of Indo-pacific Fisheries Council in Bangkok and he, also being selected as an FAO consultant, was entrusted with the editing work for the proceedings of the symposium during November 28, 1970 to January 20, 1971.

Dr. H. Chaudhuri, Fishery Scientist, completed his three years' assignment in Burma as FAO/TA Inland Fishery Biologist.

Dr. V. R. Pantulu, Fishery Scientist completed his 4th year of assignment under Economic Commission for Asia and Far East as Freshwater Fisheries Expert in Bangkok.

*Distinguished visitors* : The following scientists and distinguished persons visited the Institute and its various establishments : Members of National Commission on Agriculture, Government of India (Shri C. Subramaniam, Chairman ; Dr. N. K. Panikkar ; Sarvashri Sanyal ; P. Bhattacharjee ; S. K. Mukherjee and J. Sharma, Secretary) ; Mr. U. M. Aung, Directorate of Fisheries, Government of Burma ; Mr. Iteinz, Department of Zoology, the Hebrew University, Israel ; Mr. D. B. C. Scott, Zoology Department, St. Andrews University, Scotland ; Dr. Otto Brezny, FAO Expert (Weed Control), Chambal Project, Kota, Rajasthan ; Mr. Peter M. Jones, Project Manager, UNDP (SF), Chambal Project, Kota, Rajasthan ; and Dr. G. R. Fish, Marine Department, Newzealand visited this Institute during the period under report.

*Important events of the year* : Members of the National Commission on Agriculture, Government of India visited this Institute on November 10, 1970 and had a meeting with the Scientists of the Institute.

A staff research council has been formed in the Institute to discuss scientific achievements under various projects. During the year, the Council met on August 3-4 and November 10-12, 1970.

Fishery Economics Unit has been set up at Barrackpore to conduct the investigations under Project 11 on the economics of various fish cultural aspects.

Sanction for 4 co-ordinated projects; *viz.*, (i) composite culture of Indian and exotic fishes, (ii) ecology and fisheries of freshwater reservoirs, (iii) investigations on riverine carp spawn prospecting and collection techniques and (iv) propagation and stocking of seed of air breathing fishes for culture in swamps, has been received and 93 new posts have been created for the purpose. As an advance action for the Fourth Five Year Plan, 2 posts of Head of Division, 1 post of Fishery Scientist and 1 post of PA-cum-Stenographer have been created.

*Research collaboration with institutes, universities, colleges and other institutions at national level* : To meet the increasing demand of fish seed for fish culture, this Institute has been helping the State Governments in locating new spawn collection centres on the rivers for the last six years. During the year under report, the work was taken up at Chandra-Payrachali on the Kangsabati river (West Bengal), Hamidabad on the Brahmaputra river (Assam), Ahirauli on the Ganga river (Bihar) and Mahewapatti on the Yamuna river (Uttar Pradesh). Hamidabad on the Brahmaputra river was found to be a productive centre.

A total of 171 ampoules of carp pituitary extract were supplied to 20 induced breeding centres including 14 State Fisheries Departments during June-July, 1970 under the programme of building up of a fish pituitary bank for supply as suggested by the Estimates Committee of Parliament.

The Institute arranged for the supply of 5,000 juveniles of *Macrobrachium malcolmsonii* from Rajahmundry to Government of Maharashtra for research purpose.

Plankton samples from D.V.C. reservoirs were sent to Dr. B. S. Bhimachar, Ex Director, Central Inland Fisheries Research Institute for his work.

*Research collaboration at international level with FAO, Ford Foundation etc.* : A list of cultivated aquatic organisms with essential biological data was prepared for the FAO.

At the request of the American Bureau of Shipping, New York, a note on the important research programmes concerning "Coastal Aquaculture in India" was prepared for publication in the "Surveyor".

Informations on important researches were regularly sent on quarterly basis to FAO, Rome for publication by FAO Newsletter.

Preliminary steps have been taken to establish exchange relationship with Government of Brazil as regards literature on fisheries and fish specimens.

Information was furnished for the IBP/PM Mugilidae Project of Israel on water areas, journals and scientists involved in brackish water fishery.

Specimens of Bopyrid parasites of prawns and shrimps of Gangetic delta were sent to Dr. R. Bourdon, charge de Recherche, station Biologique de Roscoff, France for research work.

For a project on preservation of fish sperms at low temperature, to be initiated in Israel, the details of investigations carried out at Cuttack Substation of the Institute were arranged to be sent to the Ministry of Agriculture, Israel.

*Fellowships and Studentships* : During the year, Dr. V. G. Jhingran, Director of the Institute, was elected as "Fellow of the Zoological Society of India, Calcutta".

*Research Associations* : Scientists of the Institute continued to take initiative in the organisation and management of "The Inland Fisheries Society of India".

The Institute continued to have institutional membership during the year with the following Societies and Associations :

*Indian :*

- (1) The Asiatic Society, Calcutta.
- (2) Marine Biological Association of India, Mandapam Camp.
- (3) Indian Association of Water and Water Pollution Control, Nagpur.
- (4) Indian Science Congress Association, Calcutta.
- (5) Inland Fisheries Society of India, Barrackpore.

*Foreign :*

- (1) Societas Internationalis Limnologiae, Westmoreland, England.
- (2) The Fisheries Society of the British Isles, Humtingdon, England.

*Advisory services received and provided* : Technical advice, on a wide variety of topics ; like, crab control in fish culture pond, selection of magazines on fisheries, doses of fertilisers for fish pond, stream pollution and catfish culture, were supplied to individuals, private bodies, universities and Government departments.

The main topics of information ; viz., fish sperm preservation and induced breeding, status of tilapia in India and a number of freshwater species of fish in South India and Indian Subcontinent, growth and reproduction of gourami, frog-cum-fish culture, frog culture, hypophysation of Chinese carp, culture of *Chanos chanos*, survey of natural resources in inland waters of India, aquatic sites for conservation in India and status of rainbow trout in the country were provided to various foreign agencies ; viz., Oceanographic Institute of Hawaii.

University of Waterloo, Dr. & Mrs. R. C. Bethea of USSR, Republic of Central Africa, Togoland as well as Papua & New Guinea, Makapuu Oceanic centre of Hawaii, Luzonian University of Philippines, UNESCO in Indonesia, IBP Central Office in London and University of Guelph in Canada, respectively.

Important aspects of information passed on to different Government departments in India were : details of weed control by grass carp and other means, frog and prawn culture, fish farming, details of coloured fishes, probable causes for mass mortality of carp eggs in hatching hapas, commercial species of inland fishes, pond culture practices, ideal stocking rate of major carps in reservoirs of Tamil Nadu and details about Gangetic dolphins.

Informations on a number of technical matters furnished to various universities and colleges situated in India by the Institute were : details of locality from where *Gambusia* sp. and *Milliniesia* sp. are available, hydrological data on the Pulicat lake, details about fish production, thana-wise inventory of fishing area and marketing centres of Sunderbans, effect of ecological conditions on the distribution and behaviour of Doon Valley fishes, sexual dimorphism in fish, digestive system of *C. reba* and suitable publications on fish culture and fisheries.

Important items on which informations were provided to various private parties and individuals from all over the country were : freshwater fish production in India during 1958-68, growth and survival of fish seed in nursery, prawn farming, collection of tortoise shells, status of prawn in the Godavari and Krishna deltaic areas, important publications on fish culture and pond management, spots of availability of fishes belonging to Soleidae, recent developments on applied fisheries, aspects of carp culture, breeding of frogs and culture of grass carp, carp hybrids and hilsa in pond.

*Extension and any nation building activity* : Laboratory and field demonstrations and training in various aspects of fish and frog culture were given to (i) trainees of the Regional Training Centres for Inland Fishery Operatives, Agra and Hyderabad and those of the Central Institute of Fisheries Education, Bombay and Inland Fisheries Training Unit, Barrackpore, (ii) the students of final year M.Sc. from Viswabharati University and the trainees from Jammu and Kashmir and (iii) Mr. U. Kin Maung Sein, an FAO fellow from Burma.

Field trainings were also given to staff of the Cuttack Municipality for chemical control of water hyacinth. Chemical clearance of water hyacinth in a 3 ha tank of Central Rice Research Institute, Cuttack was carried out successfully in collaboration with the Orissa Fisheries Department. A small scale field trial for the control of submerged and floating weeds were undertaken in Barang lake at the request of the Wildlife Conservation Department of the Government of Orissa.

In order to promote composite culture and control of aquatic weeds in fish ponds by grass carp, spawn, fry, fingerlings and adults of Indian major carps and exotic carps have been supplied to various agencies as per details given in table 1.

TABLE I. Distribution/Sales of spawn, fry and fingerlings and large fish to various agencies during the calendar year 1970.

Agencies	Indian major carps (lakh)		Common carp (lakh)		Silver carp (lakh)		Grass carp (lakh)		Large fish (kg)		
	Spawn	Fry & fin- gerlings	Spawn	Fry & fin- gerlings	Spawn	Fry & fin- gerlings	Spawn	Fry & fin- gerlings	Indian major carps	Exotic carps	Miscellane- ous fish
To whom distributed :											
Orissa	84.00	1.38820 + 0.26000*	27.000	—	—	0.0080	—	0.02500	50.95	30.10	—
Andhra	—	—	—	—	—	0.0050	—	0.00500	—	—	—
Assam	—	—	—	—	—	0.0050	—	0.00500	—	—	—
Bihar	—	—	—	—	—	0.0050	—	0.00500	—	—	—
Rajasthan	—	—	—	—	—	0.0007	—	0.01000	—	—	—
Tamil Nadu	—	—	—	—	—	0.0050	—	0.00500	—	—	—
Tungabhadra Dam	—	—	—	—	—	0.0050	—	—	—	—	—
United Kingdom	—	—	—	—	—	—	—	0.01200	—	—	—
Uttar Pradesh	—	—	—	—	—	0.0015	—	0.00500	—	—	—
CIFRI Headquarters, Barrackpore	—	—	—	—	—	0.0020	—	—	—	—	—
CIFRI Unit, Kakkdwip	—	—	0.005	—	—	0.0100	—	—	—	—	—
To whom sold :											
Private parties/Public †	00.80	0.51175	—	0.07695	—	0.0300	—	0.02655	1,199.05	1,028.95	122.75

\* Produced in nursery ponds at Kausalyaganga.

† Selling price was Rs. 48.00 for spawn, Rs. 1,393.69 for fry & fingerlings and Rs. 5,922.99 for large fishes. The amount has been deposited with the Orissa Fisheries Department.

*Finance* : The provision of funds for the Institute for the financial year April, 1970 to March, 1971 was as under :

Non-Plan	Rs. 25,08,000
Plan	Rs. 2,18,000
Total	Rs. 27,26,000

Against the above provision the expenditure from 1.4.70 to 31.12.70 was as follows :

Non-Plan	Rs. 21,11,319
Plan	Rs. 1,49,256
Total	Rs. 22,60,575

## 2. PROGRESS OF RESEARCH

The Institute continued its research investigations as per programmes prepared under 19 projects. Each project has several problems and sub-problems to be worked out on the basis of priority. Investigations on 7 problems were completed by the end of the year, while work on the remaining problems is being continued. Besides these, a few new problems are proposed to be taken up in the year 1971.

### (a) *Research completed*

Researches on the following seven problems were completed and the research findings were as under.

#### *Project I : Optimum per hectare production of fry, fingerlings and fish in culture fishery operations*

Problem : 1.5 Fixation of nitrogen by blue-green algae in pond soils  
Personnel : G. N. Saha and D. K. Chatterjee

In laboratory, alkaline soil (pH 8.2), both partially sterilised and unsterilised, with and without addition of phosphorus and each with two replicates in conical flasks, was water logged with distilled water and a set of flasks with sterilised soil was inoculated with *Anabaena* sp. and *Nostoc* sp. After 8 weeks, the increase in total nitrogen, during the period, was 12.1 mg N/100 gm in unsterilised soil and 8 mg N/100 gm in sterilised soil plus algae compared to 38.5 mg N/100 gm in unsterilised soil with phosphorus and 28 mg N/100 gm in sterilised soil plus phosphorus and algae. Addition of phosphorus increased the rate of nitrogen fixation under both sterilised and unsterilised conditions.

To study the effect of selected blue-green algae on survival and growth of spawn, an experiment was conducted in sixteen glass jars with two replications, using both partially sterilised and unsterilised soil of neutral reaction (pH 6.9). Eight of the jars were inoculated with blue-greens; like, *Anabaena* sp. and *Nostoc* sp. Ten hybrid spawn (rohu × mrigal) were introduced in each jar and reared for 15 days. The survival and growth of spawn ranged from 90-100% and 10-25 mm/39-51 mg in sterilised treatments and 80-90% and 7-15 mm/7-15 mg in unsterilised treatments respectively. Among the treatments, blue-green algae inoculated ones, gave comparatively higher survival percentage; but the growth was higher with the sterilised treatments only.

Under semifield conditions in plastic pools, encouraging results were obtained. When the sterilised soil was inoculated with *Anabaena* sp., keeping unsterilised control without algae, it was seen that the survival of spawn of *Cyprinus carpio* stocked at 150/pool was higher with sterilised soil+algae treatment (62%) than that with unsterilised soil without algae (42%). Total nitrogen in water was higher in the former (0.46 ppm) than in the latter (0.22 ppm).

#### *Project 2: Induced breeding of fishes*

Problem : 2.1 Inducing of early maturity and breeding in major carps  
Personnel : R. M. Bhowmick, G. V. Kowtal (from March, 1970),  
G. C. Panicker (up to 28th February, 1970) and  
M. M. Bagchi

20 immature rohu (average weight 700 gm) were given 7 weekly injections of pituitary extract at 6 mg/kg. But, both the treated and untreated ones spawned through hypophysation owing to early monsoons in the 1st week of June which resulted in improvement of the maturity condition of all brood fishes.

#### *Project 3: Reservoir fisheries*

Problem : 3.7 Fisheries of Peninsular tanks : Conservation of fishery in sewage fed Bellandur tank  
Personnel : A. David, N. G. S. Rao and S. L. Raghavan

Annual production of fish in Bellandur tank was 41.027 t (113.5 Kg/ha). There were two distinct peaks of fish production, the major peak in September (7.6 t) and the minor one in May (4.734 t). January and February recorded low fishing values of 40 and 830 Kg respectively. The catches were mostly obtained from drag net (56.61%) and nylon gill net (42.91%). The catch per unit of effort for drag net was 9.67 Kg/net during the period and for the nylon gill net, it was higher for private parties (0.338 Kg/net) than for state department (0.214 Kg/net). Catch comprised scale carp, mirror carp, murrels, catfishes, rohu and mrigal in order of abundance.

There was no waste weir overflow during the year. Commercial fishes were not stocked in Bellandur tank. Breeding of common carp, *Puntius ticto*, P.

*stigma* and *Rasbora daniconius* was not confined to any particular month, as breeding spurts were noticed during different months. Owing to heavy infestation of *Eichhornia* sp. during summer and low oxygen content, mortalities of major carps were reported to have occurred.

*Project 13: Cold water fish culture*

Problem : 13.1 Control of 'whirling' disease in adult trout

Personnel : K. L. Sehgal and C. B. Joshi

In the trout farms of Kashmir, heavy loss of table-sized fish occurs every year owing to the disease associated with malnutrition called 'whirling'. The examination of such diseased fish both internally as well as externally did not show any deformities. The symptoms of the trouble tallied in toto to those described by many workers elsewhere on account of deficiency of vitamin B<sub>1</sub> in the body of trout. In Kashmir, artificial trout diet consists of raw indigenous fish given as a whole or as fillets. Raw fish when given to trout has the capacity to destroy vitamin B<sub>1</sub> in the latter due to the presence of an enzyme thiaminase in the viscera, blood, etc. To investigate the role of indigenous fish after partially boiling and adding of extra vitamin B<sub>1</sub>, various fish species constituting the normal diet of trout were given raw and after boiling. Intramuscular injections of B<sub>1</sub> were also given to trout. The results of these experiments conducted for two years, are summarised below.

In the first set of experiments conducted for two years, feeding of brown trout (*Salmo trutta*) on (a) raw Schizothoracinae (*S. niger*+*S. curvifrons*) and *C. carpio* in equal ratio after deviscerating and cleaning, (b) partially boiled Schizothoracinae and *C. carpio* in equal ratio, and (c) partially boiled Schizothoracinae and *C. carpio* in equal ratio+wheat middlings+sheep liver (85.0%+10.0%+5.0% by total weight of feed) was done. The incidence of 'whirling' was from 2.7-5.1% in the pond where feed (a) was given while it was nil—1.0% in the pond where feed (c) was given. Further in the three ponds, the incidence of 'whirling' appears to have some relation with the water temperature. The increase in water temperature resulted in deaths due to 'whirling'. The food quotient was 3.1, 2.6 and 2.3 in (a), (b) and (c) feeds respectively. This means, deviscerating and partially boiling did help in checking the incidence of the disease. The addition of extra vitamin B<sub>1</sub> in the form of wheat middlings and sheep liver in trout feed (c) though expensive, resulted in only one incidence during two years. Deviscerating, cleaning and partially boiling of fish tissue destroy the thiaminase enzyme which is responsible for the loss of vitamin B<sub>1</sub> in the body of the trout.

In the second set of experiments, feeding of brown trout and rainbow trout (*Salmo gairdneri*) on (a) raw *Crossocheilus latius* as a whole without deviscerating, (b) raw Schizothoracinae (*S. niger*+*S. curvifrons*) after deviscerating and cleaning and (c) raw *C. carpio* after deviscerating and cleaning was done. The range of incidence of 'whirling' in (a), (b) and (c) types of feed was 1.0-8.0%.

0.6-3.3% and 2.6-3.3% respectively. The food quotient in (a), (b) and (c) types of feed was 11.8, 8.2 and 8.2 respectively. Feeding of trout on raw *Crossocheilus latius* as a whole without deviscerating and cleaning resulted in considerable loss of table-sized fish. This is a practice followed in Kashmir. Further, this experiment has shown that deviscerating does help to check the incidence of 'whirling' to some extent (feed b and c). The reason for selecting *C. latius* in control pond is that this species constitutes 75.0% mixture of trout. In the ponds containing both brown and rainbow trouts, the incidence was higher in the former than in the latter.

Intramuscular administration of thiamin chloride (Berin Glaxo Trade mark) to the diseased fish was tried. The dose ranging from 1.5-2.0 cc, was administered on every alternate day. In the first 6-7 days of the treatment, the fish showed symptoms of improvement; but subsequently there was a set back and the fish died. Out of 25 specimens administered with thiamin chloride none survived. This is probably due to the fact that the disease became noticeable at a very late stage when the fish could not respond to the treatment given.

Problem : 13.4 Propagation of mirror carp in hilly areas

Personnel : K. L. Shah and P. M. Abdul Quadir

Specimens of *Cyprinus carpio communis* and *C. carpio specularis* were examined and the fecundity was observed to be 1.95 and 1.72 lakh eggs/Kg of body weight respectively while the average was 1.84 lakh eggs/Kg.

Selected breeders were fed with mustard oilcake+rice bran in 1:1 ratio at 2% body weight. The breeders were made to spawn in *hapas* with *Hydrilla* sp. against 'Kakabans' and the hatching percentage was 82.5 and 54.0 respectively. Incubation period for the eggs was 3-4 days below 30°C and 2 days above 30°C. The average survival of the hatchlings (18 mm) in ponds was 33.45% in a month, with a maximum of 75% and a minimum of 7.07%. Pond manuring @ 19,000 Kg/ha was done. The common carp hatchlings were fed at 2 and 4% of body weight with mustard oilcake—gram flour—soyabean flour—rice bran (6:2:1:1) plus T.M. 5 gm/Kg of feed. The percentage survival, the feed quotient and gain in total length were 17.2, 7.52 and 48.8 mm with 2% feed and 14.86, 14.6 and 51.0 mm with 4% feed, while the percentage survival in control ponds ranged as 11.6-16.8. In one year, 133 gm gain in weight of fish was obtained by utilising 1,000 gm of artificial feed.

Problem : 13.5 Survey of mahseer seed resources in Jammu Province

Personnel : C. B. Joshi, K. L. Sehgal and Shyam Sundar

During August-September, mahseer seed collection centres in the Behani stream of the Ravi river and the Ujh river were located. In the Ravi river, a stretch of about 5 Km stream length of the Behani stream was covered. The average number of fry was 62/m<sup>2</sup> stream area. The fry ranged 7.0-19.5 mm in total length. The physico-chemical features were in the ranges as follows :

depth, 14.0-35.0 cm ; turbidity, nil-5.0 cm ; water temperature, 27.0-31.5°C ; pH, 7.2-8.2 ; dissolved oxygen, 8.2-9.8 ppm ; and total alkalinity, 96.0-120.0 ppm.

In the Ujh river, an area of 15 Km stream length was surveyed and three fry collection centres were demarcated. The average number of fry ranged from 17.34/m<sup>2</sup>. The fry ranged 12.0-19.5 mm in total length. The physico chemical factors were in the following ranges : depth, 29.0-52.0 cm ; turbidity, 0.8-3.7 cm ; water temperature, 25.5-29.5°C ; pH, 7.6-8.0 ; dissolved oxygen, 7.6-9.2 ppm ; and total alkalinity, 120.0-150.0 ppm.

Problem : 13.7 Creel census of certain trout streams in relation to ecological conditions

Personnel : M. J. Bhagat and Kuldip Kumar

Creel census, in two beats each of the Sind and Lidder trout streams, was made for the angling season (March-September). In both the trout stream, fly and spoon fishing was done. The anglings pressure in the two beats combined was 104 rods by 295 Kg in the Sind river against 326 rods by 598 Kg in the Lidder stream. The concentration of surface net plankton was maximum in both the streams (578 u/l in the Sind river and 1,255 u/l in the Lidder stream) in January and minimum in May (83 u/l in the Sind river and 213 u/l in the Lidder stream). The dominant forms include *Navicula* sp., *Amphora* sp., *Gomphonema* sp., *Pluerococcus* sp. and *Closterium* sp. The insect population in the Sind river was maximum in February (95 u/m<sup>2</sup>) against June (169 u/m<sup>2</sup>) in the Lidder stream. The minima in both the streams were in December (39 u/m<sup>2</sup> in the Sind river and 71 u/m<sup>2</sup> in the Lidder stream). The average percentage of Ephemeroptera, Plecoptera, Trichoptera, Coleoptera and Diptera was 37.68, 4.49, 38.44, 4.57 and 9.34% respectively in the Sind river and 28.19, 9.93, 50.95, 2.90 and 7.70% in the Lidder stream. In addition to the insects, *Gammarus pulex* and planarians collectively constituted 5.48% in the Sind river and 0.34% in the Lidder stream. The predominant forms constituting the insect life of the two streams were : *Epeorus* sp., *Heptogenia* sp., *Ephemerella baetis* and *Ecdyonurus* among Ephemeroptera ; Nemouridae and Parliidae among Plecoptera ; Rhyacophilidae, Hydropsychidae and Philopotamidae among Trichoptera ; Elmidae and Dytiscidae among Coleoptera ; and Blepharoceridae, Simuliidae, Leptidae and Tipulidae among Diptera. The physico-chemical features of the two streams were in the following ranges : water temperature, 1.0-19.0°C ; pH, 7.1-7.8 ; dissolved oxygen, 9.2-11.8 ppm, alkalinity, 70-120 ppm, and silicates, 0.87-1.50 ppm.

#### (b) Research in hand

Research work on 19 projects was continued during the year under report. A description of the progress made under each project, during 1970, is outlined in the following pages.

*Project 1: Optimum per hectare production of fry, fingerlings and fish in culture fishery operations*

Problem : 1.1 Composite culture of Indian and exotic species  
Duration : Continuing  
Personnel : M. T. Philipose, S. B. Singh, R. D. Chakrabarty, M. A. V. Lakshmanan, K. Raman, P. R. Sen, A. C. Nandy, D. S. Murthy, G. V. Kowtal, D. P. Chakraborty, P. C. Chakrabarti and M. M. Bagchi

4 experiments in 0.08 ha ponds, initiated in September, 1969 for raising fingerlings, were concluded in March, 1970. Two ponds were stocked with silver, grass and common carps @ 1 and 2.5 lakh/ha respectively, both in 4:3:3 ratio. The remaining two were stocked with catla, rohu and mrigal in the ratio 2:4:4 and 1:4:8 with stocking densities of 1 and 2.13 lakh/ha respectively. Percentage survival and net production in the respective ponds were 96.7, 68.8, 62.1 and 68.8, and 774.5, 840.7, 1,582.1 and 1,701.7 kg/ha/6 months respectively.

Composite culture of fingerlings, to raise large fish in five 0.12 ha and one 0.4 ha ponds, was concluded in May, 1970. The species combinations tried were : (i) C 3 : R 3 : M 3 : Gc 1 ; (ii) Sc 3 : R 3 : Cc 3 : Gc 1 ; and (iii) Sc 1.5 : C 1.5 : R 3 : M 1.5 : Cc 1.5 : Gc 1, with two replicates for each and with 5,000/ha stocking density in all combinations. Percentage survival and net production in kg/ha/year under the respective combinations were : 58.3 and 76.9/1,732 and 2,129 ; 54 and 17/2,313.5 and 993.5 ; and 68.8 and 96.3/2,314 and 2,789. In a similar experiment in two 0.08 ha ponds with the third species combination at a stocking density of 3,000/ha, percentage survival/net production were : 85.6 and 90.7/1,422 and 1,308 kg/ha/6 months. Average weights of species were : Sc 981 and 938, C 568 and 563, R 317 and 236.6, M 300 and 269, Cc 1,218 and 737 and Gc 500 and 376 gm. Rohu, closely followed by silver carp, recorded maximum survival. In an experiment in two 0.08 ha ponds in April, 1970 with the species combination, Sc 4 : Cc 3 : Gc 2 : R 1, at 5,000/ha stocking density, silver carp, grass carp and rohu recorded average increments of 620 and 443, 257 and 258, and 411 and 299 gm respectively in nine months.

Another set of experiment using the species combinations and stocking densities of (i) Sc 0.35 : C 2.65 : R 3 : Gc 1 in two 0.15 ha ponds @ 5,000/ha each (ii) Sc 1.5 : C 0.75 : R 3 : Cc 1.5 : Gc 1 : M 1.5 was initiated in May, 1970 in two ponds (0.15 and 0.4 ha) @ 4,650/ha ; and (iii) same as (ii) but with catla omitted due to its non availability (in one 0.6 ha pond), at 4,250/ha. In the 0.4 ha pond in which catla and silver carp showed average increments of 1,016 and 1,082.3 gm respectively in five months, 50-60 per cent of the original stock were harvested and replaced by an equal number of fingerlings. In the two ponds under the first combination, percentage survival net production were 41.06 and 77.33/1,098.3 and 1,613.5 kg/ha/6 months, whereas in the third pond under the second combination they were 35.3/1,292 kg/ha/6 months

Problem : 1.2 Conversion ratio of selected carp feed into fish flesh  
Duration : Two years  
Personnel : M. T. Philipose, R. D. Chakrabarty, P. R. Sen, G. V. Kowtal, D. K. Chatterjee and D. S. Murthy

In experiments of 15 days' duration conducted in glass jars where catla spawn fed with (i) zooplankton, (ii) mustard oilcake plus rice bran, (iii) silkworm pupae and (iv) groundnut oilcake plus wheat bran separately, each at 1.95 mg/fish/day with addition of cobalt chloride at 0.01 mg/fish/day, percentage survivals of fry with the respective feeds in jars with change of water every third day (3 replicates) and without change of water (1 replicate) were : 29 and 60, 6 and 20, 15 and 54, and 10 and 50 respectively. In the second experiment using mrigal spawn, the corresponding figures were : 61 and 74, 16 and 28, 68 and 96, and 71 and 96. Best growth (in terms of length and weight) in catla was obtained with zooplankton and in mrigal with silkworm pupae. In the third experiment using rohu spawn and the four feeds (the g.o.c. in the 4th feed being replaced by m.o.c. owing to its non-availability), the survival figures were : 82 and 64, 33 and 28, 62 and 60, and 31 and 36 respectively. Similarly in the fourth experiment where water was not changed in all the four jars, percentage survival was 91, 31, 49 and 68 respectively. In the third and fourth experiments, zooplankters gave the best growth. In all the experiments, the quantity of unutilised feed was the highest with groundnut oilcake+wheat bran.

In an experiment of 15 days duration conducted in plastic pools using the same four feeds (3 replicates for each), percentage survival of mrigal fry was : 93.7, 97.9, 95.8 and 95.8 with each feed, water being not changed in the pools. Average growth increments recorded in 15 days were : 1.32 mm/0.10 gm, 2.5 mm/0.42 gm, 4.55 mm/0.87 gm and 2.86 mm/0.80 gm, the best growth being with silkworm pupae. From these experiments, it appeared that zooplankton is the best food for catla and rohu spawn and silkworm pupae for mrigal spawn and fry.

Problem : 1.3 Evolving a suitable fish diet including use of growth promoting substances  
Duration : Four years  
Personnel : M. A. V. Lakshmanan, P. R. Sen, D. P. Chakraborty and D. S. Murthy

In preliminary experiments, conducted in plastic pools with various feeds, it was observed that finely powdered fish meal and bone meal are not utilized by catla fingerlings. For rohu fingerlings, m.o.c.+prawn shell powder appeared to be a better feed than m.o.c. alone. In an experiment in which mixtures of (i) horse gram, millet and wheat bran and (ii) horse gram, millet, wheat bran, fish meal and prawn waste were fed to fingerlings of catla, rohu and mrigal, average percentage increases in weight in one month were 11.08 and 16.45 respectively compared to -2.21 in control pools.

In laboratory experiments, using antibiotics : Chloromycetin, Hostacyclin and Enterocyclin to determine their usefulness in enhancing the growth and survival of common carps spawn, Chloromycetin at 0.03 mg/fish/day when given along with feed, gave encouraging growth increment of 10.14 mm/0.071 gm with 96% survival in 15 days as against 9.84 mm/0.067 gm with 95.33% survival in control. In another jar experiment where manganese at 0.01, 0.05, 0.5, and 1.0 mg/fish/day given along with feed, rohu spawn gave survival percentages of 95.33, 96.0, 97.33 and 94.7 respectively in 15 days' rearing compared to 57.5 in control.

In a yard experiment using cobalt chloride, boron and starch as growth promoting substances for common carp spawn stocked at 15.6 lakh/ha (100 spawn/plastic pool), percentage survival at the end of 15 days was : 83.70 with starch at 3.44 mg/fish/day, 81.33 with cobalt chloride at 0.01 mg/fish/day and 75.00 with boron at 1.0 mg/fish/day compared to 69.66 in control. Cobalt chloride gave the maximum growth increment of 8.82 mm/0.0574 gm followed by starch and boron with 8.80 mm/0.0457 gm and 8.53 mm/0.0544 gm respectively against 8.53 mm/0.0530 gm in control.

In a field experiment with rohu and mrigal spawn, each stocked at 25 lakh/ha in one 0.04 ha pond and fed with cobalt chloride at 0.01 mg/fish/day along with feed, percentage survival at the end of two weeks was 87.3 in rohu and 66.9 in mrigal compared to 60.4 and 65.3 in two control ponds respectively. Growth increments recorded were 14.67 mm/0.114 gm in rohu and 24.99 mm/0.384 gm in mrigal in the treated ponds as compared to 17.21 mm/0.148 gm and 21.62 mm/0.298 gm respectively in the untreated ponds. Slightly better growth of rohu in the control was obviously due to lower survival. In the second field experiment in which cobalt chloride @ 0.01 mg/fish/day, starch @ 3.44 mg/fish/day, and boron @ 1.0 mg/fish/day were supplied to fingerlings of catla, rohu and mrigal, each stocked @ 6,000/ha in 1:1:1 ratio in one 0.04 ha pond, percentage survival at the end of four months was 94.30 with starch followed by 91.30 with cobalt chloride, 81.83 with boron and 81.73 in control. Growth in four months was maximum (109.90 mm/133.06 gm) with cobalt chloride followed by 104.30 mm/117.03 gm with starch, 96.78 mm/118.50 gm with boron and 94.22 mm/100.75 gm in control. Gross/net production in the respective treatments were 907.75/735.00, 849.50/675.75, 773.50/599.75 and 647.25/473.50 kg/ha/4 months, the production with cobalt chloride being about one and a half times that of the control.

In another set of experiments initiated in November, 1970 in four 0.04 ha ponds, each stocked with fingerlings of catla, rohu and mrigal in the ratio 1:1:1 and @ 6,000/ha and cobalt chloride, starch and manganese supplied @ 0.01, 3.44 and 0.01 mg/fish/day respectively against an untreated control, catla and mrigal have shown maximum growth with cobalt chloride and rohu with starch at the end of one month. The experiment is being continued.

Problem : 1.4 Relative efficiency of different nitrogenous fertilizers in relation to different soil types

Duration : Three years  
Personnel : G. N. Saha, K. Raman and D. K. Chatterjee

In a laboratory experiment (in 10 l jars) with three replicates for each treatment using fertilizers at three rates : 20, 50 and 80 Kg N/ha, 10 rohu spawn were reared for 15 days. Of the three rates, the medium rate gave better survival percentage and growth of spawn ; *i.e.*, 94 and 12.9 mm/21.6 mg, 97 and 12.5 mm/19.8 mg, and 97 and 12.1 mm/15.3 mg with urea, ammonium sulphate and ammonium nitrate respectively as against 83 and 9.6 mm/6.5 mg in control. Rate of primary productivity was higher at the medium rate of urea (56.1 mg C/m<sup>3</sup>/hr) and of ammonium sulphate (89.0 mg C/m<sup>3</sup>/hr) ; but was the highest in ammonium nitrate (104.0 mg C/m<sup>3</sup>/hr). Water and soil qualities did not vary much except for the available nitrogen which was higher in treated jars.

In yard experiments, both medium and high rates (50 and 80 kg N/ha) were tried on the same soil type. The medium rate of three fertilizers again gave better results. The survival percentage and growth of rohu spawn with the medium rate of fertilizer application were 92 and 23.64 mm/130.4 mg, 92 and 21.40 mm/87.4 mg, and 98 and 16.72 mm/37.8 mg and with the high rate 91 and 21.80 mm/92.2 mg, 75 and 22.90 mm/112.1 mg, and 88 and 20.68 mm/90.84 mg from ammonium sulphate, urea and ammonium nitrate treatments respectively as against 78 and 19.7 mm/67.0 mg in control. The results indicated that the response of nitrogenous fertilizers was highly marked in alkaline soil type.

Problem : 1.5 Fixation of nitrogen by blue-green algae in pond soils.  
(Research completed)

Problem : 1.6 Crude culture of fish food organisms

Duration : Four years

Personnel : M. T. Philipose, A. C. Nandy, G. V. Kowtal and  
D. P. Chakraborty

In confirmatory experiments conducted in field pits (2.3 × 1.4 × 0.45 m<sup>3</sup>) during March-June, crude cultures of the diatoms : *Navicula* sp., *Nitzschia* sp., *Gomphonema* sp. and *Pinnularia* sp. could be obtained by using N-P-K in two combinations ; *viz.*, (i) ammonium sulphate—bone meal—potassium nitrate and (ii) urea—double superphosphate—potassium nitrate, each at 5-15-3 and at 230 ppm and with two replications against a single untreated control. As in previous laboratory experiments, the first combination gave better results (0.700 cc plankton/l and 40,640 u/l) than the second (0.235 cc/l and 26,845 u/l) as against 0.030 cc/l and 1,525 u/l in the control within six weeks. However, other phytoplankters ; like, *Volvox* sp., *Oscillatoria* sp. and *Anabaena* sp. also developed in the treated pits. In the second experiment using the same treatments conducted during September-November, the first combination yielded 0.235 cc/l and 10,440 u/l within one month as compared to 0.060 cc/l and 2,812 u/l in the second combination and 0.010 cc/l and 1,475 u/l in the control, the

major constituents being diatoms, *Cyclops* sp. and nauplii in the treated pits and a few of these in the control.

Problem : 1.7 Culture of fish food organisms in the laboratory and field for feeding fish  
Duration : Three years  
Personnel : C. S. Singh (till August 22, 1970) and K. K. Bhanot (Mrs.)

Preparatory culture of *Spirogyra* sp. was done in Czurda's solution with 0.1% micronutrient solution on agar plates. *Spirogyra* filaments collected from natural populations (0.1 cc) were inoculated in 3 liters of Czurda's solution made in tap water for cultures, from which 50 cc *Spirogyra* sp was produced in two months.

*Cyclops* sp. (females) with egg sacs were maintained in two batches (in glass jars), each consisting of 30 numbers and kept in 5 litres of 0.025% cotton seed extract and paddy straw extract. Eggs developed into adults in both the media in 25-50 days but the F<sub>1</sub> generation did not develop eggs even after one months.

Thirty numbers of *Moina* sp. were kept separately in paddy straw extract as well as in cotton seed extract. In the latter medium, snails were also introduced resulting in better survival and *Moina* sp. which were observed to feed on the bacterial growth on the faeces of the snails.

Regular subcultures of *Chlorella* sp., *Gomphonema* sp. and *Nevicula* sp. were done. *Pinnularia* sp. was isolated and put in Chu-10 solution for stock culture.

Problem : 1.8 Algae in relation to fish nutrition  
Duration : Three years  
Personnel : C. S. Singh (till August 22, 1970) and K. K. Bhanot (Mrs.)

Three types of feed were prepared in the ratio of *Spirogyra* powder, plankton powder or fish meal—40 gm, potato starch—58 gm, yeast—1 gm, Terramycin—0.5 gm and salt—0.5 gm. An experiment was set up, using *Cyprinus carpio* fry to test the nutritive value of the algae feed, keeping fish meal and dried plankton feed to serve as the controls. Twenty fishes (4.5-4.9 cm) were kept in each experimental plastic pool and were fed daily between 11.00-13.00 hours, after which the feeding screen plate fitted above the excretion screen plate was removed. The fishes and the excretory plate were left undisturbed for the rest of the day. Feed was supplied @ 10% of the body weight of the fish.

Length and weight of the individual fish were taken initially and then after every 10 days intervals during the experimental period. Chemical analyses for protein, fat, ash and carbohydrates for the individual feed ingredients, feed, resultant faeces and fish in the initial and final stages of the experiment gave the following results (Table 2).

Table 2. Details of chemical analyses (%).

	Fish				Feed and resultant faeces						Basic ingredients			
	Initial		Final		Algae		Fish meal		Plankton		Spirogyra powder	Potato starch	Fish meal	Plankton dried
		Fed on algal feed	Fed on fish meal feed	Fed on plankton feed	Feed	Faeces	Feed	Faeces	Feed	Faeces				
Moisture	77.30	77.35	77.40	77.50	4.20	11.20	6.30	10.90	8.90	12.10	8.90	6.80	10.80	79.20
Protein	12.00	19.67	16.20	17.93	14.00	12.19	12.39	9.81	26.00	7.18	20.95	6.40	17.87	56.00
Fat	5.39	9.67	6.20	7.93	1.65	0.89	1.45	0.67	2.00	0.83	4.44	0.40	2.05	4.30
Carbohydrate	71.92	58.81	65.57	62.20	68.55	48.52	50.06	34.62	40.90	30.89	50.91	82.40	48.37	31.20
Ash	10.69	11.85	12.03	11.94	11.60	27.20	29.80	44.00	13.20	49.00	14.80	4.00	20.91	08.50

- Problem : 1.9 *Response of unproductive, pond soils, to different, in organic, manurial, combinations*
- Duration : Three years
- Personnel : S. M. Banerjea, E. Mitra (Miss) and S. R. Ghosh

To study the response of unproductive pond soils to different inorganic fertiliser combinations, a laboratory experiment was taken up under semi-field conditions with two unproductive fish pond soils from (i) Lingipur farm (Orissa) and (ii) Lembucherra farm (Tripura). 20 Kg of farm soil was used as substratum in each of 12 plastic cisterns and 400 l of water added to make the soil : water ratio as 1:20. Three replicates were taken both for control and for treated cisterns. After allowing sufficient time for the establishment of nutrient equilibrium between soil and water, a measurable quantity of phytoplankton was obtained by repeated seeding. The first instalment of the fertiliser dose was added and the observations on nutrient levels and primary productivity continued. The fertiliser mixture was  $N_{40} P_{40}$  to be added in 4 divided doses at an interval of 3 months. The results indicated that both the soils showed a marked response to the fertiliser combination as measured by primary productivity. The nutrient levels of the added fertiliser elements also showed an increase in treated cisterns. The value of primary productivity, dissolved nitrogen ( $NH_4 + NO_3$ ) and dissolved phosphorus ( $PO_4$ ) in the cisterns with Orissa soil, varied between 238.0-395.2 mg C/m<sup>3</sup>/hr; 0.02-0.62 ppm and 0.35-1.35 ppm in the fertilized condition and 46.8-107.2 mg C/m<sup>3</sup>/hr, 0.02-0.08 ppm and 0.06-0.18 ppm in the unfertilized state. Respective values in the cisterns with Lembucherra soil from Tripura, varied between 206.3-350.2 mg C/m<sup>3</sup>/hr, 0.02-0.76 ppm and 0.46-1.30 ppm in the fertilized condition and 36.4-154.3 mg C/m<sup>3</sup>/hr, 0.02-0.10 ppm and 0.03-0.19 ppm in the unfertilized state.

- Problem : 1.10 Factors responsible for low and high productivities of fish ponds in acid soil zones of Tripura
- Duration : Four years
- Personnel : S. M. Banerjea, S. R. Ghosh, N. C. Ghosh (Tripura Fisheries) and M. Bhattacharja (Tripura Fisheries)

To elucidate the factors responsible for low and high productivity of fish ponds in acid soil zones of Tripura, observations were continued on two fish farms : one highly unproductive and one highly productive. All the ponds were stocked with equal number of fingerlings of catla, rohu and mrigal at a uniform rate of 5,000/ha. The pronounced differentiating characters of the two waters were observed in their soluble organic content and different forms of soluble nitrogen and phosphorus. The productive water had a markedly higher organic content and dissolved phosphorus both in organic and inorganic forms. While organic nitrogen and ammoniacal nitrogen were relatively much

higher in productive water, nitrate nitrogen concentration was higher in unproductive water. Owing to unprecedented flood condition in Tripura in September, 1970, all the experimental ponds were completely over flooded and the experiment was spoilt and had to be abandoned. The results up to September are presented in table 3.

Table 3. Average growth of fish and average nutrient levels in the productive and unproductive pond soils of Tripura

	NH <sub>4</sub> -N (ppm)	NO <sub>3</sub> -N (ppm)	Org.-N (ppm)	PO <sub>4</sub> -P (ppm)	Org.-P (ppm)	Primary produc- tivity (mg C/m <sup>2</sup> /hr.)	Weight of fish (gm)		
							Catla	Rohu	Mrigal
<i>College Tilla farm (unproductive) :</i>									
Jan	0.032	0.320	0.163	0.020	0.030	105.3	19	15	16
Feb	0.030	0.280	0.180	0.020	0.030	117.4	—	—	—
Mar	0.028	0.268	0.175	0.020	0.020	101.0	99	43	35
Apr	0.024	0.214	0.140	0.030	0.020	140.4	—	—	—
May	0.031	0.266	0.120	0.030	0.020	144.2	—	—	—
Jun	0.037	0.273	0.107	0.030	0.020	128.3	133	99	69
Jul	0.022	0.283	0.094	0.030	0.020	115.4	—	—	—
Aug	0.020	0.200	0.082	0.040	0.030	95.1	—	—	—
Sep	0.026	0.220	0.074	0.040	0.020	100.3	169	116	82
<i>Rajdharnagar farm (productive) :</i>									
Jan	0.245	0.117	0.978	0.230	0.340	265.3	19	15	16
Feb	0.235	0.103	0.955	0.190	0.280	251.2	—	—	—
Mar	0.161	0.070	0.811	0.150	0.240	220.2	262	227	167
Apr	0.129	0.050	0.767	0.120	0.180	245.3	—	—	—
May	0.120	0.055	0.752	0.130	0.200	304.3	—	—	—
Jun	0.118	0.051	0.747	0.130	0.210	271.4	557	355	293
Jul	0.128	0.060	0.650	0.160	0.240	260.8	—	—	—
Aug	0.132	0.060	0.600	0.240	0.360	190.5	—	—	—
Sep	0.141	0.069	0.620	0.230	0.350	145.1	797	645	442

Problem : 1.11 Remedial measures for preventing seepage in fish ponds by physico-chemical treatment of bottom soil

Duration : Three years

Personnel : S. M. Banerjee and S. C. Banerjee

Following the laboratory experiments in tall tubes with perforations at the bottom, to reduce the seepage rate through a percolative soil to the minimum, experiments were conducted under semifield condition with the same soil and the seepage rate was found to be reduced to 8.8 cm/hr as compared to 26 cm/hr in the control. Applications of organic matter, raw cow-dung have got some

effect in reducing the seepage rate, the minimum seepage rate with this being noted to be 7.4 cm/hr. Increasing the concentration of NaOH in the leaching mixture to 1.0%, the seepage rate was further reduced to 5.4 cm/hr which is also far from satisfactory result. So, laboratory experiments were again tried to note the seepage rate with varying concentrations of common salt, caustic soda, raw cow-dung and their combinations and to find the optimum dose for reducing seepage under laboratory condition. The optimum dose and corresponding seepage rate after 3 leachings under laboratory condition are given below.

Doses of chemicals added :	Raw cow-dung 2%	Common salt 2.5%	Caustic soda 2.5%	Common salt and caustic soda 2.5% each	Common salt 0.6% and caustic soda 1.0%
Seepage rate (cm/hr) :	10.6	2.1	1.6	1.25	0.6

Of the above combinations of chemicals and their doses, common salt 0.6% + NaOH 1.0% appear to be the best.

Problem : 1.12 Evaluation of indigenous plants as fish poisons  
 Duration : Three years and four months  
 Personnel : M. T. Philipose, D. P. Chakraborty and A. C. Nandy

In a confirmatory field experiment conducted in April, 1970 in a nursery pond 0.04 ha in area and 1.5 m depth, the seed powder of *Barringtonia acutangula* at 15 ppm killed murrels, catfishes, tilapia, carp and weed fishes within 1½ hr of its application. Affected murrels which were salvaged and released in freshwater survived while other fishes similarly salvaged did not survive. The toxic effect of the poison lasted for about 48 hr. Zooplankters were not apparently affected and started increasing from the third day, reaching the peak within 9-11 days. The poison was toxic to notonectids which came up within half to one hour after the treatment and could be removed in quantity. Toxicity to notonectids, in treated waters and revival of zooplankters by the third day after treatment, were significant in that the poison can be used about 3-4 days before stocking a nursery and it may keep down the notonectids considerably at the time of stocking.

Problem : 1.13 Estimation of fish population in ponds by capture-recaptured method  
 Duration : Three years  
 Personnel : M. D. Rout and D. S. Murthy

Three ponds (0.12 ha—0.13 ha) with known fish population of 750 and a farm pond (0.4 ha) with fish population of 2,000 comprising catla, rohu, mrigal,

silver carp, grass carp and common carp were selected for study. 10% and 15% of low and high stocking density populations were marked. From the recovery samples, the population was estimated by two combined hauls. More than 90% clipped fishes were recovered in case of catla silver carp and grass carp, 30-50% for rohu, 10-30% for mrigal and 30-40% for common carp. Specieswise population when estimated and compared with the number of fishes harvested after poisoning the pond showed an under estimation of the specieswise population by 2-15% for surface feeders, 3-20% for column feeders and 15-45% for bottom feeders. This led to the modification of the conventional drag net which when operated afterwards, resulted in an increase of catch of bottom feeders by 10% as compared to the preliminary trials.

Problem : 1.14 Qualitative segregation of fish seed  
 Duration : Two years  
 Personnel : R. D. Chakrabarty and D. S. Murthy

Reactions of 2-15 days old spawn/fry to coloured lights of different intensities were observed in a specially fabricated glass aquarium ( $91.44 \times 30.48 \times 30.48$  cm<sup>3</sup>) by providing illumination from below by 6 bulbs being placed equidistant to one another and the wattage of which varied from 25 to 100. Glass plates of three different colours at a time were used to provide coloured lights and their position was also changed for providing variations. No positive or negative reaction could be detected in the fish spawn. Different colours tried were : red, blue, green, yellow, orange and white.

Sound provided by a falling drop of water from above as also under water sound created from a bell did not show any positive or negative reaction of the spawn in the aquarium.

Problem : 1.15 Selective capture of predators and unwanted fishes from carp culture ponds  
 Duration : Three years  
 Personnel : A. David, R. M. Rao, S. L. Raghavan and M. F. Rahman

Specially designed fibre, metal and bamboo traps were fabricated for experiments on selective fishing and were successfully employed to capture predators and unwanted fishes in ponds and tanks around Shimoga during May and June and in Madaga Tank in December. The following fishes were recorded :

Bamboo trap : *Channa gachua*, *Notopterus notopterus* and *Mystus cavasius*  
 Metallic trap : *Puntius sarana*, *P. stigma*, *P. ticto*, *Channa striatus*, *Rasbora daniconius*, *Notopterus notopterus*, *Osteobrama vigorsii* and *Ambassis ranga*  
 Fibre traps : *Puntius sarana* and *Channa leucopunctatus*

Problem : 1.16 Age and growth of pond grown *Labeo rohita* (Ham.) as indicated by the study of scales and bony parts against known age method

Duration : Three years

Personnel : R. D. Chakrabarty

Monthly records of length, weight and maturity condition of rohu, collection of otoliths, scales, vertebrae and opercular bones as well as plankton and fish guts were continued to be made. Fish in the age groups of 1, 2 and 3 were used.

Opercular bones, vertebrae and the otoliths removed from fish specimens were thoroughly cleaned and treated in chemicals to accentuate the appearance of growth rings on them.

Growth checks did not appear to be clear in otoliths. On the opercula, transparent rings could be seen; but they were more in number than the age of the fish in years. The dark bands concentric with the rim of the vertebrae were found to be more in number than the age in years of the fish.

The fish attained the first maturity when it was 1 year 11 months old. The growth recorded by the fish was very slow. Females of age, 2 year 11 months (roughly 3+ year), were 910 gm and males of age, 3+ year, 867 gm only. The study of the material collected is in progress. In the scales examined, growth checks appeared to be more than the years of the fishes life and as such these cannot be considered as true annuli.

#### Project 2: Induced breeding of fishes

Problem : 2.1 Inducing of early maturity and breeding in major carps

(Research completed)

Problem : 2.2 Use of various hormones for inducing spawning in carps

Duration : Three years

Personnel : R. M. Bhowmick G. C. Panicker (till March 5, 1970)  
K. H. Ibrahim (till July, 1970) and G. V. Kowtal (from March, 1970)

Catfish pituitary glands collected from mature specimens of *Pangasius pangasius* and *Silonia silonia* were found equally effective as carp pituitary in inducing spawning in Indian major carp (rohu) for the first time. Four sets of rohu were injected with catfish pituitary extract, keeping suitable controls injected with carp pituitary extract at the same dose. All the four sets as well as the controls gave positive response. The use of catfish pituitary glands for induced breeding will reduce expenditure and will also save donor carps for use as breeders.

In another experiment, 3 sets of rohu were injected with either Synahorin or HCG (25 R U/Kg) and pituitary (6 mg/Kg), keeping suitable controls injected with 6-10 mg/Kg pituitary extract alone. All the treated ones which received combined doses spawned and amongst the controls only those injected at 10 mg/Kg of pituitary extract bred while others treated at lower doses did not respond. This confirmed that Synahorin/HCG reduces the requirement of pituitary extract. Antuitrin—S (HCG) administered alone at varying doses (100 to 1,500 Tu/Kg) or along with pituitary extract (2.4 mg/Kg) did not induce rohu to spawn. Pituitary glands of mullets (*M. cephalus* and *L. troschelli*) and *Tilapia* sp. were ineffective in hypophysation of carp.

Problem : 2.3 Extraction, preservation and ampouling of fish pituitary hormones and setting up of pituitary bank  
Duration : Three years  
Personnel : R. M. Bhowmick and K. H. Ibrahim (upto June 1970)

215 ampoules (40 mg/ml) of carp pituitary extract in glycarine were produced of which 171 were distributed to 24 induced breeding centres including 14 State Directorates. Eight of the agencies (Assam, Andhra Pradesh, RTC—Hyderabad, Mysore, Orissa, Tungabhadra Board, Tamil Nadu, Estuarine Division of CIFRI) have reported positive results by using the ampoules. Two agencies (RTC—Agra and Chief Training Superintendent, Barrackpore) reported negative results. Reports from the other agencies are still awaited. The positive results obtained from most of the centres indicate the usefulness of such ampoules.

Pituitary glands of carps preserved and dried in acetone and kept at room temperature for about 3 months, were effective in inducing spawning in rohu. Carp pituitaries preserved in acetone and kept under refrigeration for 1½ years and one year and 2 months' old pituitary extract ampoules kept under refrigeration were also found effective.

2,067 pituitary glands were collected during May, 1970 from Calcutta fish market. 100 pituitary glands were sent to CIFRI Unit at Hazaribagh.

Problem : 2.4 Hatching of eggs of major carps in newly designed hatching jars under controlled conditions  
Duration : Two years  
Personnel : R. M. Bhowmick and M. M. Bagchi

Eggs of major carps (rohu, catla and mrigal) were successfully hatched in the hatching jars (6.35 l) and 3.55 lakh spawn was produced. Eleven experiments were carried out successfully under laboratory conditions having running water facilities. Nearly cent per cent hatching was obtained in the jars. These experiments demonstrated the possibility of installing hatchery for effective hatching of major carp eggs under controlled conditions.

Incidental to various induced breeding experiments, 98.7 lakh of major carp and hybrid spawn were produced. Bulk of the spawn produced (84.0 lakh) was supplied to Orissa Fisheries Department.

- Problem : 2.5 Effect of inbreeding on the growth, maturity and viability of major carps  
Duration : Three years  
Personnel : M. A. V. Lakshmanan and R. M. Bhowmick

No distinct differences between the growth of advance fry of major carps obtained from induced breeding and that from riverine source could be noticed in a rearing period of two months in the two halves of a 0.08 ha pond partitioned with wire netting. However, catla of induced bred origin showed only an average gain in weight of 261.96 gm in five months compared to 314.40 gm by catla from riverine source. No definite conclusions regarding rohu and mrigal could be drawn since sufficient number of these species could not be obtained in the samplings during the third, fourth and fifth months. The experiment is still in progress.

*Project 3 : Reservoir fisheries*

- Problem : 3.1 Fisheries of the Tilaiya reservoir  
Duration : Three years and 8 months  
3.1.1 Physico-chemical characteristics of water and soil and primary productivity  
Personnel : A. V. Natarajan and S. K. Sarkar

The pooled annual averages of various physico-chemical determinations are presented in table 4. DO does not show much depth variation. The total alkalinity shows that the reservoir has high productive potential.

Annual mean gross primary productivity for the Tilaiya reservoir was 397.7 mg C/m<sup>3</sup>/day (12 hr) and monthwise evaluations ranged from 218.8-1,162.5 mg C/m<sup>3</sup>/day (12 hr).

Table 4. Pooled averages of various hydrological observations in the Tilaiya reservoir.

Depth (mm)	Transparency (cm)	Water temperature (°C)	pH	Dissolved oxygen (ppm)	Free CO <sub>2</sub> (ppm)	Total alkalinity (ppm)	PO <sub>4</sub> (ppm)	NO <sub>3</sub> (ppm)	SiO <sub>2</sub> (ppm)	Fe (ppm)
0	37.25 (13.5-67.0)	25.05 (17.8-31.0)	7.95	8.20	3.65	66.90	0.048	0.750	6.81	0.013
3		24.15 (17.2-29.8)	7.85	8.00	4.45	68.05	—	—	—	—
6		22.30 (17.1-29.8)	7.95	8.00	2.95	70.65	0.038	0.813	5.30	0.047
9		20.20 (17.0-26.5)	7.70	8.05	4.60	59.10	—	—	—	—

Note: Results are for Urwan Sector of the Tilaiya reservoir. Figures in the brackets show the range.

3.1.2 Food resources—A. Plankton, B. bottom biota and C. larger aquatic plants and associated fauna and flora

Personnel : A. V. Natarajan and B. V. Govind

A. *Plankton* : The plankton showed a dominance of zooplankton over phytoplankton (3.7:1.0). The zooplankters comprised larval *Diaptomus* sp. and *Cyclops* sp. among copepods and *Keratella* sp. among rotifers. During the year, Chlorophyceae represented by *Botryococcus* sp. were dominant among phytoplankters.

The vertical distribution of plankton showed increasing densities both by number and volume up to a depth of 9 m. The densities of plankton at surface and different depths at 3, 6 and 9 m were : 14,865 u/m<sup>3</sup> (0.323 ml/m<sup>3</sup>) 36,305 u/m<sup>3</sup> (1.150 ml/m<sup>3</sup>), 28,100 (1.010 ml/m<sup>3</sup>) and 38,930 u/m<sup>3</sup> (1.437 ml/m<sup>3</sup>) respectively. The average plankton density during the year, was 29,550 u/m<sup>3</sup> (0.980 ml/m<sup>3</sup>).

B. *Bottom biota* : The bottom macrofauna comprised chiefly dipteran (*Tendipes* sp.) larvae followed by *Chaoborus* sp. and *Tubifex* sp. The others were trichopteran (*Philopotamus* sp.), bivalve (*Corbicula* sp.) and gastropod (*Melanogaster* sp.). The bathymetric distribution of macrofauna at different depths was as under.

Depth in metres	2	4	6	8	10	16
Units/sq m	82	54	426	240	438	143
Weight in mg/sq m	1,112	452	2,107	1,392	2,570	430

Studies on periphyton on submerged stumps of the Tilaiya reservoir initiated in July, 1970 revealed the algal complex of filamentous green algae ;

viz., *Oedogonium* sp., *Hormidium* sp., *Chaetophora* sp. and *Cladophora glomerata*; filamentous blue-green algae; viz., *Anabaena* sp., *Phormidium* sp. and *Oscillatoria* sp.; and diatoms; viz., *Navicula* sp., *Pinnularia* sp., *Synedra* sp., *Fragillaria* sp. and *Pleurosigma* sp. The average number and volume of periphyton deposit were 286 u/sq cm and 0.26 ml/sq cm in the Urwan sector of the reservoir.

C. Larger aquatic plants and associated fauna and flora:

(Nothing to report)

3.1.3 Effect of impoundment on reproduction and survival of fishes

Personnel : A. V. Natarajan, S. Parameswaran, M. Ramakrishna and M. A. Khan

Operations of *Khadijal* (close meshed shore seine 4.0 m × 1.75 m size; 1.59—2.12 mm mesh) to study the juvenile and trash fish composition, showed that *A. nama* predominated the catches followed by *L. labuca*, *R. corsula*, and *E. danrica*. Other species included *O. bacaila*, *O. phulo*, *P. ticto*, *P. stigma*, *O. cotio*, *A. mola*, *G. giuris*, *B. barna*, *B. barila*, *A. ranga*, *N. notopterus*, *Channa* spp. *C. batrachus* and the minor carps *C. reba*, *L. bata*, *L. angra* and *L. boggut*. The pooled annual total catch per effort (number and weight per 10 hauls of a total duration of one hour) and catch per effort of the dominant species are given in table 5. No major carp fry or fingerling was encountered in the samples.

Table 5. Pooled annual average catch per unit of effort (by number and weight) of trash fishes in the Tilaiya reservoir.

	<i>A. nama</i>	<i>E. danrica</i>	<i>L. labuca</i>
	c/u	c/u	c/u
No.	203.41	6.78	31.07
Wt. (gm)	56.44	1.87	15.20

3.1.4 Biology of commercial fishes

Personnel : A. V. Natarajan, M. Ramakrishna and M. A. Khan

The annual fish yield from the Tilaiya reservoir was estimated as 12.2 t, which comprised *C. mrigala* (31.22%), *L. calbasu* (7.79%), *C. catla* (10.59%), *L. rohita* (4.38%), and other fishes (46.02%). Among others mention may be made of *L. bata* (1.69%), *L. boggut* (3.72%), *W. attu* (6.97%), *M. cavasius* (1.58%), *N. notopterus* (5.50%) and *P. sarana* (1.45%).

Size ranges and modal values (in brackets) of mrigal, calbasu, catla and rohu in the catch were 120-550 (270/490), 150-502 (352), 200-957 (362/662) and 140-570 (410) mm respectively. The annual mean size/weight of major carps in the catch were: *C. catla*, 618 mm/3,000 gm; *C. mrigala*, 502 mm/1,300 gm; *L. calbasu*, 366 mm/660 gm; and *L. rohita*, 411 mm/790 gm.

The coefficient of condition of *C. catla*, *C. mrigala* and *L. calbasu* was 1.03, 1.02 and 0.97 respectively.

During the period under report, 3,153 fingerlings (av. length 77 mm and av. wt. 4.5 gm) of mrigal were clipped and released in the Tilaiya reservoir. Recoveries of clipped catla in the Tilaiya reservoir are detailed in table 6.

Table 6.

Date of release	Size at release (mm/gm)	Date of recovery	Size at recovery (mm/gm)	Rate of growth (mm/gm/month)
24.9.68	100/12.5	3.1.70	295/400	13/25.8
24.9.68	100/12.5	7.1.70	350/680	16/43.0
24.9.68	100/12.5	9.1.70	329/600	14.7/37.9
24.9.68	100/12.5	9.1.70	305/400	13.2/25.0
25.10.68	117/21.2	22.2.70	365/610	15.5/36.8
24.9.68	100/12.5	22.3.70	337/475	13.2/25.7
25.10.68	117/21.2	28.3.70	357/550	14.2/31.5
25.10.68	117/21.2	7.12.70	362/655	9.8/25.4

### 3.1.5 Experimental fishing

Personnel : A. V. Natarajan, B. V. Govind, B. Roy and B. K. Banerjee

Meshwise catch for experimental fishing is given in table 7, which shows that 100 mm mesh bar exclusively caught catla, while 40, 45, 50 and 55 mm mesh bars were effective for calbasu and 40-60 mm mesh bar for mrigal.

Table 7. Meshwise average catch in the mid zone of the Tilaiya reservoir (Experimental gill net fishing).

Mash bar (mm)	Catch/unit of effort (gm/10 sq m net area/day)	Species composition (%) in catch per unit of effort					
		Catla	Rohu	Mrigal	Calbasu	Wallago	Others
30	84.8	10.97	—	4.71	18.28	—	66.04
35	125.1	7.51	4.00	4.95	19.34	—	64.20
40	87.8	—	4.10	17.65	36.67	19.36	22.34
45	54.1	—	16.63	17.00	40.66	—	25.71
50	43.8	—	9.58	25.11	52.05	0.71	12.55
55	67.7	—	4.43	13.58	55.68	20.97	5.34
60	30.1	5.31	4.65	67.77	14.61	4.65	3.01
65	13.0	—	—	—	—	—	100.00
80	—	—	—	—	—	—	—
100	78.4	100.00	—	—	—	—	—
150	—	—	—	—	—	—	—

In the mid zone, when experimental fishing was done the maximum catch/day (7.2 Kg/day) was noted in August. Details of catch and fishing day

are given in table 8. Over-all index of abundance for the fish catch from mid zone works out to be 3.883 Kg/day.

Table 8. Mid zone monthly catch (Kg) per fishing day (Experimental gill net fishing) in the Tilaiya reservoir.

Month	Total catch	Total fishing days	Catch/Day
July	76.169	22	3.462
August	129.915	18	7.217
September	40.650	9	4.517
October	11.788	9	1.310
November	19.720	11	1.793
December	63.420	19	3.338

Note: Fishing effort constant for the period studied.

The mesh size-fish length proportionality co-efficient in respect of *L. calbasu* and *C. mrigala* for the experimental gill nets were 0.130 and 0.106 respectively.

### 3.1.6 Population dynamics of commercial fishes (Nothing to report)

### 3.1.7 Fishery management and development in reservoir

Personnel : A. V. Natarajan

Gill nets with 40-60 mm mesh were found effective for *W. attu*. Further studies are in progress, for selective fishing of this fish which is well established in the Tilaiya reservoir. Uneconomic species appear vulnerable in the small mesh bar (30-45 mm) in gill net fishing.

Problem : 3.2 Fisheries of the Konar reservoir

Duration : Three years and 8 months

#### 3.2.1 Physico-chemical characteristics of water and soil, and primary productivity

Personnel : A. V. Natarajan and S. K. Sarkar

Details of observations on vertical series of sampling carried out for various physico-chemical characteristics of the Konar reservoir are presented in table 9.

Water temperature in summer showed a clear difference of 8.5°C in the range of 27.1-18.6°C between surface and bottom (24 m depth) in May. In winter (January) the difference was narrowed down to 0.6°C in the range 16.7-16.1°C. Dissolved oxygen showed variation at depths and was in the range of 4.2-8.2 ppm (pooled annual average). Total alkalinity for the Konar reservoir (annual mean : 48.05 ppm at surface and 39.0 ppm at 27 m depth) shows that the reservoir has a medium productive potential. Analyses of

Table 9. Pooled averages of various hydrological observations in the Konor reservoir.

Depth (m)	Transparency (cm)	Water temperature (°C)	pH	Dissolved oxygen (ppm)	Free CO <sub>2</sub> (ppm)	Total alkalinity (ppm)	PO <sub>4</sub> (ppm)	NO <sub>3</sub> (ppm)	SiO <sub>3</sub> (ppm)	Fe +++ (ppm)
0	14.95 (6.1-31.7)	24.13 (16.70-29.20)	7.60	8.20	4.75	48.05	0.039	0.805	7.65	0.028
3	—	23.57 (16.20-29.20)	7.50	7.85	4.70	43.10	—	—	—	—
6	—	23.08 (16.30-28.30)	7.55	7.75	3.85	45.25	0.036	0.845	7.15	0.030
9	—	22.23 (16.00-27.70)	7.35	7.20	5.65	39.25	—	—	—	—
12	—	21.75 (16.00-27.60)	7.65	7.30	5.00	39.55	0.028	0.899	8.31	0.032
15	—	21.15 (16.00-27.20)	7.25	7.05	6.40	37.75	—	—	—	—
18	—	20.58 (15.80-27.05)	7.58	7.05	3.90	38.30	0.037	0.905	6.75	0.031
21	—	20.68 (16.20-26.85)	7.47	6.90	5.25	37.80	—	—	—	—
24	—	21.57 (16.10-26.70)	7.57	6.05	3.75	42.90	0.042	1.015	8.50	0.029
27	—	—	6.90	4.20	14.00	39.00	—	—	—	—

Figures in the brackets show the range.

dissolved organic matter and total hardness, reveal mean values of 2.48 and 18.9 ppm respectively.

Mean gross primary productivity was 321.5 mg C/m<sup>3</sup>/day (12 hr) and monthwise evaluations mainly ranged from 156.2-712.5 mg C/m<sup>3</sup>/day (12 hr).

### 3.2.2 Food resources—A. plankton, B. bottom biota and C. larger aquatic plants and associated fauna and flora

Personnel : A. V. Natarajan and B. V. Govind

*A. Plankton* : The Myxophyceae (*Microcystis aeruginosa*) dominated the plankton while other phytoplankters were relatively meagre. The zooplankters were represented by copepods (larvae of *Diaptomus* sp. and *Cyclops* sp.).

Vertical distribution of plankton showed a gradual decrease from surface towards the depth, except at 27 m depth where Myxophyceae were more in number. The details of their distribution are as in table 10.

Table 10. Vertical distribution of plankton in the Konar reservoir (Annual averages)

Depth (m)	Units/m <sup>3</sup>	Volume in ml/m <sup>3</sup>
0	1,26,075	0.928
3	35,495	1.252
6	31,165	1.105
9	24,710	0.822
12	19,205	0.968
15	10,610	0.580
18	13,500	0.716
21	7,790	0.500
24	5,705	0.315
27	11,250	0.333

*Periphyton* : Studies on periphyton on submerged stumps in the reservoir, revealed the presence of algal complex comprising filamentous green algae; viz., *Mougeotia calcarea*, *Hormidium* sp., *Oedogonium* sp. and *Chactophora* sp. and blue-green algae; viz., *Phormidium* sp., *Anabaena* sp., *Lyngbya birgei* intermixed with Diatomaceae; viz., *Navicula* sp., *Pinnularia* sp., *Surinella* sp., *Synedra* sp., *Gyrosigma* sp., *Fragillaria* sp., *Pleurosigma* sp. and *Rhopalodia* sp. The studies showed that the volume of periphyton deposited on stumps was more in the deeper zones than in the shallow zones.

### 3.2.3 Effect of impoundment on reproduction and survival of fishes

Personnel : A. V. Natarajan, S. Parameswaran, M. Ramakrishna and M. A. Khan

Standard shooting nets of 1/16" (1.59 mm monofilament mesh, synthetic), 1/24" (1.06 mm monofilament mesh) and 1/12"-1/16" (1.59-2.12 mm cotton mesh) were operated to study their comparative efficiency. A total of 1,036 ml spawn (eggs) was obtained in 238 net-hours. The physico-chemical conditions of water, flood level and current velocity on spawn occurring and non-occurring days were studied. The spawn yield per net-hour for the different types of nets is given in table 11.

Table 11. Spawn yield with different types of shooting nets at the Konar reservoir

Months	Spawn yield per net-hour (ml)			Total spawn (ml)	Total net-hour when all three nets were operated
	S <sub>1</sub>	S <sub>2</sub>	C		
June	0.30	0.30	1.10	88.0	45
July	1.70	1.00	2.80	493.0	89
August	0.17	0.17	0.75	118.5	104
Season's total	0.76	0.52	1.58	699.5	238

Note : Catch per net-hour for different nets was calculated whenever three nets were operated simultaneously.

S<sub>1</sub> = Synthetic net (1.59 mm mesh).  
S<sub>2</sub> = Synthetic net (1.06 mm mesh).  
C = Cotton (2.12-1.59 mm mesh).

Samples of eggs were reared to identifiable size and it was observed that the bulk of the spawn comprised *C. reba* (91.45%) as in previous years. However, scanty spawning of *L. rohita* and *C. mrigala* was also observed being represented by 0.54 and 0.94% of the spawn (eggs) collected during the year.

Analysis of *Khadijal* (close meshed shore seine 4.0 m x 1.75 m size; 1.59-2.12 mm mesh) collections showed that among the juvenile and trash fishes, *A. nama* predominated throughout the year followed by *E. danrica* and *O. bacarla*. Other miscellaneous fishes in the collection included *O. phulo*, *P. ticto*, *P. stigma*, *P. sarana*, *O. cotio*, *A. mola*, *G. giuris*, *B. barna*, *A. ranga*, *Channa* spp. *M. armatus*, *N. notoapterus*, *O. bimaculatus* and *R. corsula*. The pooled annual total catch per effort (numbers and weight 10 hauls of 50 minutes duration) and that of the dominant species are given in table 12.

Table 12. Pooled annual average catch per effort (in number and weight) of trash fishes in the Konar reservoir

	<i>A. nama</i> c/u	<i>E. danrica</i> c/u	<i>O. bacaila</i> c/u
No.	158.94	9.80	5.97
Wt. (gm)	28.40	3.61	1.93

### 3.2.4 Biology of commercial fishes

Personnel : A. V. Natarajan and S. Parameswaran

The annual fish yield for the Konar reservoir was estimated as 1.7 t, comprising *C. mrigala* (14.16%), *L. calbasu* (14.23%), *C. catla* (62.48%), *L. rohita* (3.89%) and other fishes (5.24%). The size ranges and modal values (in brackets) of mrigal, calbasu, catla and rohu in the catch were : 370-570 (470), 285-457 (382), 300-987 (362/587) and 240-690 mm. The annual mean size/weight of major carps in the catch were : *C. catla*, 570 mm/2,800 gm ; *C. mrigala*, 457 mm/850 gm ; *L. calbasu*, 367 mm/660 gm and *L. rohita* 438 mm/950 gm.

The length-weight relationships derived for the major carps of the Konar reservoir are given below.

$$C. mrigala : \text{Log } W = -2.3889 + 2.012 \text{ Log } L$$

$$C. catla : \text{Log } W = -2.5718 + 2.167 \text{ Log } L$$

$$L. calbasu : \text{Log } W = -3.6187 + 2.485 \text{ Log } L$$

The mean coefficient of condition for *C. catla*, *C. mrigala* and *L. calbasu* was 0.97, 0.96 and 1.03 respectively.

During the year, 5,050 fingerlings of mrigal (av. size 94 mm and av. weight 9.5 gm) 543 fingerlings of scale carp and 21 fingerlings of mirror carp were clipped and released in the Konar reservoir.

### 3.2.5 Experimental Fishing

Personnel : A. V. Natarajan, B. V. Govind, S. L. Kar and B. K. Banerjee

Meshwise catch (gm/sq m net area) for experimental gill net fishing is given in table 13 which shows that 100 mm mesh bar is effective for catla (yielding a catch of 268 gm/10 sq m net area/day). Other major carps occur variously in mesh bars between 30 and 65 mm. The over-all fish density at various zones for the reservoir (excluding seasonal riverine stretch) indicates that riverward zone of the reservoir is most productive (6.01 Kg/day) followed by mid (5.16 Kg/day) and deep zones (3.38 Kg/day).

The 'mesh size-fish length' proportionality coefficients in respect of *L. calbasu*, *C. mrigala* and *C. catla* for the experimental gill nets were 0.139, 0.101 and 0.155 respectively.

Table 13. Meshwise average catch in the Konar reservoir  
(Experimental gill net fishing)

Mesh bar (mm)	Catch/unit of effort (gm/10 sq m net area/day)	Species composition (%) in catch per unit of effort				
		Catla	Rohu	Mrigal	Calbasu	Others
30	96.3	—	0.25	21.81	23.23	54.21
35	108.2	—	2.58	28.83	25.23	43.36
40	119.3	9.97	1.51	29.92	22.80	35.80
45	106.3	—	1.59	31.51	56.53	10.37
50	68.1	36.12	8.81	18.06	28.34	8.67
55	94.2	45.32	—	38.74	12.95	2.99
60	82.9	22.43	11.94	38.11	17.00	10.52
65	63.8	2.98	35.89	—	48.27	12.86
80	39.5	95.44	—	—	—	4.56
100	268.1	100.00	—	—	—	—
150	66.9	100.00	—	—	—	—

### 3.2.6 Population dynamics of commercial fishes (Nothing to report)

### 3.2.7 Fishery management and development in reservoir

Personnel : A. V. Natarajan

678 fingerlings av. size 65 mm and av. weight 3 gm of mrigal were stocked in the month of September, 1969. Selective stocking of catla in the Konar reservoir in 1968 appears to have improved the catla fishery from 491 Kg in 1969 to 1,082 Kg in 1970.

Problem : 3.3 Fisheries of the Loni reservoir  
Duration : Five years  
Personnel : H. P. C. Shetty, A. G. Jhingran, D. V. Pahwa, S. N. Mehrotra, K. P. Srivastava, S. Jena, M. Sinha, A. G. Godbole, S. D. Gupta, B. Singh, R. K. Saxena, V. R. Desai, Ravish Chandra, S. C. Pathak and S. K. Das

*Hydrology* : The transparency ranged between 38.7 (Sept.)-96.5 cm (May). The water temperature fluctuated between 18.36 (Jan.)-31.05°C (April). pH varied from 6.9-8.2, remaining steady at 6.9 during July to September and reaching its maximum (8.2) in December. Alkalinity was because of carbonate and bicarbonate ions, except during monsoon when only bicarbonate ions were present. Carbonate ions varied between 1.0-13.5 ppm, and the bicarbonate ions between 66-101.5 ppm. Maximum and minimum concentration of carbonate and bicarbonate were found in December and in June in case of former and in January and September in case of latter. Free carbondioxide observed during monsoon months, ranged between 0.25-5.17 ppm. The hardness of water varied between 76-101 ppm during January to June and later declining to 26

ppm by December. Of the nutrients, both nitrates and phosphates were moderately rich during May to November, their range of concentration being 0.200-0.453 and 0.130-0.263 ppm respectively and in rest of the months, their values were low. However, the nitrates were always in higher concentration than phosphates. Silicates varied between 7.7 and 24.75 ppm, with their concentration being maximum during monsoon months and minimum in December. Calcium ions (71.93-117.00 ppm) were found more during January to July; but from August they declined to a range of 43.73-64.93 ppm. DO ranged from 4.70-8.76 ppm, being maximum in December and minimum in May.

*Soil analysis*: Analysis of soil samples for the period from May to December, 1969, revealed the following characteristics: pH, 6.4-7.0; alkalinity, 0.312-0.620 m e %; chlorides, 8.2-13.6 m e %; calcium, 0.06-0.14 m e %; nitrate, 0.11-0.18 ppm; and phosphate, 0.10-0.15 ppm. Organic matter in the air dried samples varied from 2.0 to 4.0% during the period.

*Primary productivity*: The monthly values of primary productivity as a whole, showed two peaks, one in June (590.6 mg C/m<sup>3</sup>/6 hr) and the other in November (562.5 mg C/m<sup>3</sup>/6 hr). The minimum primary productivity was observed in August.

*Plankton*: Quantitatively average monthly plankton varied between 25-485 u/l during the year with two peaks in February and June, minimum plankton density being recorded in October. The phyto- and zooplankton ranged from 14-469 and 10-91 u/l respectively. *Pediastrum* spp., *Merismopedia* spp. and *Glenodinium* spp. dominated the phytoplankton, while the rotifers represented by *Brachionus* spp., *Polyarthra* spp., *Keratella* spp. and *Filinia* spp. dominated the zooplankton. Nauplii larvae were commonly encountered during the monsoon months. Observations on diurnal variations indicated that the maximum concentration of plankton was at 06.00 hours in surface waters and minimum at 24.00 hours. Of various zones, zone I was most productive.

*Bottom fauna*: The macrobenthic fauna mainly comprised molluscs, insect larvae and annelids. Freshwater sponges and crustaceans were also encountered occasionally.

The pattern of relative abundance of major groups of macrobenthic fauna of the reservoir showed marked differences during the three years 1968-70. While the insect larvae dominated (48.2%) in 1968, the annelids (41.9%) and molluscs (37.3%) respectively dominated during the years 1969 and 1970. The average monthly concentration of bottom fauna ranged from 87 u/m<sup>2</sup> in January, with higher concentration during the months January to July. Except during January, the quantity was invariably less than 1,000 u/m<sup>2</sup>, and as such, the reservoir has to be regarded as poorly productive.

Gastropods recorded were: *Viviparus bengalensis*, *Melanooides tuberculatus*, *Lymnaea* sp., *Gyraulus* sp. and *Indoplanorbis exutus*. Among the bivalves, *Farreysia faavidens*, *Pisidium clarkeanum* and *Indonaia caerulea* were observed

in abundance, while *Lamellidens corrianus* and *Parreysia corrugata* were recorded occasionally.

*Insect larvae* : The insect larvae encountered consisted of Diptera larvae, followed by Trichoptera (caddisworm), Plecoptera and Odonata. Hemipterans were observed in limited numbers (3 u/m<sup>2</sup>) only in February. The monthly average number of insects ranged from 31 u/m<sup>2</sup> in October to 716 u/m<sup>2</sup> in January. Annelids, represented by oligochaetes and leeches were encountered throughout the year, with their average monthly density ranging from 13-400 u/m<sup>2</sup> and were represented by two species; viz., *Aulodrilus plurisetus* and *Branchiura sowerbyi*.

*Macro-vegetation* : 14 species belonging to 10 different families, were collected in limited numbers. *Vallisneria spiralis*, *Hydrilla verticillata* and *Potamogeton pectinatus* were the most predominant. *Najas marina* was available in abundance when the water level was low, but with rise in water level this plant was found to decompose and float up. *Alternanthera sessilis*, *Triadax procumbens* and *Argemone mexicana* were prominent on the bank of the reservoir.

*Experimental fishing* : Gill nets with varying mesh sizes (4, 5.5, 6, 7.5, 9.5, 10 and 15 cm) with floats and sinkers and with floats only were operated over two days and two nights in every fortnight. The fishing experiments were intensified from July, by operating gill nets and hook and line for two days and two nights every week. The rigging of the new gill nets was completed and the particulars of these nets were as follows :

- (1) Gill nets having head rope, breast line and with floats only (mesh sizes 5, 6 and 13.5 cm);
- (2) Gill nets having head rope, foot rope and breast line and with floats only, (mesh sizes 4.5, 5 and 6 cm);
- (3) Gill nets having head rope, foot rope and breast line with floats and sinkers both, (mesh sizes 5, 6 and 6.5);
- (4) Gill nets having head rope, foot rope, breast line and frame lines with floats and sinkers both, (mesh sizes 5, 6 and 13.5 cm).

A total of 338.04 Kg of fish was landed during the year as against the preceding year's 204.35 Kg. The maximum catch (71.070 Kg) was recorded in August, when a single specimen of *C. calla* weighing 19.590 Kg was caught in a gill net (mesh size 15.5 cm) having floats and sinkers. The minimum catch of 6.315 Kg was recorded in the month of October. Gill nets without sinkers and having floats only were more effective and accounted for 280.047 Kg of the total catch, as against 57.463 Kg from nets having both floats and sinkers. Night catches were invariably better than the day catches. A total of 270.741 Kg of fish, was landed in night (18.00-06.00 hours) operations of nets, against 66.769 Kg during day time (06.00-18.00 hours) operations. In zonewise distribution of catch, zone I recorded the maximum catch of 150.265 Kg, followed by zone III (87.578 Kg), zone II (82.487 Kg) and zone IV (17.180). (Table 14).

Table 14. Showing zonewise catch in Kg from gill nets with two types of nets used in the Loni Reservoir (a=with floats and sinkers, b=with floats only)

Month	Zone I		Zone II		Zone III		Zone IV		Total
	a	b	a	b	a	b	a	b	
Jan	—	5.662	—	2.311	2.825	—	—	—	10.798
Feb	—	14.678	5.862	—	—	10.668	—	—	31.208
Mar	—	4.555	—	12.090	—	13.160	3.330	—	33.135
Apr	—	25.409	—	—	—	15.513	—	—	40.922
May	—	7.578	—	4.361	2.512	0.775	3.115	—	18.341
Jun	2.330	11.050	—	12.519	—	1.492	—	—	27.391
Jul	—	10.135	—	18.960	2.490	—	—	—	31.585
Aug	—	28.517	19.590	2.120	—	14.493	6.350	—	71.070
Sep	—	11.477	—	—	—	2.527	0.825	—	14.829
Oct	—	3.295	—	—	—	3.020	—	—	6.315
Nov	—	6.590	—	—	—	2.686	2.170	—	11.446
Dec	—	18.989	4.674	—	—	15.417	1.390	—	40.470
Total	2.330	147.935	30.126	52.361	7.827	79.751	17.180	—	337.510

During the year, *M. seenghala* (112.867 Kg & 33.5%), *C. mrigala* (83.428 Kg & 24.7%), *L. bata* (52.810 Kg & 15.6%), *C. catla* (24.293 Kg & 7.2%), *P. sarana* (23.193 Kg & 6.9%), *L. calbasu* (20.523 Kg & 6.0%), *L. rohita* (6.797 Kg & 2.1%), *N. notopterus* (3.677 Kg & 1.1%), *E. vacha* (3.460 Kg & 1.0%), *W. attu* (2.537 Kg & 0.7%), *Barilus* sp. (2.293 Kg & 0.6%), *C. reba* (0.970 Kg & 0.3%), *C. garua* (0.472 Kg & 0.2%) and *O. pabda* (0.190 Kg & 0.1%) were caught by gill nets.

The appearance of *C. catla* in the fishery of the Loni reservoir was an outstanding feature of this year's fishery. New nets of 6 cm mesh size, which were put into operation during December, recorded for the first time 5 specimens of *C. catla* (370-483 mm).

Hook and line and cast nets were operated from time to time and a total of 0.53 Kg recorded by hook and line, comprised *O. pabada*, *O. bimaculatus* and *P. sarana*.

*Biology of commercially important fishes*—(a) *Cirrhina mrigala*: Forty two specimens (365-665 mm) were examined for gut content analysis. The fish was found to feed on decayed organic matter and phytoplankton, besides frequent occurrence of sand and mud in the gut. Feeding intensity was poor throughout the year. Phytoplankters that could be identified in the gut content were: *Microcystis* sp., *Pediastrum* sp., *Cosmarium* sp., *Clostridium* sp., *Diatoma* sp., *Gyrosigma* sp., *Amphora* sp., *Synedra* sp. and *Navicula* sp. while *Monostyla* sp. and *Notholca* sp. among Zooplankters were rarely found.

The sex ratio was 1.0 ♂ : 2.2 ♀. The gastro-somatic index varied between 0.88 (July) and 5.191 (December).

Ovaries of 12 specimens were examined for maturity studies. The size range of ova diameters and their modal values are given below :

Stage	Specimens examined (No.)	Average size range of ova (mm)	Average modal value (mm)
I	1	0.0048-0.0176	0.0064
II	2	0.0032-0.0272	0.0112
II	2	0.0048-0.0288	0.0160
II	5	0.0048-0.0304	0.0192
IV	2	0.0096-1.2400	1.0480

(b) *Labeo calbasu* : 27 specimens (229-505 mm) were examined. The sex-ratio of the specimens was found to be 1.0 ♂ : 2.9 ♀ .

Gut contents analysis indicated that the fish mainly subsisted on decayed organic matter, phytoplankton, mud and debris. Negligible quantities of vegetable detritus and algal filaments were also encountered. The analysis done by volumetric and occurrence methods and synthesized into index of preponderance are given for each item in table 15.

(c) *Labeo bata* : 119 specimens, (198-396 mm) were examined. The sex ratio was found to be 1:1. The species was found to subsist mainly on decayed organic matter, followed by phytoplankton. Mud, debris, vegetable detritus, algal filaments, rotifers and fish eggs were also encountered in the gut. The volumetric and occurrence percentages of various food groups and the resultant index of preponderance of each are given in table 15. The fish appears to be a bottom feeder.

Table 15. Gut contents analysis and index of preponderance of *L. calbasu* and *L. bata*.

Food item	Vol. %	Occurrence %	Index of preponderance
<i>L. calbasu</i> :			
Decayed organic matter	74.6	48.0	90.300
Phytoplankton	8.4	28.0	5.300
Mud & debris	7.7	16.0	3.200
Vegetable detritus	6.2	4.0	0.800
Algal filaments	3.1	4.0	0.400
<i>L. bata</i> :			
Decayed organic matter	71.9	42.9	84.300
Phytoplankton	15.5	28.1	11.200
Mud & debris	6.9	19.3	3.700
Algal filaments	2.0	4.4	0.300
Miscellaneous	0.1	0.9	0.002

(d) *Puntius sarana* : Guts contents of 81 specimens (76-306 mm) were analysed. 18.2, 1.3, 36.4, 27.3, 10.4, 2.5 and 3.9% fish were observed to be in

empty, traces,  $\frac{1}{4}$  full,  $\frac{1}{2}$  full,  $\frac{3}{4}$  full, full and gorged condition of feed respectively. The feeding intensity was minimum in May. Of the total feed, 44.6% was identifiable and the rest was in advanced stage of digestion. Plant parts dominated the total average feed (24.2%), followed by molluscan shells (11.3%). Plankton formed only 6.1% of the average feed, being mainly constituted of phytoplankton. The year's catch was dominated by females with the sex-ratio 1.0 ♂ : 6.0 ♀.

The gonadosomatic index showed a rising trend from January, with the maximum in June (0.09393), while in July and August it was 0.08637 and 0.8406 respectively. There was a sudden fall in September (0.00432), suggesting that the breeding period of this fish was from June to August.

(e) *Mystus seenghala* : 47 specimens (416-1,023 mm) were examined. Four stomachs out of 47 were found to be empty. The fish was found to subsist on teleosts, prawns and frogs. The species of fish and prawns encountered in the stomachs of the fish were : *G. chapra*, *Chela* sp., *P. sarana*, *Mastocembelus* sp., *Barbus* sp., *C. reba*, *R. cotio* among fish and the prawn, *P. lamarrei*.

Gastrosomatic indices for different months were calculated, except for the month of August when it was 0.08, for all the other month it being 0.10.

The sex ratio of the individuals examined was found to be 1.0 ♂ : 2.3 ♀. Ova diameter measurements of 20 ovaries were done. The diameters ranged between 0.1552 and 0.5932 mm and the ovaries were in I, II and III stage of maturity.

(f) *Notopterus notopterus* : 19 specimens of this species (252-297 mm) were examined during the period under report.

Gut content analysis revealed that it subsisted mainly on a carnivorous diet, the constituents being fish matter (40.5%), insect matter (51.0%), plankton (3.5%), sand particles (2.6%), plant matter (2.0%) and molluscan shell (0.4%).

*Larval survey* : Most of the collections, made with the help of a organdie tow net, were not found to have any fish larvae. Only during the month of July, a few *C. mrigala* fry were caught in zone II and III. During other months, only a few minor carp fry were found.

The collections mainly consisted of *G. chapra*, *Chela* sp., *G. giuris* and other minor carps.

Problem : 3.4 Fisheries of the Govindgarh reservoir  
Duration : Five years  
Personnel : S. J. Karamchandani, D. N. Mishra, Shri Prakash,  
H. C. Joshi and M. D. Pisolkar

*Hidrology* : The surface water temperature ranged between 20.07 (January) and 32.08°C (May). The transparency was highest in February (100.56 cm) and decreased regularly up to July (67.55 cm) and thereafter increased up to October (99.75 cm) to again decline in December (85.31 cm). pH fluctuated between

8.0 and 8.25 from January to December. Total alkalinity showed an upward trend from March (32.400 ppm) to July (50.780 ppm) and a downward trend from August (47.540 ppm) to October (29.726 ppm) and again an upward trend from November (35.125 ppm) to December (37.431 ppm). Hardness of water fluctuated between 20.250 (October)—31.812 ppm (June) with abrupt rise and decline during the other months. Dissolved oxygen varied between 6.490 (January)—9.668 ppm (December). Intermediate values of DO : 8.75, 8.27, 9.33 and 7.05 ppm were recorded in January, March, April and October respectively. Free carbon dioxide ranged between 1.475 (August)—3.180 ppm (April), fluctuating abruptly during other months. Phosphates, nitrates and silicates did not show any regular trend in their fluctuations and ranged between, 0.0025 (December)—0.0580 ppm (July), traces (January, February, November and December)—0.03275 ppm (August) and 3.300 (October)—8.025 ppm (January) respectively.

*Soil analysis* : 12 soil samples up to October, 1969, when analysed, revealed the following ranges of various characters : pH, 6.0-7.2 and organic carbon content, 1.84-4.32%, thereby showing a high percentage of carbonaceous matter in the soil.

*Primary productivity* : Gross organic production varied from 208.550 (January)—718.750 mg C/m<sup>3</sup>/6 hr (July) and net organic production varied from 135.470 (January)—339.375 mg C/m<sup>3</sup>/6 hr (July).

*Plankton* : The total plankton content (by number), which was rich in January (1,886.6 u/l) and February (1,907.5 u/l), showed a downward trend up to May (161.0 u/l). From June to October the values fluctuated between 111.9 (July)—193.9 u/l (September). Thereafter, it increased in November (1,058.9 u/l) and December (1,599.7 u/l). The plankton content was comparatively high in zone I (28.0%) and zone II (29.5%) and low in zone III (22.2%) and zone IV (20.3%). The plankton density was high at 06.00, 18.00 and 24.00 hours (25.3-27.8%) and low at 12.00 hours (20.0%).

Phytoplankton (93.18%) dominated over zooplankton (6.82%). The phytoplankton count varied from 92.9 (July)—1,835.1 u/l (January) and the zooplankton from 19.0 (July)—98.1 u/l (February). The phytoplankters comprised dinoflagellates (66.2%), diatoms (9.61%), blue-green algae (9.28%) and green algae (8.09%). *Ceratium* sp. and *Peridinium* sp. among dinoflagellates; *Melosira* sp. among diatoms; *Microcystis* sp. among blue-green algae and *Pediastrum* sp. and *Ophiocytium* sp. among green algae were most dominant forms. The zooplankton was made up of crustaceans (3.28%), rotifers (2.2%) and protozoans (1.34%). Nauplii, *Cyclops* sp. and *Ceriodaphnia* sp. among crustaceans; *Brachionus* sp. and *Keratella* sp. among rotifers; and *Diffugia* sp. among protozoans were most dominant forms.

*Bottom fauna* : The number of bottom organisms ranged from 387 (November)—1,610 u/m<sup>2</sup> (December), while the weight ranged from 1,113 (November)—5,108 mg/m<sup>2</sup> (January). The dominance of bottom organisms by number and weight in 3 zones was in the order of zone IV (36.3 and 37.7%),

zone II (33.6 and 35.2%) and zone III (30.1 and 27.1%). The bottom biota by number and weight comprised chironomid larvae (59.6 and 46.2%), nematodes (17.8 and 46.2%) and insect larvae and pupae (22.6 and 13.0%).

*Experimental fishing*: During the year under report, experimental fishing with gill nets of various mesh sizes and with floats and sinkers or with floats only, was conducted in 3 zones of the Govindgarh reservoir for 48 days when a total quantity of 86.66 Kg of fish was landed. The percentage composition (by weight) of the catches was *Tor tor* (28.45%), *Labeo rohita* (20.99%), *Cirrhina mrigala* (17.71%), *Catla catla* (15.0%), *Wallago attu* (12.25%) and miscellaneous fishes (5.6%).

*Biology of commercially important fishes*—(a) *Labeo rohita*: 11 specimens (340-570 mm) were examined from the Govindgarh reservoir. The presence of sand and mud in moderate quantities (20.2%) has indicated that this fish feeds at the bottom of the reservoir subsisting mostly on decayed organic matter (28.6%) and phytoplankton (51.18%). The latter mainly comprised dinoflagellates (27.78%) represented mainly by *Ceratium* sp.; diatoms (14.78%) represented by *Melosira* sp. and *Eunotia* sp.; and green algae (7.93%) represented by *Ophiocytium* sp. Among zooplankton, copepods were rarely encountered.

One specimen of rohu, measuring 63 mm in total length at the time of tagging on 13.2.70, was recovered from the reservoir on 5.9.70, having a total length of 190 mm. This recovery has indicated that the growth rate of rohu in the Govindgarh reservoir is 127 mm (about 5 inches) in about 7 months during the first year.

(b) *Cirrhina mrigala*: 19 specimens (342-450 mm) were examined. The guts had large quantities of sand and mud (62.63%), indicating bottom feeding habit. The fish was found to subsist on decayed organic matter (31.66%) and phytoplankton (5.71%) which mainly comprised diatoms (4.4%) represented mostly by *Melosira* sp.; green algae (0.75%) represented mostly by *ophiocytium* sp.; dinoflagellates (0.5%) represented mostly by *Ceratium* sp., and blue-green algae (0.06%) represented by *Merismopedia* sp.

(c) *Ompok bimaculatus*: 64 specimens (135-297 mm), collected from June, 1969 to September, 1970, were examined. 75% stomachs were empty. The stomach contents of this fish consisted of fish matter (51.0%), insects and their larvae (25.7%) and digested matter (23.3%). For maturity study, ova diameters from 42 ovaries were measured and the maximum size range of ova was 1.06-1.08 mm in July in 1969 and 1970. The gonadosomatic index in these months was 9.29 and 17.3 respectively.

*Biology of uneconomic species*—(a) *Labeo boggut*: 90 specimens (88-175 mm) were examined. Large quantities of sand and mud (58.75%) in the gut, showed that the fish fed at the bottom. The fish was found to subsist on decayed organic matter (39.0%), diatoms (1.41%), green algae (0.76%) and blue-green algae (0.08%).

(b) *Puntius sarana*: 67 specimens (83-175 mm) were examined during the period under report. Bottom feeding habits were indicated by the presence

of sand and mud (51.0%) in its guts. The fish appeared to have subsisted on decayed organic matter (45.2%), plant matter (3.0%) and phytoplankton (0.8%).

(c) *Puntius sophore* : 121 specimens (55-79 mm) were examined. 51.25% of the gut contents were made up of sand and mud, indicating bottom feeding habit. The main items of food were decayed organic matter (40.25%) and crustaceans (5.0%). Other plankters in the diet were blue-green algae (1.64%), green algae (1.08%) and diatoms (0.78%).

(d) *Puntius ticto* : The gut content analysis of 7 specimens (51-61 mm) has shown that the fish feeds at bottom (sand and mud : 60.0%) and it subsisted on decayed organic matter (36.0%), blue-green algae (3.48%), green algae (0.42%) and diatoms (0.1%).

(e) *Amblypharyngodon mola* : Analysis of guts of 19 specimens (75-85 mm) has shown the presence of large quantities of sand and mud (60.0%), indicating bottom feeding habit. The food was made up of decayed organic matter (32.0%), green algae (4.42%), diatoms (2.48%) and blue-green algae (1.1%).

(f) *Garra gotyla* : The gut contents of 7 specimens (78-97 mm) comprised sand and mud (50.0%), decayed organic matter (47.5%), green algae (1.38%), diatoms (0.92%) and blue-green algae (0.2%). This fish also appears to be feeding at the bottom.

Problem : 3.5 Fisheries of the Kulgarhi Reservoir

Duration : Five years

Personnel : G. K. Bhatnagar, S. J. Karamchandani, D. N. Mishra,  
J. B. Rao, H. C. Joshi, R. K. Dwivedi and S. N. Mehrotra

*Hydrology* : The surface water temperature ranged between 16.81 (December)—29.16°C (June). Transparency of water declined from its maximum 116,900 (January) to 18,370 cm (September). During October to December, it fluctuated between 30,375-54,000 cm. pH was 8.0 throughout the year, except during October to December and February when it fluctuated between 8.1-8.2. During January to August, the total alkalinity ranged between 61.72-108.16 ppm while, during September to December, it varied between 72.0-74.9 ppm. Hardness of water was maximum (60.75 ppm) in June and minimum (43.69 ppm) in November. The dissolved oxygen varied between 8.03-11.46 ppm during January to April, 7.21-7.94 ppm during May to August and 6.81-10.27 ppm during September to December. Free carbon dioxide fluctuated between 2.144-4.800 ppm from January to December. Phosphates, nitrates and silicates ranged from trace—0.0825 ppm, trace—0.047 ppm and 4.30-13.84 ppm respectively.

*Soil analysis* : Soil samples analysed showed that the pH varied from 6.0 to 7.4 and the organic carbon content varied 0.78 to 3.75 mg/100 gm soil. Zone I and II were found to be richer in carbon content as compared to Zone III and IV.

*Primary productivity* : The total gross organic production varied from 248.875 (January) to 671.250 mg C/m<sup>3</sup>/6 hr (December) and net organic production varied from 93.750 (November) to 294.375 mg C/m<sup>3</sup>/ 6 hr (March).

*Plankton* : Samples of plankton collected from the 4 zones of the reservoir at 06.00, 12.00, 18.00 and 24.00 hours were analysed. The total plankton content (by number) increased from January (700.1 u/l) to March (860.2 u/l) and gradually declined through October (39.2 u/l) and again increased in December (75.5 u/l). The plankton content was minimum at 24.00 hours (19.34%) and maximum at 06.00 hours (30.72%). Phytoplankton (78.25%) dominated over zooplankton (21.75%). The former varied from 4.1 (October) to 801.5 u/l (February) and the latter from 34.3 (January) to 182.5 u/l (June). The phytoplankton comprised dinoflagellates (62.35%), blue-green algae (12.63%), diatoms (2.35%) and green algae (0.92%). *Peridinium* sp. among dinoflagellates and *Microcystis* sp. and *Phormidium* sp. among blue-green algae were the dominant forms. Zooplankton was made up of protozoans (9.15%), rotifers (7.4%), copepods (3.57%) and cladocerans (1.63%). *Arcella* sp. among protozoans and *Keratella* sp. and *Brachionus* sp. among rotifers were the dominant forms.

*Bottom fauna* : The average concentration of organisms in all the four zones was found to be highest in November (255 u/m<sup>2</sup>) and the lowest in April (29 u/m<sup>2</sup>). The bottom biota comprised chironomid larvae (60.4%), insect larvae and pupae (33.0%) and nematodes (6.6%).

*Experimental fishing* : Experimental fishing with gill nets of various mesh sizes and with floats and sinkers or with floats only, was conducted in 4 zones of the Kulgarhi reservoir for 35 days when a total of 174.545 Kg of fish was landed. The percentage composition (by weight) of the catches was *Catla catla* (76.0%), *Labeo rohita* (12.0%), *Cirrhina mrigala* (3.0%) and miscellaneous fishes (9.0%).

*Biology of commercially important fishes*—(a) *Labeo rohita* : 53 specimens (168-408 mm) were examined. Large quantities of sand and mud (56.88%) were present in the guts. The important food components encountered in the guts were decayed organic matter (28.32%) and phytoplankton (14.21%). The phytoplankton mainly comprised dinoflagellates (7.91%) represented by *Peridinium* sp.; diatoms (4.91%) represented by *Melosira* sp., *Navicula* sp. and *Cyclotella* sp. and green algae (1.0%) represented by *Gleocystis* sp. Zooplankters (protozoans and rotifers) were only occasionally encountered in the guts. The feeding intensity was high (GSI=47.3) in June and comparatively low (GSI=23.7) in November.

(b) *Catla catla* : 19 specimens (437-885 mm) were examined. Most of the food was in digested condition (57.62%). The fish appeared to have subsisted on decayed organic matter (13.27%), phytoplankton (10.26%) and zooplankton (1.73%). The phytoplankton comprised blue-green algae (8.64%), represented by *Microcystis* sp.; and diatoms (1.25%), represented by *Melosira* sp., *Cyclotella* sp. and *Nitzschia* sp. Other phytoplankters were dinoflagellates (0.2%) and

green algae (0.17%). The zooplankton food was made up of copepods (0.93%), rotifers (0.64%), cladocerans (0.1%) and protozoans (0.06%).

Fecundity of one mature specimen (885 mm) was found to be 32,00,000 ova.

(c) *Cirrhitina mrigala*: The gut content analysis of 6 specimens (377-477 mm) showed large quantities of sand and mud (76.25%), indicating bottom feeding habit. The fish appeared to have subsisted on decayed organic matter (20.25%) and plankton (3.5%). The dominating plankters were *Melosira* sp. and *Nitzschia* sp. among diatoms; *Gleocystis* sp. among green algae; *Microcystis* sp. among blue-green algae and *Eudorina* sp. among protozoans. The fecundity of one mature female (477 mm) was found to be 3,25,000.

(d) *Ompok bimaculatus*: 128 specimens (173-380 mm) were examined. 115 stomachs (89.8%) were empty. The stomach contents comprised fish matter (38.7%), insects (38.7%), prawns (20.0%) and unidentified digested matter (2.6%). The gastro-somatic index, indicating maturity and breeding, was highest in May (3.12). The measurement of ova diameters from 46 ovaries showed progressive increase from 0.17 (January) to 0.83 mm (May). These observations indicate that the fish breeds from May to July.

*Biology of uneconomic species*—(a) *Puntius sophore*: 406 specimens (44-106 mm) were examined. Presence of large quantities of sand and mud (66.3%) in the guts indicated bottom feeding habit. The fish appeared to have subsisted on decayed organic matter (29.4%), diatoms (1.09%), blue-green algae (0.3%) and green algae (2.91%).

(b) *Amblypharyngodon mola*: 83 specimens (38-58 mm) were examined. The gut content comprised sand and mud (30.0%), decayed organic matter (69.0%), diatoms (0.9%) and green algae (0.1%).

(c) *Puntius sarana*: 40 specimens (76-146 mm) were examined. The gut contents were found to comprise sand and mud (50.0%), decayed organic matter (44.3%), diatoms (1.22%), green algae (0.1%), blue-green algae (0.4%), plant matter (1.85%) and insect (2.13%).

(d) *Puntius ticto*: Analysis of 88 guts (41-68 mm) indicated that the fish is a bottom feeder. The gut contents consisted of sand and mud (57.0%), decayed organic matter (40.6%) and phytoplankton (2.4%). The latter comprised diatoms (1.03%), green algae (0.86%) and blue-green algae (0.51%).

(e) *Labeo boggut*: 21 specimens (63-155 mm) were examined during the year. Large quantities of sand and mud (77.0%) in the guts indicated its bottom feeding habit. The fish subsisted on decayed organic matter (22.6%), diatoms (0.2%), green algae (0.07%) and blue-green algae (0.13%).

(f) *Labeo boga*: Examination of 7 guts (120-150 mm) has indicated that its feeding habits are comparable to those of *L. boggut*. The gut contents consisted of sand and mud (77.5%), decayed organic matter (21.5%) and diatoms (1.0%).

(g) *Garra mullya*: Analysis of 20 specimens (88-135 mm) has indicated the presence of sand and mud (58.0%), decayed organic matter (23.2%), plant

matter (3.0%), fish matter (14.0%), and phytoplankton (1.8%). The plankters were mainly green algae (1.21%) and diatoms (0.59%).

(h) *Mystus vittatus* : 25 specimens (45-148 mm) were examined. The fish appeared to have subsisted on decayed organic matter (43.0%), plant matter (10.5%), insects (10.0%), nematodes (2.5%), fish matter (2.5%), rotifers (0.14%) and green algae (0.11%). Sand and mud to the extent of 31.25% were also encountered in the stomachs.

*Tagging experiments*: 120 fingerlings of *Cirrhina mrigala* (152-237 mm) were tagged and released in the Kulgarhi reservoir in November, 1970.

*Recovery of silver carp*: During the course of experimental fishing, 2 specimens of silver carp measuring 575 and 755 mm in total length and weighing 2 and 5 Kg respectively were caught on December, 3, 1969 and September 5, 1970 indicating that this fish is thriving well in the reservoir. 229 silver carp fingerlings (121-216 mm) were stocked in the Kulgarhi reservoir on February 2, 1969.

Problem : 3.6 Fisheries of peninsular tanks: Assessment of biological productive potentialities  
Duration : Three years  
Personnel : A. David, N. G. S. Rao, S. L. Raghavan and M. F. Rahman

*Primary productivity*: Primary productivity was assessed once in two months by light and dark bottle technique in the selected ponds and tanks except in Bellandur where monthly observations were made. Photosynthetically fixed carbon values indicating primary productivity ranged as follows:

Hutchammankere tank	125.0- 512.4 mg C/m <sup>3</sup> /day
Sakalawara tank	250.0- 324.9 mg C/m <sup>3</sup> /day
Karpur tank	200.0- 448.2 mg C/m <sup>3</sup> /day
Bellandur tank	654.2-2,260.0 mg C/m <sup>3</sup> /day
Kadagrahara pond	150.0-1,199.0 mg C/m <sup>3</sup> /day
Sidehoskote pond	332.2-1,375.0 mg C/m <sup>3</sup> /day

In the Bellandur tank, *Eichhornia* infestation and consequent reduction in light penetration leading to low carbon productive values were noticed during April and May. With the decrease in the weed concentration from September onwards, however, the tank registered a gradual increase in the primary production values. Low values of carbon content noticed in the Hutchammankere tank during January-February were due to the persistent turbidity.

*Biomass production*—(a) *Epiphytic organism*: Epiphytic organisms on weeds were represented mainly by Desmids, Chlorophyceae and Rhizopod protozoans.

(b) *Settled particulate organic matter*: Extent of settled particulate organic matter assessed by slide immersion experiments indicated carbon production of 3.0-23.0 mg on 30 sq cm slide area (36.08-511.10 mg C/sq m/day) in the Hutchammanakare tank and 3.2-23.0 mg on 30 sq cm area (37.04-511.10 mg C/sq m/day) in the Kadagrahara pond.

*Plankton*: Plankton density ranged as 4-57,360 u/l in tanks (0.02-204 ml/m<sup>3</sup> by volume) and 4-15,720 u/l in ponds (0.02-104 ml/m<sup>3</sup> by volume). The plankters encountered in ponds and tanks were: Phytoplankton—*Microcystis* sp., *Spirulina* sp., *Desmidium* sp., *Ulothrix* sp., *Scenedesmus* sp., *Oscillatoria* sp. etc. and zooplankton—*Cyclops* sp., *Diatomus* sp., *Brachionus* sp., *Keratella* sp., *Ceriodaphnia* sp., *Diaphanosoma* sp. and nauplius larvae. There was a general tendency for the dominance of phytoplankters in tanks and zooplankters in ponds, except in the Sidehoskote pond where there was a sudden *Microcystis* bloom during August.

*Littoral and benthic organisms*: The organisms encountered in the littoral and benthic zones in ponds and tanks were: chironomid larvae, gastropods (*Ammicola* sp., *Gyraulus* sp., *Limnaea* sp., *Melanoides* sp. and *Viviparus* sp.), insects (*Nepa* sp., *Corixa* sp., *Ranatra* sp., *Notonecta* sp. and May-fly nymphs) and prawns (*Macrobrachium idae*, *M. scabriculum* and *Caridina* sp.) Density of organisms found in the range of 1-613 u/m<sup>2</sup> in tanks and 1-183 u/m<sup>2</sup> in ponds.

*Physico-chemical conditions of the water and soil*: The physico-chemical conditions of water and soil in the ponds and tanks during the period were as in table 16.

Table 16

Factors	In Tanks	In Ponds
<b>A. WATER PHASE:</b>		
<i>Physical factors</i>		
Temperature (°C)	22.5—30.5	20.0—31.0
Turbidity (ppm)	100—480	100—500
<i>Chemical factors</i>		
pH	6.8—8.9	6.8—8.8
Dissolved oxygen (ppm)	4.80—20.00	1.84—16.20
Alkalinity (ppm)	52.0—800.0	136.0—680.0
Hardness (ppm)	28.0—164.0	40.0—160.0
Specific conductivity ( $\times 10^{-6}$ mhos)	88.0—922.0	140.0—884.0
<i>Nutrient factors</i>		
Nitrate (ppm)	0.200—0.726	0.200—0.400
Silicate (ppm)	15.0—32.0	10.0—22.5
Phosphate (ppm)	Trace—0.76	Trace—0.03
Iron (ppm)	0.08—2.00	0.06—1.20
<b>B. SOIL PHASE:</b>		
<i>Chemical factors</i>		
pH	6.5—8.5	7.0—8.5
Calcium (ppm)	400—1,200	200—1,200
Magnesium (ppm)	8—25	8—25
Phosphorous (ppm)	Trace—5	Trace—5
Ammonia (ppm)	3—25	3—25

Higher turbidities in the Anekalchickere and Hutchammankere tanks and in the Chembenahalli pond were due to silt suspension whereas in the Bellandur tank and Sidehoskote pond, it was due to *Microcystis* blooms. Higher values of alkalinity, pH and dissolved oxygen were noticed in the Bellandur tank and Sidehoskote pond when *Microcystis* concentration was more. Direct relationship between turbidity, silicate and iron was noticed. The Hutchammankere tank soil recorded a low pH of 6.5, while others exhibited alkaline nature. Phosphorous was in traces to low quantities in all tanks and ponds.

*Biological investigations* : A natural nursery for fry and fingerlings of *Puntius pulchellus* was discovered in the Kumudwathi river. Spawn prospecting investigations were undertaken. Fingerlings (90-150 mm) were collected in quantity in nature and experiments were set up to determine the efficacy of weed consuming capacity of the fish with the experimental feeds ; like, terrestrial grass—*Agrastis* spp., *Vallisneria* sp. and *Hydrilla* sp. The gut contents of adult fishes examined showed preponderance of grassy cellulose matter. 225 fingerlings of smaller size range were stocked in Bhadra Fish Farm for follow-up studies. Occurrence of oozing females, fry and early fingerlings (17-60 mm) collected in November or even later. Availability of oozing females in the Anjanapur reservoir even in November, indicates that the species may spawn in stagnant ponds (when cultured) naturally or by stripping.

500 and 100 juveniles of fresh water prawn, *Macrobrachium malcolmsonii*, transported from the Godavari river at Rajahmundry have been stocked in the nurseries of Vanivilas Sagar Fish Farm and in Hessarghatta Fish Farm respectively.

Problem : 3.7 Fisheries of peninsular tanks: Conservation of fishery in the sewage fed Bellandur tank  
(Research Completed)

*Project 4: Riverine carp spawn prospecting and collection technique*

Problem : 4.1 Location of new spawn collection centres and assessment of their potentiality

Duration : One year

Personnel : H. P. C. Shetty, Ravish Chandra, A. G. Jhingren, K. V. Rao, A. C. Godbole, S. C. Pathak, and S. K. Das

*Premonsoon survey*: To conduct spawn prospecting investigation during 1970 in the States of Assam, Bihar and West Bengal, comprehensive surveys of selected stretches of three rivers ; viz., the Brahmaputra, the Ganga and the Kangsabati, were conducted.

*River Brahmaputra*: A 385 km stretch from Gauhati to Dhubri, in the districts of Kamrup and Goalpara was surveyed. Eight sites, one each at Chandrapur, Dompara, Khanamukh, Palasbari and Nagarbera along the south

bank and at Amingaon, Bamundi and Kurua along the north bank in the district of Kamrup were examined for their suitability in respect of accessibility during the rainy season, operational areas available, slope gradient of the river bank in relation to anticipated current pattern during floods, etc. and none of these sites were found suitable for round the clock observations. In the district of Goalpara, 4 sites, one each at Dolgoma and Hamidabad along the south bank and at Tatipara and Bhashanichar along the north bank were surveyed. The site at Hamidabad was found suitable and selected for round the clock investigations.

**River Ganga:** A 150 km stretch of the Ganga from Patna to Buxar was surveyed and the site at Ahirauli along the south bank of the Ganga in the district of Shahabad was selected for spawn prospecting investigations.

**River Kangsabati:** A 25 km stretch of the river upstream of the reservoir from Bud Bud Ghat in Purulia district to the head water region at Lapan on the West bank and Kenda and Bhedua on the east bank were surveyed. Two sites one each at Bud Bud Ghat and Chadra Pairachali Ghat were found suitable and selected for spawn prospecting investigations. The only other accessible point at Purulia was not covered, because it was reported that fishes from the reservoir do not ascend up to that point.

*Spawn prospecting investigations:* On the basis of the Pre-monsoon surveys, 3 centres; viz., Hamidabad on the river Brahmaputra in Assam, Pairachali on the river Kangsabati in West Bengal and Ahirauli on the river Ganga in Bihar were selected for detailed spawn prospecting investigations. At all these sites, observations were made as in previous years. Besides, nets of different dimensions were also operated simultaneously, to assess their efficiencies.

**Hamidabad:** Spawn prospecting investigations on the river Brahmaputra in the Goalpara district of Assam, were initiated at Hamidabad in May, 1970. A total of 12,785.5 ml of spawn, estimated at 63,92,750 hatchlings, was collected in 1-14 experimental nets in the course of three major floods that occurred in the Brahmaputra river during the season. A characteristic feature of the river was the frequent change in the current pattern and direction and the adverse transposition of the bank topography resulting from the heavy erosion of the banks. On account of this, the site of net-operation had to be shifted at frequent intervals, since the main site at Hamidabad became unfavourable soon after the first flood in the first week of May, 1970.

The second flood yielded the bulk of the season's total spawn catch. The entire collection was made in the rising phase of the flood in three spawn spurts. The first spurt commenced on 9.6.70 and lasted for 22 hr, yielding 9,940 ml of spawn. The second spurt appeared on 10.6.70 and in its duration of 30 hr, yielded 2,385.5 ml of spawn. The third and last spurt, lasting for 8 hr only, commenced on 11.6.70 and yielded 204 ml of spawn.

The indices of spawn quantity and quality were estimated to be 970 ml; and 43.98% major carps, 53.70% minor carps and 2.31% others.

The quality of the spawn determined by microscopical examination and rearing of spawn in State nurseries is presented in the following table 17.

Table 17. Spurt-wise quality of spawn collected in the Second flood from the river Brahmaputra at Hamidabad

Spurt No.	Percentage Composition									
	By microscopical analysis			By nursery rearing						
	Major carps	Minor carps	Others	Catla	Rohu	Mrigal	Calbasu	Total major carps	Minor carps	Others
1.	42.40	55.70	1.90	6.25	36.60	Nil	1.78	44.63	55.34	0.03
2.	36.25	61.25	2.50	0.55	42.23	Nil	0.55	43.33	52.03	4.64
3.	42.00	56.50	1.50					Samples could not be drawn.		

Prospecting for spawn availability was also carried out at Dolgoma upstream of Hamidabad and at Bhashanichar, downstream of Hamidabad. Of these, Dolgoma was found unsuitable while Bhashanichar was found to be suitable for exploitation.

Pairachali: The observations at this centre were initiated on 20.6.70 and were continued till 12.8.70. Though, during the period of observations, 12 floods of varying intensity were encountered, when the water level increased from 0.80 to 1.83 m, no spawn was available. The probable reasons for the non-availability of spawn may be as under:—

(i) Indiscriminate fishing with fixed gill nets, operated in large numbers, was largely responsible for obstructing the movements of the fish upstream during the freshets.

(ii) The river, flowing through hilly tracts, has a high slope gradient. As such, the intensity of floods encountered could not inundate the breeding grounds.

(iii) The fishes might have bred in the shallow marginal areas and fields in the vicinity of the reservoir, which got flooded during freshets. The fact that spent fish specimens were also observed in catches at Khadra, substantiates the above.

Ahirauli: At Ahirauli investigations were conducted from 29.6.70 to 31.8.70. During the period, the river had four floods, of which the second flood lasted for more than a month. Nine spawn spurts of duration ranging between 8-49 hr, were observed at Ahirauli during the second and third floods. A total of 2,546 ml of spawn was collected in five standard nets. Out of this, the second flood contributed 14.38% and the third flood 85.46%. The period of maximum spawn availability was from 10.8.70 to 12.8.70. The bulk of the collection was associated with turbidity values ranging between 360 and 440 ppm.

All the spurts yielded desirable spawn, with major carp contents varying between 40 and 80%. The pooled average for the season was 67.49%. *Labeo rohita* was the most dominant species among the major carps in all the spurts.

The seasonal indices of spawn quality, as determined by rearing in State nurseries, spawn analysis, rearing in nursery pits and earthen gamlas were found to be 85.49, 67.49, 84.62 and 60.27% respectively. The seasonal index of spawn quantity was found to be 552 ml.

*Labeo rohita* was available in all the spurts recorded. *C. catla* was represented with maximum contribution of 66.82% during the ninth spurt, when the water level showed a rise of nearly 7.0 m above the summer level.

Chausa, Neagipur and Singhghat on the south bank in Bihar and Ujhiar, Bharoli and Baraket on the opposite bank in Uttar Pradesh were prospected for their suitability for spawn collection and Singhghat was found suitable for exploitation throughout the season.

Problem : 4.2 Standardisation of spawn collection techniques  
Duration : Three years  
Personnel : K. K. Ghosh, M. Sinha, H. P. C. Shetty and N. K. Srivastava

*Spawn availability in relation to other variables:* During the year under report, very little spawn was available in the Yamuna river at Mahewapatti. The river touched the flood levels of 76.83, 79.64, 78.57, 82.02 and 82.07 m above MSL in five floods of which the fourth flood only yielded spawn, all of desirable quality. During the rising phase of flood IV, some spawn was available for 26 hr at a very low rate of 0.87 ml per net-hour, mostly on 13.8.70. The flood touched its peak during the early hours of 19.8.70 and yielded the only spawn spurt of the season. This availability commenced 28 hr after the flood peak and yielded spawn for 68 hr at the average rate of 1.06 ml per net-hour. The quality of this spurt, as adjudged by spawn analysis, was found to be 82% major carps, 16% minor carps and 2% others.

The over-all index of spawn quantity was found to be 98.3 ml, while the quality of spawn, as estimated by rearing in small chetty pots, was 17.2% major carps.

*Filtration rate:* Filtration rate decreased more in smaller meshed nets than in bigger meshed nets. Table-18 gives the results of these experiments.

*Net size and mesh size effects:* The operational efficiency of standard-type nets of different size and mesh showed that the top wing sag was too much in about four hours of continuous operation, so as to seriously affect the easy flow of water to the ring end. The stretching force required to keep a net in shape was seen to rise with time. Similar was the observation for loosening of the net as measured by the loosening of the ring end. 10 m and 14 m nets were about equally efficient, while 1/8" and 1/12" meshed nets were also about equally efficient.

*Rate of spawn escapement from different meshed nets:* Escapement studies by cod-end cover method showed that the rate of escapement of hatchlings from 1/8" was about 37%, as against 22% from 1/12" mesh. The escape-

Table 18. The fall in maximum filtration rates expressed as percentage of river discharge for 10 m nets of various mesh sizes

Hrs. after fixing	River discharge in cm/sec.			% fall in filtration in smaller meshed nets of the pair								
	Surface	40 cm depth	Average	1/8" & 1/12"			1/12" & 1/16"			1/8" & 1/16"		
				Surface	40 cm depth	Average	Surface	40 cm depth	Average	Surface	40 cm depth	Average
0				7	3	3	7	11	9	9	13	10
2				4	12	8	13	17	15	9	18	14
4				5	10	7	6	16	10	21	27	25
10				5	12	12	8	16	10	18	26	24
12				6	11	11	10	12	11	22	28	23

Range 25—45  
Av. 33.4

Range 24—35  
Av. 30.8

Range 25—40  
Av. 32.5

ment rate was seen to be largely dependent on the average size of hatchlings. In direct estimation, using known population method, by releasing known number of marked spawn at net mouth, the escapement percentage was found to be too high from 10 m standard shape nets. The escapement rates were around 90% from 1/8", 65% from 1/12" and 30% from 1/16". In extremely low velocities (about 0.4 Km/hr), the escapement from 1/16" meshed net was much higher and of about the same magnitude as from 1/12". This may be ascribed to the capacity of the hatchlings to negotiate low velocities and escape through the mouth of the net. Using the known population method, the escapement from the rear end of the net was assessed using cod end covered shooting nets. About 42% escapement from 1/8" cod end was seen, which agreed very closely with the earlier finding of about 40% from the entire net in a fully covered net, suggesting thereby that the escapement from the rear is of the same order as from the entire net for 1/8" mesh. However, with 1/12" mesh, cod end escapement was found to be nil. The over-all escapement was of the same order as observed earlier.

*Net selectivity:* The mean selection length for the 1/8" meshed shooting net made of handloom cotton twine number 1 & 2 and tanned with *Lahi* was found to be 5.9 mm by the cover method, with selection length from 5.0 to 7.0 mm.

*Improvement of gear:* A modified gamcha having an inner compartment of mosquito netting was found very effective in automatically sieving spawn from associates and debris while in operation.

*Mass marking of live spawn:* A method of mass marking of carp hatchlings by the biological stain Bismark Brown was developed to meet the need for studies on the escapement and dynamics of spawn by known population method. Immersion of hatchlings for a period of 5 hr in 1:25,000 dilution of Bismark Brown in clear water produced a brilliant golden yellow colour, which was retained for 30 hr. Neutral Red, at concentration of 1 part per 100,000 also gave good results, but the hatchlings died after about 24 hours.

*Other studies:* The measurement of turbidity and current velocity using the transparency data of Secchi's disk and rod float respectively were critically examined *vis-a-vis* the more refined and standard method of Jackson's turbidity meter and current meter. It was found that turbidity meter measurements were generally much higher than those determined by Secchi's disk transparency, while the current velocity was generally underestimated by the rod float method. However, since the interest is in the average flow velocity of the column of water filtered by the net, the 50 cm long rod-float measurements were probably more realistic.

Problem : 4.3 Commercial spawn catch in the lower stretch of Ganga River System

Duration : Four years

Personnel : G. N. Mukerji, S. N. Sar, R. N. Seth and K. S. Banerjee

The total fish spawn production recorded on the basis of railway booking figures at selected spawn exporting centres within the stretch from Koelwar on the river Sone to Agradwip on the river Bhagirathi, covering the in-between stations on the river Ganga, and Lalgola on the river Padma, was found to be 52,530 "hundies" during the year. The stationwise export figures of fish spawn from different railway stations are: 1,918 (Koelwar), 8,096 (Patna Jn.), 225 (Futwah), 318 (Bakhtiarapur), 190 (Barh), 2,089 (Jamalpur), 2,287 (Sultanganj), 2,447 (Bhagalpur), 3,138 (Colgong), 352 (Pirpainti), 5,505 (Sahibganj), 4,695 (Rajmahal), 5,332 (Farakka), 1,019 (Nimtita), 870 (Sajnipara), 2,029 (Jangipur Road), 778 (Gankar), 1,433 (Ajimganj Jn.), 665 (Lalbagh Court), 1,037 (Tenya), 1,627 (Katwa Jn.), 1,324 (Dainhat), 1,771 (Moharajpur) and 3,385 (Lalgola) hundies.

The production of fish spawn recorded from nine newly included railway stations; viz., Futwah, Bakhtiarapur, Barh, Gankar, Ajimganj Jn., Lalbagh Court, Tenya, Katwa Jn. and Dainhat was found to be 7,597 hundies (14.46% of the total fish spawn production of the year).

The total fish spawn export from fifteen railway stations visited during the years 1969 and 1970, was found to be 43,978 and 44,933 hundies respectively, thereby showing an increase of 2.17% in the fish spawn export of the year under report.

- Problem : 4.4 Comparative growth rate of spawn from different river systems  
Duration : Three years  
Personnel : H. P. C. Shetty, Balbir Singh, P. M. Mathew, G. N. Mukherji and R. N. Seth

*At Allahabad:* Major carp spawn obtained from four sources, (i) bundh-breeding from Nowgong, Madhya Pradesh (*L. rohita* and *C. catla*); (ii) induced-breeding from Taraon, Allahabad (*C. mrigala*); (iii) riverine from the river Ganga at Buxar in Bihar (*L. rohita*, *C. catla* and *C. mrigala*); and (iv) riverine from the river Yamuna at Allahabad (*L. rohita*, *C. catla* and *C. mrigala*), were reared under identical conditions up to fry stage in plastic pools. The rate of stocking was 300 spawn per pool.

The spawn in all the pools were given identical quantities of plankton and artificial feed (rice bran and mustard oilcake in 50:50 proportion), as was done in 1969.

Among 600 spawn of each source, stocked in the beginning, the numbers that survived on the 22nd day of rearing were 39, 191, 100 and 210 in the case of bundh-bred, induced-bred, Ganga and Yamuna spawn respectively. The survival was the least in bundh-bred spawn, and the highest in Yamuna spawn.

Fry raised from different sources were stocked again separately in the same plastic pools, with one replicate of each, except in the case of Ganga fry, @ 16 fry/pool. It was also not possible to keep the number of different

species identical in the various pools, since the entire stocking had to be done only from the surviving fry at hand. Size range and average length (T.L.) of the fry from various sources at the time of re-stocking were as in table 19.

From the table it is clear that rohu from the bundh with an average T.L. of 29.1 mm had the best growth and rohu from the river Ganga (23.7 mm), the least. The Ganga catla (27.5 mm) showed the maximum growth, while that from the Yamuna (18.5 mm) the minimum. The induced-bred mrigal showed very poor growth as compared to those from the Ganga and the Yamuna.

Rearing was continued till 52 days. The species-wise and source-wise measurements are shown in table 19.

The best growth (70.5 mm) was seen in case of Yamuna rohu instead of the bundh-bred rohu as at the fry stage. Ganga rohu showed the poorest growth (58.25 mm). Catla from the river Ganga showed the minimum growth (39 mm), while catla from the bundh-bred stock showed the maximum (54.8 mm). Mrigal following the same pattern as in the fry stage, had the maximum growth (79.10 mm) for Yamuna mrigal and the lowest (74.26 mm) for induced-bred.

A third observation was made on the 80th day and the results are also shown in table 19. As can be seen from the table, bundh-bred catla showed the best growth. While Ganga mrigal had grown faster than Yamuna mrigal, the induced-bred mrigal continued to show poor growth.

The fourth observation was made on the 110th day and the details thereof are given in the table 19. It is evident from the table, that the pattern of growth of catla and mrigal from the various sources on the 110th day continued to be the same as on the 80th day. It appears that induced bred spawn are distinctly poorer in their rate of growth as compared to the riverine spawn.

*At Bhagalpur:* Due to non-availability of spawn from different sources and lack of suitable rearing facilities, no tangible results could be obtained at Bhagalpur, since the experimental rearing was confined to only one set of spawn from the river Ganga at Bhagalpur.

#### *Project 5 : Brackish water fish farming*

Problem : 5.1 Seepage through puddle core and non-puddle core dykes in the lower Sunderbans

Duration : Two years

Personnel : B. B. Pakrasi, R. K. Banerjee and S. C. Banerjee

Observations on the seepage in the experimental ponds of different specifications were continued to confirm the results of 1969. The total rainfall of 195.06 cm has been recorded during the year and the reported loss of water due to evaporation in the Sunderbans is 152.0 cm. Thus the total gain of water

Table 19. Growth pattern of fry raised from spawn of different sources

Source	No. of fingerlings surviving			Rohu		Catla		Mrigal	
	Rohu	Catla	Mrigal	Length range (mm)	Av. length (mm)	Length range (mm)	Av. length (mm)	Length range (mm)	Av. length (mm)
<i>After 22 days rearing :</i>									
Bundh-breeding	—	—	—	23—36	29.12	16—32	24.69	—	—
Induced-breeding	—	—	—	—	—	—	—	20—34	24.00
Ganga river	—	—	—	22—29	23.67	27—28	27.50	34—40	37.60
Yamuna river	—	—	—	25—32	28.00	16—23	18.47	34—42	38.20
<i>After 52 days rearing :</i>									
Bundh-breeding	9	5	—	61—70	65.90	52—58	54.80	—	—
Induced-breeding	—	—	31	—	—	—	—	66—81	74.26
Ganga river	8	1	6	52—77	58.25	39	39.00	68—83	77.43
Yamuna river	2	14	10	70—71	70.50	41—50	45.43	75—84	79.10
<i>After 80 days rearing :</i>									
Bundh-breeding	—	1	—	—	—	80	80.00	—	—
Induced-breeding	—	—	26	—	—	—	—	77—94	85.95
Ganga river	2	1	6	76—86	81.00	56	56.00	107—113	109.50
Yamuna river	—	13	10	—	—	51—62	56.92	95—105	100.10
<i>After 110 days rearing :</i>									
Bundh-breeding	—	1	—	—	—	85	85.00	—	—
Induced-breeding	—	—	25	—	—	—	—	80—98	90.08
Ganga river	2	—	5	80—91	85.50	—	—	115—121	117.40
Yamuna river	—	12	9	—	—	55—68	59.92	96—109	103.44

is expected to be 43.06 cm and this tallies with the average gain of water by both the types of ponds having puddle and non-puddle core dykes, showing that the loss due to seepage is negligible.

The tidal amplitude of Bakkhali creek is found to be av. 504 cm (range: 520.0-16.0 cm). During the year, the water salinity of the central reservoir 'K' decreased further and varied between 9.5-3.2‰, whereas the same in 1969 was 15.1-6.0‰. With the stoppage of fertilisation, the primary productivity ranged between 272-104 mg C/m<sup>3</sup>/hr as compared to 803-250 mg C/m<sup>3</sup>/hr in 1969 when it was manured regularly.

The survival of 24-40 mm carp fry in 12.0‰ water salinity is negligible. But 10 carp fingerlings stocked in 7.0‰ water salinity survived well and attained 322 mm in length and 186 gm in weight in 4½ months. The mullets *M. parsia*, *M. tade* and *M. cephalus* have grown to average length of 168, 261 and 454 mm respectively in 9 months. The milk fish *Chanos chanos* attained the average length of 458 mm and weight of 648 gm. The prawns, *P. monodon* and *P. indicus*, have grown to the average length of 237 and 186 mm and the average weight of 85 and 53 gm respectively in 10 months. The central pond 'K' has been further stocked with 592 carp fingerlings (catla, rohu, mrigal, silver carp, grass carp, common carp), 43 mullet fingerlings (*M. parsia*, *M. tade* and *M. cephalus*), 3 milk fish (*Chanos chanos*) and 650 prawn fry (*P. monodon*).

Problem : 5.2 Contour survey of Henry's Island No. 1  
Duration : Two years  
Personnel : A. Sengupta, A. B. Mukherjee and P. N. Bhattacharya

The contour survey of 243 ha forest land on Henry's Island at Bakkhali has been completed in all respects and a revised layout plan of the proposed fish farm has been prepared to facilitate both freshwater and brackish water fish farming within the surveyed plots. Low saline reservoirs will be filled by rain water. Low saline tanks will be partly filled by rain water and partly fed by tidal water. Whereas, the brackish water impoundments will be fed by tidal water.

The bench mark has been carried to Dia Island for detailed contour survey of the island. Prismatic survey has been made for Fradrick Island.

Survey of other islands suitable for the development of fisheries in the lower Sunderbans has been taken up for detailed investigations.

Blue print of the layout plan along with the project report (pilot) has been submitted to the Ministry of Food, Agriculture, Community Development and Co-operation for further necessary action.

Problem : 5.3 Experimental trial of model brackish water fish farm  
in the Lower Sunderbans  
Duration : Two years  
Personnel : B. B. Pakrasi, R. K. Banerjee, N. C. Basu and M. K. Mukhopadhyaya

For studying different methods of stocking brackish water pond with fish seed, wild and selective stocking have been done in the experimental ponds. One 0.17 ha pond has been stocked with seeds of fish and prawn drifted with tidal water flow, without regulating the size at entry by putting screens; whereas in another pond of same size, the size at the time of entering into the pond has been regulated through the screens, so that six varieties of the predatory fishes may be kept under control. In another pond selective stocking has been done with 6,300 mullet fry (*M. parsi*) and 5,650 prawn larvae at the over-all stocking rate of 70,000/ha.

The available nitrogen content of the experimental pond soils ranged between 3.2 and 9.0 mg/100 gm, organic carbon 0.630 and 0.164% and the phosphate 1.57 and 38.40 mg/100 gm. Though phosphate in water phase remained low (trace—0.5 ppm), the nitrate-nitrogen ranged between 0.08-1.18 ppm. The soil salinity varied between 0.308-1.350‰. Although no manuring has been done, the nutrients have been brought in by tidal water.

The experiment had to be abandoned due to sudden spill over of tidal water inflow over the dykes, owing to excessive high tide in August, 1970.

To experiment on sluice designs for the maximum ingress of quality fish and prawn seed into brackish water pond with the intake of high tide water, a sluice has been designed so that only the top layer of tidal water carrying most of the seed, may be allowed to flow in, by adjusting the sluice shutters.

The analysis of seed prospecting data from the Bakkhali creek revealed that 22.91-177.98 ml catch/net/hr at spring tides, during seed collection season, is expected. *P. indicus* has been found as one of the important commercial species of prawn to occur in plenty.

Problem : 5.4 Salinity tolerance of major carp fingerlings

Duration : Two years

Personnel : A. N. Ghosh and S. R. Ghosh

The normal salinity tolerance of major carp fingerlings has been determined by setting up statistically designed yard experiments with salinity grades at trace, 1, 2, 3, 5, 8, 11 and 15‰. Up to 5‰ fingerlings of *Labeo rohita* and *Catla catla* were found to thrive and grow well (average growth/week 14-15 and 18-20 mm respectively). With rising salinity up to 8‰, the fish exhibited reluctance to feed and at 11‰, they refrained from taking food. Complete mortality occurred at 15‰ within 2 hr of introduction. Mortality was nil up to 8‰, but at 11‰, 50% mortality was observed, *Cirrhinia mrigala* exhibited very low tolerance (mortality 95%) even at a salinity of 5‰.

Problem : 5.5 Nursery management in brackish water ponds

Duration : Three years

Personnel : A. N. Ghosh, S. R. Ghosh, N. K. Das, L. K. Das and H. S. Mazumder

5.5.1 Pilot investigations on different stocking rates and ratios fish and prawn, their survival and growth, effect of artificial fertilizers and removal of uneconomic species for better production

*Mugil parsia*, *Eleutheronema tetradactylum*, *Otolithus maculatus*, *Lutianus argentimaculatus*, *Gerres setifer*, *Penaeus indicus*, *Metapenaeus monoceros* and *Metapenaeus brevicornis* were stocked at a total stocking density of 33,000/ha in the proportion of 135.7:15.1:30:64.2:14: 1:7:6 respectively.

Without the removal of unwanted varieties, *Mugil parsia* achieved an average length/weight of 57 mm/3.01 gm in 90 days. With the removal of unwanted varieties, the fish achieved an average length/weight of 107 mm/29.3 gm in the same period. The survival rate of prawns was practically negligible.

Experiment on relative growth of prawn, *Penaeus indicus* under extensive and intensive cultures: In a yard experiment, 4 sets of 3 each of 12 earthen vats (diameter: 75 cm) containing 10 cm thick soil at the bottom and water (salinity: 22.11‰) from the same brackish water pond, were set up. In each vat 40 young *Penaeus indicus* (av. size : 21 mm/47.5 mg) were introduced. While the first one of the four sets was kept as control, the second set was fed with mustard oilcake + rice bran in the ratio of 1:1 and at the rate of 100 mg/prawn on every alternate day and the third and fourth sets were manured with cow-dung (@ 6,000 Kg/ha) and superphosphate (@ 60 Kg/ha). The fourth set was fed with supplementary food. After a period of 37 days, the average length/weight attained by prawns in the respective sets was observed to be 50 mm/405 mg, 38.21 mm/304 mg, 38.7 mm/266 mg and 46.6 mm/500 mg, with a percentage mortality of 75.0, 91.9, 27.5 and 91.8. The average growth per prawn was less than that of the control and the experiments thus proved to be unsuccessful.

In order to determine the food requirement of prawns (*Penaeus monodon*, *Penaeus indicus* and *Metapenaeus monoceros*), the food preferences at different stages of their life have been studied. It was observed that juveniles of *Penaeus monodon* (10-70 mm) fed on diatoms (98%), the next size group (71-150 mm), on algae and plant matter (34.4 and 43% respectively), and the larger individuals (151-250 mm) on plant matter (57.5%) and diatoms (32.1%). In case of *Penaeus indicus*, diatoms (96.2%) formed the main food item in 21-50 mm sizes, plant remnants (81%) and crustaceans (11%) in 51-80 mm sizes, diatoms (69.5%), plant debris (15.9%) and crustaceans (13.1%) in 81-100 mm sizes, and plant debris (32.3%) and crustaceans (14.5%) in 101-160 mm sizes. *Metapenaeus monoceros* (30.80 mm) was found to feed on diatoms (51.73%) and plant remnants (49.65%).

In a yard experiment, the favourable salinity for growth and survival of juveniles of *Penaeus monodon* (37-69 mm) was found to be between 15.2-24.2‰. In this range, the survival rate varied between 50 and 60%, with the maximum

survival at 19.5‰ salinity. In lower salinity (8.33‰), the survival was only 25%. In still lower salinity (6.5‰), the survival rate was 10%. In case of *Penaeus indicus* (35-67 mm), the maximum survival of 20% could be obtained in the salinity range between 6.5-8.3‰. Only 10% survival was obtained when the salinity reached 19.20‰. Beyond this limit, there was no survival. The range of temperature and pH were 27-29°C and 8.0-8.8 respectively.

In mono-culture, *Penaeus monodon* (stocking rate 40,000/ha) exhibited an average growth of 50 mm per month during summer, average length being 103 mm from initial of 28 mm in a period of 45 days. Heavy mortality took place with the onset of monsoon due to lowering of the temperature and salinity. The experiment was repeated with fresh stock and an average growth of 6 mm/month (average length of 58 mm from an initial 52 mm in 30 days) was recorded during monsoon, which increased to 18 mm/month during post-monsoon period (average of 76 mm from an initial 58 mm).

In the mono-culture of *Penaeus indicus* (stocking rate 2,00,000/ha), an average growth of 48 mm/month (average length of 105 mm from the initial 32 mm in 45 days) was achieved during summer, while in monsoon the average growth was only 10 mm/month (average length of 64 mm from the initial 54 mm in one month). No appreciable growth was observed during the post-monsoon period.

In the mono-culture of *Lates calcarifer*, specimens fed with young prawns (12 gm/fish/day) had grown at an average rate of 22 mg/month in a 0.02 ha pond, when stocked at the rate of 300/ha and the specimens were of an average size of 336 mm.

In extensive culture of *Mugil cunnesius*, without supplementary food and at the respective stocking densities of 20,000, 30,000 and 40,000/ha, the best growth (average growth 27 mm in 75 days) was obtained at 20,000/ha. A mixture of rice bran and mustard oilcake which proved to be an efficient supplementary food for *Mugil parsia* was not liked by this species.

#### 5.5.2 Pilot investigations to breed *Mugil parsia*, *Mugil tade*, *Lates calcarifer* *Eleutheronema tetradactylum* through hormone injection and/or stripping

Homoplastic pituitary gland injection was administered to *Mugil parsia* in penultimate and ultimate stages of maturity (size range 135-170 mm) at different doses (1, 2 and 2½ pituitary to the males and 3, 4, 5 and 6 pituitary to the females according to the stage of gonadal development) from identical sized donors. The doses were administered in three instalments. In all cases, the response was positive; but the development was found to continue only up to formation of embryo, after which the eggs disintegrated.

#### 5.5.3 Investigation for evolving suitable manuring and stocking rates

Organic manure (mustard oilcake) and inorganic fertilisers (Urea, superphosphate, muriate of potash and commercial N<sub>6</sub>P<sub>8</sub>K<sub>4</sub>) were tried individually

and in combination at the rate of 90 Kg N—120 Kg P—60 Kg K per ha. Among them, the mustard oilcake individually and urea plus superphosphate in combination were found to be more efficient than other fertilisers. Between the two, better results were obtained in mustard oilcake treated ponds (Primary productivity : 190 mg C/m<sup>3</sup>/hr, as against 140 mg C/m<sup>3</sup>/hr after 90 days). The average growth achieved by mullet fry (initial length 27 mm) at a stocking density of 5,000 and 10,000/ha was estimated to be 81 and 76 mm respectively with mustard oilcake as manure and 79 and 61 mm respectively in urea + superphosphate manured ponds in corresponding period of 90 days.

Problem : 5.6 Brackish water fish farm management techniques  
Duration : Three years  
Personnel : A. N. Ghosh, S. R. Ghosh, P. K. Pandit and H. S. Mazumder

5.6.1 The role of tidal amplitude in relation to the lunar phase and calendar months in determining the extent of flooding the fish farm and quantitative availability of required species of fish and prawn

Seed of *Penaeus indicus* were available throughout the year with a peak between January and March, while that of *Penaeus monodon* appeared in the collection in February and reached the maximum in the month of August. *Metapenaeus monoceros* was available mainly during February and March.

*Mugil parsia* seed were available from December to June with a peak between December and January.

5.6.2 Control of pond siltation

Raking operation was found suitable to control the settlement of silt on the pond bed. Bamboo piling and brick edging along the dyke have been found to be effective in controlling erosion and consequent silting up of the canal and pond beds. (Soil loss : 14.7 gm/m<sup>2</sup>/10 min in protected area as against 30 gm/m<sup>2</sup>/10 min in unprotected area).

5.6.3 The compatibility of different species of herbivorous fishes and prawns under mix-culture

*Penaeus monodon* was cultured with *Mugil tade* stocking densities of 6,000 and 10,000/ha respectively. The results obtained indicated that *P. monodon* achieved an average length/weight of 176 mm/50 gm, while *Mugil tade* attained an average length/weight of 178 mm/62 gm in 139 days. The survival rate at the end of the experiment was estimated to be 5 and 8.5% for the two species, indicating their incompatibility to be cultured together.

#### 5.6.4 Establishment of ratio between carnivorous and forage fishes for proper utilisation of fish food

Composite culture of *Lates calcarifer* and *Scatophagus argus* at the ratio of 1:4 and *Lates calcarifer* with grown up mullet (size 110 mm and above) in the proportion of 1:14, indicated that the herbivorous fishes grew well in these combinations (growth of *Mugil parsia* : 7 mm/month, *Scatophagus argus* : 8 mm/month). Growth of *Lates calcarifer* was not appreciable (2 mm/month).

#### 5.6.5 Establishment of silt-clay and water volume relationship and effect of salinity on productivity

Benthic algae were found to grow profusely at a depth of 23-54 cm. The best medium for their growth was found to be silt-loamy soil having about 75% silt with exchangeable calcium and magnesium as 8.35 and 5.40 m.e./100 gm respectively. At low salinity (4‰), *Spirogyra* sp. was produced and at higher salinity *Lyngbya* sp. and *Oscillatoria* sp were the dominant algae produced.

Problem : 5.7 Culture of brackish water fish food organisms  
Duration : Three years  
Personnel : C. S. Singh, A. N. Ghosh, S. R. Ghosh and K. K. Bhanot (Mrs.)

Preparatory cultures of selected brackish water plankters have been done in brackish water pond soil extract, artificial sea water and natural sea water and kept at a temperature of 25°C ( $\pm 1^\circ$ ) and illumination of 100, 200 and 500 lux. *Cymbella* sp. and *Nitzschia* sp. are growing in preparatory cultures made in artificial sea water and natural sea water.

In the field, a medium made with the mixture of urea, mustard oilcake, superphosphate and cow-dung in the ratio of 1:4:8:12 produced *Gyrosigma* sp., *Synedra* sp. and *Pinnularia* sp. Mustard oilcake alone, at the rate of 1,800 Kg/ha, produced *Closterim* sp. and *Amphora* sp. at 10 and 20‰ salinity.

Problem : 5.8 Induced breeding of *Mugil cephalus*  
Duration : Three years  
Personnel : R. M. Bhowmick, K. H. Ibrahim (up to June, 1970).  
G. V. Kowtal (March, 1970 onwards) and M. M. Bagchi

For the first time in India, success was achieved in induced breeding and hatching of *Mugil cephalus* during December, 1970. The larvae could be reared for 6 days in sea water at the Cuttack laboratory.

Out of 19 sets tried, only 10 were available for stripping (5 died in hapa and 4 escaped to sea) and 5 out of these have responded. Fertilisation and hatching took place in 3 sets and the eggs hatched out 33.48 hr. after fertilisation at 20-25°C water temperature and salinity of 19-20‰.

## Project 6: Freshwater prawn culture

Problem : 6.1 Freshwater prawn culture technique  
Duration : 6½ years (including 2½ years extension)  
Personnel : K. Raman

Fingerlings of *Macrobrachium malcolmsonii* (58 mm/1.3 gm), stocked @ 25,000/ha in three 0.12 ha nursery ponds in January, 1970 along with catla and silver carp @ 2,000/ha and fed on mustard oilcake, rice bran and waste prawn powder in two ponds, keeping the third as control, have shown average increase in length/weight of 73.8 mm/29.66 gm, 65.0 mm/24.7 gm and 32.7 mm/7.2 gm respectively in 10 months. Males were more than females in all the ponds. Most of the females became berried during the breeding season, but no larvae were observed in the ponds. Early in June, some mortality of prawn occurred in one of the experimental ponds, because of oxygen depletion caused by a bloom of *Microcystis* sp. Weeds; like, *Ottelia* sp. and *Hydrilla* sp. planted in wooden trays and kept in the experimental ponds did not thrive well. Catla and silver carp have grown well in the pond. After the rainy season, the prawns seem to have suffered loss in number, though no mass mortality was observed.

In plastic pool (0.665 sq m), prawn fry (av. 37 mm/0.325 gm), stocked @ 3,45,000/ha and fed on mustard oilcake, rice bran and waste prawn powder, gave the best survival with rice bran (95.65%) followed by prawn powder (87%) and the best growth with prawn powder (8.948 mm/1.068 gm) closely followed by rice bran (8.785 mm/1.010 gm), in one month. With mustard oilcake also growth was good but heavy mortality occurred due to pollution of water. During the second month same artificial feeds were given and growth was good. Those fed on rice bran and prawn powder, matured and bred in the pools. Eggs of berried females collected from the river and those fed on rice bran hatched out and the larvae survived for a week. Eggs in the berried specimens and free swimming larvae were infested with epizotic ciliates. One female moulted a week after spawning and became berried on the next day. Dissolved oxygen below 3 ppm was found to cause distress to the prawns.

Observations on the physico-chemical and biological conditions of the prawn rearing ponds and the river and the prawn fishery of the neighbouring stretch of the river are being continued. A study of the migration of prawn fry at the Jobra anicut is also being pursued.

Problem : 6.2 Propagation and culture of *M. malcolmsonii*  
Duration : Five years  
Personnel : T. Rajyalakshmi, P. L. N. Rao, G. R. Rao, L. H. Rao,  
T. S. Ramaraju, K. S. Rao and D. R. Rao

Experimental work was initiated in 6 ponds, each at Kadium and Katheru fish farms. While the Kadium ponds were stocked with 5,000 juveniles prawns

in each in October, the Katheru ponds were stocked in December at the rate of 15,000 prawns per pond. The stocked prawns ranged in size from 15-30 mm.

Organic and inorganic manuring was done in different sets of 2 ponds each with a third pond as the control. Superphosphate (single, 16%) and potassium sulphate (48%) were used in the ratio of 1:2.

Studies on plankton productivity and primary productivity were initiated. Analysis of water and soil and analysis of gut contents etc. were also initiated.

Sampling programme was initiated from the 1st week of December, 1970 to estimate the abundance of juvenile prawns migrating over the Dowlaiswaram anicut.

About 40,000 juvenile prawns were successfully sent under oxygen packing to Bangalore. Each tin was packed with 250 live prawns, this rate having been found to be the optimum per tin in 3 litres of water.

#### *Project 7 : Murrel and live fish culture*

Problem : 7.1 Induced breeding of murrels

Duration : Three years

Personnel : R. M. Bhowmick, K. H. Ibrahim (up to June, 1970), G. V. Kowtal (from March, 1970), G. C. Panicker (up to February, 1970) and M. M. Bagchi

Murrel breeders (*Channa striatus*), stocked in a separate pond, spawned naturally during the month of April. About 2,000 fry were collected and stocked in a nursery pond and plastic pool for future study. They showed an average growth of 110 mm/10.4 gm within 3 months. Examination of gut contents showed that the specimens beyond 100 mm length subsisted on prawns and young fish.

Problem : 7.2 Breeding of *Anabas*, *Clarias* and *Heteropneustes*

Duration : Three years

Personnel : H. A. Khan and S. K. Mukhopadhyay

Among 55 specimens of *Anabas testudineus* examined, majority of the females were found to be in the 4th stage of maturity during April-May and in the 5th and 6th stages during June-July respectively. Seventy specimens of *Heteropneustes fossilis* were examined and twenty five of them were females in the 4th-5th stages of maturity, while 25 males were in the 5th stage during April-May. Fifteen females and five males were observed to be in the 5th and 6th stages respectively. Out of 25 females of *Clarias batrachus* studied, Twenty-two females were in the 4th stage of maturity during April-June and 3 females in the 5th stage in July. Three thousand spawn was produced from a pair of *A. testudineus* (70 gm ♀ & 30 gm ♂) through hypophysation. Of these, 500

were reared in an aquarium and 100 fingerlings of 35-51 mm length were produced.

Three females of *Anabas* (25-70 gm) and two females of *Heteropneustes* (70-90 gm) produced 10,750 and 4,000 spawn respectively through hypophysation. Rearing of *Heteropneustes* hatchlings (3 days old) using yeast (@ 0.05 gm/l) and cobalt chloride (1 ppm) in culture water and live plankton as feed, showed 80 and 52% survival for a period of 18 days, while the control showed only 42% survival. Experiments on rearing the fry in similar way are in progress. Fecundity of *Anabas testudineus* (100-164 mm in total length, and 24-77 gm in weight) was found to vary from 10,710 to 36,477 ova.

*Project 8: Estuarine and brackishwater lake fishes*

Problem : 8.1 Brackishwater fish seed prospecting  
 Duration : Four years  
 Personnel : V. Gopalakrishnan, Apurba Ghosh, K. K. Bhanot, S. B. Saha and S. N. Datta

Investigations on the brackish water fish seed resources at Diamond Harbour, Namkhana and Port-Canning stretches of the Hooghly-Matlah Estuarine System were made during the year under report. The salient features are summarised below:

*Port-Canning (Matlah Estuary)*

In addition to the five centres in and around Port-Canning (already selected), one more centre situated on the island opposite Port Canning was taken up for finding out the seed potentiality. Besides the standard Midnapore net, fyke and drag nets were also used. It was found that the different types of nets were useful for collecting seed of different species of fish. The catch/net/hour in respect of seed of different species of fish is presented in table 20.

Table 20.

Species	No./hr (Shooting net)							
	February	March	April	May	June	July	August	September
<i>P. indicus</i>	64	45	34	—	16	69	188	160
<i>M. brevicornis</i>	19	9	6	—	12	10	66	115
<i>P. styliferus</i>	79	79	58	—	7	35	55	77
<i>M. monoceros</i>	55	—	7	—	75	13	80	65
<i>M. rude</i>	16	8	11	—	11	2	73	—
<i>M. affinis</i>	—	—	—	—	37	5	52	43
<i>P. monodon</i>	189	45	27	—	—	3	111	83
<i>M. persia</i>	16	17	85	—	19	11	17	11
<i>I. elongata</i>	2	—	—	—	—	4	8	6
<i>E. tetradactylum</i>	—	—	20	—	—	10	6	6
<i>H. nehereus</i>	—	3	—	—	9	—	8	—
<i>C. ramcarati</i>	—	63	—	—	6	—	11	3
<i>S. panijus</i>	68	11	—	—	—	15	13	10
Sciaenids	3	17	6	—	—	11	23	13
Clupeids	57	—	51	—	—	17	63	11

### Namkhana (Hooghly estuary)

Collections were made in the Namkhana canal connecting the Hooghly estuary, by operating standard shooting net and fyke nets. This stretch of the canal appears to be a promising centre for the collection of brackish water prawn seed. The species encountered were: *P. monodon* (12-15 mm), *P. indicus* (14-55 mm), *M. brevicornis* (16-37 mm), *M. parsia* (15-22 mm), *E. tetradactylum* (20-24 mm) and *M. gulio* (52-67 mm). The catch/net/hour in respect of *P. indicus* was the highest (268.41) in the month of August in standard shooting net at high tide. The catch/net/hr of *P. monodon* varied from 2.66 to 7.18 in the month of August in standard shooting net and between 1.50 to 2.75 in fyke net collection of the same month.

### Diamond Harbour (Hooghly estuary)

Fish seed prospecting investigations and related hydrological studies were conducted from June, 1970 to September, 1970 at Haragram (Diamond Harbour). Fortnightly collections were made with standard Midnapore type shooting nets and fyke nets. Collection of seed, in general, was poor during this period of study. Midnapore type of shooting net proved to be much better than fyke net. The fish seed collected were: *I. elongata*, *M. parsia*, *M. corsula*, *M. tade*, *E. tetradactylum*, *Sillago panigius*, *Pama pama*, *Sciaena spp.*, *H. nehereus*, *M. gulio*, etc. The prawn seed consisted mainly of *P. indicus*, *P. styliferus*, *M. brevicornis* and *P. sculptilis*. *Acetes indicus* was present in very large numbers. In the monsoon months some major and minor carps and other freshwater fish seed were also encountered in the collections. Catch/net/hour of *M. parsia* was maximum in June (4.0) and minimum in August and September (0.13); *M. corsula* was maximum in July (0.30) and *M. tade* in September (3.50). Catch/net/hour of *E. tetradactylum* varied from 0.10 to 1.20 between June and August. Catch/net/hour of prawn seed; i.e., *P. indicus*, *M. brevicornis* and *P. styliferus*, was 15.50 (August), 10.25 (September) and 14.00 (September) respectively.

Problem : 8.2 Prawn fishery of Hooghly Matlah estuarine system  
Duration : Four years  
Personnel : M. Subrahmanyam, V. Gopalkrishnan, R. M. Rao and  
R. K. Chakraborty

No further success was achieved in rearing the zoeal stages of *Macrobrachium rosenbergii*, over that reported in the previous year.

Partial success was achieved in rearing the larval stages of *M. malcolmsonii*. Two larval stages were reared and all of them died after six days. Application of antibiotics and feeding on yeast had no effect on the survival and growth.

From the shooting net collections made at Nurpur on the river Hooghly, the postlarvae and juveniles of *Macrobrachium rude*, *Penaeus monodon*, *P.*

*indicus*, *Metapenaeus monoceros*, *M. brevicornis* and *Macrobrachium mirabile* were identified.

Shooting net operations were made at Nurpur, on the Hooghly estuary, from March to December, during day time, the period of collection coinciding with the full moon or new moon periods. The postlarvae of *P. monodon*, *P. indicus*, *Parapenaeopsis sculptilis*, *Metapenaeus* spp. and palaemonids were dominant in the collections, both at high tide and low tide. The period of availability and abundance are shown in table 21.

Table 21

Name of species	Tide	Period of availability	Range (catch/net/hr)	Period of peak abundance
<i>Penaeus monodon</i>	High	March-August	1.00-1,169.00	June
	Low	November-December		
		-do-	0.40-95.75	June
<i>P. indicus</i>	High	March-July	8.57-30,485.00	June
	Low	November-December		
		-do-	1.00-2,219.00	June
<i>Parapenaeopsis sculptilis</i>	High	March-June	0.16-35.75	June
	Low	-do-	2.52-113.75	June
<i>Metapenaeus</i> spp.	High	May-September	6.00-13,825.00	June
	Low	-do-	3.00-1,615.00	June
<i>Palaemonids</i>	High	March, May-December	6.54-3,841.75	June
	Low	-do-	1.33-153.00	July-September

The salinity and temperature during the course of investigations ranged between 0.09-21.15‰ and 21.10-32.12°C respectively.

- Problem : 8.3 Fisheries of the Pulicat lake  
 8.3.1 Studies on larvae and juveniles of fishes and prawns
- Duration : Three years
- Personnel : Ch. Gopalakrishnayya, A. V. Prabhakar Rao and K. Janardhana Rao

Post larvae and juveniles of fishes were collected throughout the year, using shooting net with three peaks of abundance, in March (680.2/net/hour), August (227.6/net/hour) and November (771.0/net/hour). Post larvae and juveniles of *Anchoviella* spp. *Ambassis gymnocephalus*, *Therapon jarbua*, *Gerres* spp. *Sillago sihama* and *Mugil* spp. were available throughout the year. Their peaks of abundance were: *Anchoviella* spp.—March, August and October (45.0, 54.1 and 30.9/net/hr), *Ambassis gymnocephalus*—April, August and October (129.3, 40.7 and 107.9/net/hr), *Therapon jarbua*—March, July and October (10.3, 6.3 and 3.3/net/hr), *Gerres* spp. (10-23 mm)—March, June and October (50.3, 16.6 and 14.9/net/hr), *Sillago sihama* (10-25 mm)—February, June and October (16.5, 7.6 and 13.9/net/hr) and *Mugil* spp.—March, August and

November (20.9, 12.4 and 17.3/net/hr). Fish eggs showed three peaks of abundance in April, August and November with 4,440, 2,496.8 and 1,908/net/hr respectively, while larvae showed three peaks in April, July and November with 11.6, 13.8 and 55.0/net/hr respectively.

*Penaeus indicus* was available throughout the year with peaks in March, August, October and November (1,204.50, 3,957.50, 3,149.00 and 1,387.00/hr by shooting net). *Penaeus monodon* was available in good numbers during January, April, August, October and November. *Penaeus semisulcatus* was available round the year with a peak from March to August. *Metapenaeus monoceros* was available throughout the year with a peak in October (273.50/hr). *Metapenaeus dobsonii* occurred throughout the year with maximum occurrence in July (130.00/hr).

Problem : 8.3.2 Studies on mullets  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya, C. P. Rangaswamy and R. D. Prasadam

*Mullet biology: Mugil cephalus:* The sex ratio was female: male: : 1:1.45. Analysis of length frequency data from the Adyar and Ennore estuaries indicated a faster growth rate in the Adyar estuary with 25.0 to 26.7 mm per month as compared to 21.6 to 25.0 mm in the Ennore.

*Experimental feeding:* Artificial feeding of *Mugil cephalus* fry with powdered prawn resulted in heavy mortality.

Artificial feeding of *Mugil macrolepis* with a variety of combinations of food items were tried, of which two combinations; viz., weeds+fish meal+tapioca and rice bran+prawn meal+tapioca gave better results both in regard to gain in weight and survival; in the former set, the gain in weight was 8.6 gm with 100% survival and in the latter the gain in weight was 5.1 gm with 70% survival. Another set of experiments with weeds + prawn meal + tapioca also showed encouraging results with 9.65 gm gain in weight and 90% survival. Replication of experiments confirmed the above observations.

Problem : 8.3.3 Studies on bottom biota  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya and K. N. Krishnamurthy

The zone II continued to be rich in bottom fauna, the prominent group changed from amphipods to polychaetes, with 6,048 u/m<sup>2</sup> while the former occupied the second place with 1,080 u/m<sup>2</sup>.

Problem : 8.3.4 Studies on hydrography, plankton and productivity  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya and M. Kalamurthy

The hydrographic features of the lake during the year were as in table 22.

Table 22

	Lake-mouth		Southern sector		Northern sector	
	Min.	Max.	Min.	Max.	Min.	Max.
Air temp. °C	25.9 (Jan)	29.9 (Jun)	26.7 (Jan)	30.8 (May)	27.4 (Jan)	32.7 (May)
Water temp. °C	26.6 (Jan)	30.2 (Apr)	26.4 (Jan)	29.9 (Sep)	27.4 (Jan)	31.8 (May)
Depth of water-cm	104.0 (Nov)	155.5 (Mar)	152.7 (Mar)	300.0 (May)	105.0 (May)	164.0 (Oct)
Secchi disc transparency-cm	38.0 (Jun)	106.0 (Oct)	53.3 (May)	71.3 (Feb)	26.0 (Feb)	56.0 (Jun)
pH	8.4 (May, Jun, Sep, Oct)	8.5 (Jan, Apr, Jul, Aug & Nov)	8.3 (May)	8.5 (Jan- Apr) Jul-Nov)	8.4 (Oct)	8.7 (Apr)
D O ppm	4.6 (Mar)	6.6 (Nov)	4.2 (Jun)	6.1 (Sep)	5.3 (Jan)	6.4 (Aug)
Salinity-ppt	21.3 (Jan)	37.5 (Jun)	23.5 (Jan)	39.0 (Jun)	7.1 (Jan)	39.3 (Jun)
Total alkalinity- ppm	45.0 (Apr)	85.7 (Sep)	94.4 (Apr)	91.4 (Sep)	53.9 (Feb)	87.0 (Oct)
Inorganic phos- phate mg/a/l	0.322 (Feb)	0.950 (Apr)	0.337 (Feb)	0.800 (Sep)	0.100 (Feb)	0.680 (Oct)
Silicate mg/a/l	4.00 (Jun)	16.75 (Jan)	5.00 (May)	16.67 (Jan)	7.00 (Jul. & Aug)	24.40 (Jan)

Primary productivity ranged from 0.36 (January and February) to 1.71 gm C/m<sup>2</sup>/day (March). Among phytoplankters, Bacillariophyceae showed a peak in March (3,69,699/haul in southern sector), while Dinophyceae and Myxophyceae showed peaks in August (9,810/haul at lake-mouth) and October (2,000/haul at lake-mouth). Among zooplankters, protozoans showed a peak during September (91,000/haul at lake-mouth) while copepods showed a lean period in July (500/haul in northern sector) and a rich period during March (71,990/haul in northern sector). The larval forms of invertebrates showed a peak during April (9,500/haul at lake-mouth) and were poor during October (345/haul in northern sector). The standing crop of plankton ranged from 0.23 ml (August in Northern sector) to 40.4 ml (March in Northern sector).

Problem : 8.3.5 Experimental fishing in the Pulicat lake  
 Duration : Three years  
 Personnel : Ch. Gopalakrishnayya, K. N. Krishnamurthy and S. Srinivasagam

The catch per hour of trawling was 3,586 gm of fish, 1,010 gm of prawns 32 gm of crabs. Species caught were: *Platycephalus* sp., *Mystus* spp., *Sparus*

spp., *Pseudorhombus arsius*, Leiognathids and *Gerres* spp. among fishes and *Metapenaeus dobsonii* and *Metapenaeus monoceros* among prawns.

Problem : 8.3.6 Food habits of *Penaeus indicus*  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya and K. Gopinathan

Food analysis of *Penaeus indicus* indicated the presence of insect matter, diatoms etc. None of the specimens examined had molluscs in their guts.

Problem : 8.3.7 Marking experiments on *Penaeus indicus*  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya and K. Janardhana Rao

Trials on marking of prawns with various stains were conducted but the stain retentivity achieved was poor.

Problem : 8.3.8 Rearing of crab  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya and S. Srinivasagam

Successful spawning of *Scylla serrata* under laboratory conditions was achieved and the eggs could be reared between salinity of 37 to 41 ppt and the temperature from 26 to 29°C.

Problem : 8.3.9 Induced breeding  
Problem : 8.3.10 Flora of the Pulicat lake  
Problem : 8.3.11 Studies on oysters of the Pulicat lake

Investigations on the above three problems were just initiated during the year.

#### *Project 9 : Selective Breeding and hybridization*

Problem : 9.1 Biological and genetical features of some Indian carp Hybrids  
Duration : Three years  
Personnel : R. M. Bhomick, K. H. Ibrahim (upto June, 1970), G. V. Kowtal (from March, 1970) and G. C. Sahoo

Some of the hybrids, of mrigal × catla, rohu × mrigal and rohu-calbasu × calbasu × calbasu were observed to have attained maturity in 2 years.

About 5,000 hybrids between rohu ♀ × catla ♂ and 2,000 hybrids between rohu ♀ mrigal ♂ were produced. They are being reared. Observations on their survival and growth in comparison with the pure progeny from the same parents are in progress.

Problem : 9.2 Storage of fish sperms  
Duration : Two years  
Personnel : R. M. Bhowmick and M. M. Bagchi

Sperms of *C. carpio* and rohu were stored in GPC-5 solution containing 3% glycerine and kept under refrigeration. Fertilization of eggs of rohu and common carp was attempted with sperms stored for various periods but no positive results could be obtained though controls gave positive results. Sperms preserved in coconut water for 3 hr were not motile.

Problem : 9.3 Hybridization between silver, grass and common carp  
Duration : Three years  
Personnel : S. B. Singh and P. C. Chakrabarti

As envisaged in the programme, hybrids between common carp ♀ silver carp ♂, Common carp ♀ × grass carp ♂ were successfully produced. The cross, Cc × Sc and Cc × Gc have been obtained for the first time in India and the cross Sc × Gc was again obtained for further observations. The reverse crosses were tried on a limited scale, but without success. In the cross, Cc × Gc, mortality, during early growth of fry, was rather high and abnormal swelling of the abdomen was encountered in large number of cases. Initially the hybrid offsprings recorded better growth than the pure progenies, but later growth of the hybrids was comparatively slower. The hybrid offsprings were initially reared in glass jars and *hapas* fixed in ponds, later in plastic pools and were also stocked in nursery ponds. Large number of the hybrids were lost due to flooding of the ponds, and therefore, only a small number of the remaining stock were restocked in ponds. Growth of the hybrids as well as pure progenies was found to be slow during the winter months. Observations on growth, maturity etc. are being continued. The study will be continued further.

#### *Project 10 : Fish farm designing*

(Not yet initiated)

#### *Project 11 : Economics in fishery investigations*

Problem : 11.1 Economic evaluation of fish culture operations in West Bengal and Orissa  
Duration : Two years  
Personnel : M. Ranadhir

Preliminary results obtained from economic studies of fish culture operations made in West Bengal are given below:

Type of management	Area (ha)	Net return per ha (Rs)	Net return per fixed capital (%)	Net return per earning (%)
Govt.	2.85	970.5	5.6	8.9
Govt.	0.58	181.7	6.6	16.6
Private	10.52	2,370.4	14.7	32.8

High profitability of fish culture operations is indicated by Private management. A break up of cost composition showed more recurring expenditure on managerial staff (49.3% × 83.1%) and less on labour (1.6% and 5.0%). It is reverse in the case of private sector (managerial cost 5.7% and labour 66.8%).

#### *Project 12: Exotic Fish Culture*

Problem : 12.1 Standardization of techniques of breeding of grass and silver carps

Duration : 5½ years (incl. 2½ years extension)

Personnel : S. B. Singh, P. C. Chakrabarti

38 sets of grass carp and 39 sets of silver carp were injected with fish pituitary hormones, and only 8 and 14 sets respectively gave positive results. Early monsoon and poor condition of females possibly were responsible for poor results. The total spawn produced were 1,01,000 grass carp and 41,000 silver carp. Complete natural spawning in injected grass carp and partial in silver carp (without stripping) were repeatedly encountered. Favourable weather conditions gave encouraging results as observed previously. Initially when the weather was rainy, sufficient freshwater had accumulated and water temperature ranged between 27 and 30°C, 100 per cent success in induced breeding was obtained. However, large scale destruction of fertilized eggs inside breeding *hapas* was caused by small tilapia in the pond from outside the *hapas* hence another outer nylon *hapas* was used which saved the eggs from this menace.

Problem : 12.2 Mono-culture of silver carp

Duration : Three years

Personnel : S. B. Singh, P. C. Chakrabarti, M. M. Bagchi

The experiment initiated in 1969 in two 0.12 ha ponds stocked at 4,000/ha with fingerlings of silver carp (initial av. wt. 46 gm) was concluded after one year. The final average weight of fish attained was 700 and 458.5 gm in the two ponds, and the gross/net production worked out as 1,558/1,374 and 1,923/1,739 Kg/ha/yr respectively.

In a short term mono-culture experimental set up in a 0.12 ha pond, silver carp fingerlings (6 gm) stocked at 1,500/ha, attained an average weight of 131 gm in one month.

Problem : 12.3 Food preferences of grass carp  
Duration : 5½ years  
Personnel : S. B. Singh, P. C. Chakrabarti, M. Rout

A series of experiments to screen suitable feeds for grass carp were conducted. In an experiment conducted inside *hapas* for one month giving guinea grass, leaves of cauliflower, cabbage and *Ipomoea* (terrestrial species) at 100 gm/day and keeping control without feeding, the gain in average weight obtained was 28.5, 25.0, 14.0 and 5.6 gm respectively with the feeds as against the loss in weight (-1.9 gm) in control. In another experiment conducted inside *hapas* grass carp fed with guinea grass at 500 gm/day and *Ficus* fruit at 125 gm/day, the gain in average weight in one month was 30 and 12.5 gm respectively, suggesting the utilization of *Ficus* fruits by the fish

Feeding experiment of grass carp with guinea grass was initiated in two 0.04 ha ponds free from water weeds. In each pond 40 fish, weighing on an average 194 and 199 gm were introduced, feed was given at 4 and 8 Kg/day in the two ponds and within two weeks the fish considerably improved in health and weighed 276 and 315 gm on an average respectively. During the next two weeks the feeding rates followed were 1 and 2 Kg/day, when lot of feed remained unutilized, and an additional increase of 82 and 116 gm in fish weight was recorded. The feeding rate was increased to 2 and 3 Kg/day, the increase in weight in subsequent 2 weeks was 49 and 54 gm respectively. With further increase in feeding rate of 4 and 5 Kg/day, the gain in weight recorded was only 12.5 and 16.9 gm within 4 weeks.

#### Project 13: Cold water fish culture

Problem : 13.1 Control of whirling disease in adult trout (Research completed)  
Problem : 13.2 Food and feeding habits of trout (Research contemplated)  
  
Problem : 13.3 Standardisation of trout culture techniques  
Duration : Three years  
Personnel : K. Sehgal, K. V. Ramakrishna, C. B. Joshi, Shyam Sundar, M. J. Bhagat and Kuldip Kumar

The hatching trays stocked with the green eggs of brown trout @ 3,000, 2,000 and 1,000 gave an average survival percentage up to eyed-ova of 93.94, 96.69 and 98.32 respectively at Laribal and 92.84, 86.48 and 92.86 at Harwan.

The use of Malachite green, (1:2,00,000 for 1 hr) to control fungus, gave 99.24% survival in treated against 90.58% in control troughs at Laribal and 85.51% in treated against 15.99% in control troughs at Harwan. The green egg mortality was due to fungus, white spot, uncertain water supply and silt deposition. The 'thinning' operation of the trays and troughs was done in January and February at Laribal and Harwan respectively. The hatching of eggs and absorption of yolk sac was completed in March at Laribal and in April at Harwan. The cumulative percentage of survival from green egg to fry stage was 94.96 in treated against 83.32 in control troughs at Laribal and 55.73 in treated against 6.07 in control troughs at Harwan. The newly hatched fry numbering 12,280 at Harwan and 20,022 at Laribal were stocked in 3 and 4 nursery ponds respectively. The fry in the beginning was given finely minced hen's yolk for the first fortnight and then changed to hen's yolk + liver in equal ratio. The rate of feeding was 2.5, 5.0 and 7.0% of body weight in both the farms. In May there was a heavy loss of brown fry both at Laribal and Harwan due to escape from the nursery ponds. The remaining fry in the ponds were rearranged in June and were fed with pure liver. By the end of June the diet was changed to liver + Aurofac + TM 5 + silkworm pupae in percentage of 50.00, 21.45, 21.45 and 7.10 respectively by weight. The rate of feeding was 10.0 and 15.0% at Harwan and 15.0% at Laribal. The feeding of brown fry was continued till October. Due to certain constructional drawbacks there was an escape of large number of fry from the ponds and the experiment was spoiled. As a result, only 94 fingerlings in the size-range of 100-150 mm in total length were recovered and handed over to the State Fisheries.

Rainbow breeders were segregated in February and fed daily with partially boiled fish @ 2.0% body weight. Stripping operation commenced in the first week of March. The breeders ranged 280-375 mm ♀ and 285-387 mm ♂ in total length. The range of weight was 400-750 gm ♀ and 350-800 gm ♂. The average percentage of fertilisation was 83.47% while the average number of eggs/Kg body weight was 1,586. In all, 16,650 green eggs were stripped and stocked in the hatching trays at the rate of 3,000, 2,000 and 1,000 in replicates of 2 each. The average percentage of survival upto eyed-ova was 41.66, 78.90 and 77.76 respectively. The average percentage of survival upto eyed-ova was 82.68 in Malachite green treated against 34.69 in control troughs. The cumulative percentage of survival from green egg to fry stage was 57.77 in treated against 17.12 in control troughs. The fry numbering 7,340 were handed over to the State Fisheries Department.

In October 100 ♀ and 94 ♂ breeders at Laribal and 100 ♀ and 100 ♂ breeders at Harwan were selected and segregated. The breeders were given a diet of partially boiled fish at the rate of 2% body weight. The stripping operation commenced in the third week of November and was completed by the end of the month. The breeders ranged 205-380 mm in total length and 100-750 gm in weight at Laribal and 205-405 mm in total length and 150-950 gm in weight at Harwan. The average number of eggs/Kg of body weight was

1,483 at Laribal against 1,135 at Harwan. The average percentage of fertilisation was 93.0 at Laribal and 90.5 at Harwan. The total number of eggs stripped was 35,304 at Laribal against 27,819 at Harwan. The 'eyeing' of green eggs at Laribal started in the third week of December and was complete by the end of the month.

Preliminary experiments on hybridisation in trout have been initiated at Achhabal farm in Kashmir.

Problem : 13.4 Propagation of mirror carp in hilly areas  
(Research completed)

Problem : 13.5 Survey of mahaseer seed resources in Jammu  
(Research completed)

Problem : 13.6 Assessment of productive potential of high altitude lake  
Duration : Three years  
Personnel : K. V. Ramakrishna, C. B. Joshi and Shyam Sunder.

The catch/man/hr during January-December ranged 117-557 gm at Hazaratbal and 211-658 gm at Saidakadal. The dominant species recorded in the fish catches were *Schizothorax esocinus*, *S. niger*, *S. micropogon*, *S. curvifrons*, *C. carpio*, *Crossochilus latius* and *Botia birdi*.

The physico-chemical factors of the lake at the two centres were in the following ranges : depth, 1.80-4.25 m ; turbidity, 73.0-298.0 cm ; water temperature, 3.5-30.0°C ; pH, 7.4-8.8 ; dissolved oxygen, 8.4-12.0 ppm ; free carbon dioxide, 0.0-8.0 ppm ; total alkalinity, 80.0-180.0 ppm and silicates, 0.43-1.37 ppm.

The surface net plankton ranged 1-143 u/l at Saidakadal and 23-18,955 u/l at Hazaratbal. The  $\frac{1}{2}$  metre organdie tow netting samples gave a range of 810-70,687 u/min at Saidakadal against 16,297-1,55,265 u/min at Hazaratbal. The predominant forms recorded in the net plankton were *Amphora* sp., *Navicula* sp., *Synedra* sp., *Fragilaria* sp., *Gomphonema* sp., *Eunotia* sp., *Cymbella* sp., *Brachionus* sp., *Asplanchna* sp., *Conochilus* sp., *Polyarthra* sp. and *Cyclops* sp. The vegetation in the lake consisted of *Myriophyllum* sp., *Potamogeton* sp., *Salvinia* sp., *Nymphaea* sp., *Ceratophyllum* sp. and *Hydrilla* sp. The fauna inhabiting the vegetation was dominated by Nematoda, Cladocera, Copapoda and Diptera. Their respective percentages were 11.27, 42.91, 15.43 and 29.36 at Saidakadal and 20.86, 39.32, 8.45 and 29.46 at Hazaratbal. The bottom biota analysis has shown that Naididae, Tubificidae and Chironomidae were the dominant inhabitants in the lake. Their respective percentages were 19.53, 39.58 and 28.68 at Saidakadal against 88.27, 8.94 and 2.64 at Hazaratbal.

Problem : 13.7 Creel census of certain trout streams in relation to ecological conditions  
(Research completed)

Project 14: Riverine and estuarine fish catch statistics

Problem : 14.1 Fish catch statistics of the middle stretch of the Ganga river system

Duration : 4 years

Personnel : (a) K. K. Ghosh, S. Jena, S. K. Wishard, G. N. Srivastava and N. K. Srivastava  
(b) S. N. Mehrotra

(a) *Fish catch statistics* : Data on market arrivals at various araths located at Sadiapur, Rasulabad, Daraganj, Meja Road, Mirzapur and Chunar were collected under a pilot survey to assess the variation patterns in the landings to find the best estimators of daily mean landings. From the data gathered so far, analysis suggests that the estimation of mean landings per day can be best estimated on an arath basis, with araths stratified into two categories. The coefficient of variation of mean landings per arath-day for the important high activity araths, which, on the average, were estimated to account for over 90% of the total marketed quantity, was found to be around 50%. The best plan of sampling the days and araths will only be known after the analysis of variance tables are computed. The correlation between number of araths and mean landings per arath per day within a market appears to be significant. Hence a ratio estimate based on the number of araths as the concomitant variable may be more suitable, especially since the coefficient of variation of the number of araths per centre appears much lesser than that of mean landings per arath day.

The correlation between landings on successive days being of a high order, cluster choice may have to be of small size. The efficiency of different systematic plans is under study.

The only landing centre covered regularly during the pilot survey showed that almost all the catches landed there are brought to the market at Sadiapur.

The market arrivals of catches from the Ganga coming to the assembly centre at Buxar were collected during the year 1970 on a complete enumeration basis excepting holidays. The estimated specieswise landings at Buxar were *C. mrigala* 261.4 Kg; *C. catla* 462.0 Kg; *L. rohita* 592.3 Kg, *L. calbasu* 160.5 Kg, *M. aor* 1,107.1 Kg, *M. seenghala* 563.8 Kg; *W. attu* 58.7 Kg; *M. ilisha* 15,698.3 Kg; and Miscellaneous species 4,110.4 Kg.

A fall of 61% in annual landings of 1970 as compared to the average landings of earlier 8 years was observed. The most notable fall being in the landings of the group classified as 'others'. Against an earlier 8 years' average of 25.17 t, only 4.11 t were landed, showing a short fall of over 84%. Hilsa landings were also lower, but much nearer the average than others. The composition of the catches of other fishes did not vary much from the average, although the absolute landings were much lower.

(b) *Primary productivity of Ganga river system*: As in the previous years the observations were made at three centres, one on the Yamuna river and two

on the Ganga river, one above and one below the confluence. Primary organic production of the Ganga water upstream of confluence ranged between 300-1,537.5 mg C/m<sup>3</sup>/6 hr; the Yamuna water, between 75-1,125 mg C/m<sup>3</sup>/6 hr and the Ganga water below the confluence, between 300-1,350 mg C/m<sup>3</sup>/6 hr during the period under report. Minimum carbon fixation was recorded in September at every centre, but maximum value was first observed in the Ganga river above the confluence in April followed by the Ganga river below the confluence in May. The river Yamuna had peak value in June.

Problem : 14.2 Fish catch statistics of the lower stretch of the Ganga river system  
 Duration : Four years  
 Personnel : G. N. Mukherji, S. N. Sar, R. C. Singh, B. L. Pandey, R. N. Seth, A. Sarkar and K. S. Banerjee

(a) *Fish catch statistics*: The total annual landings of fish from the lower stretch of the Ganga river system from Sultanganj to Lalgola were estimated to be 320.42 t, as against 400.08 t in the previous year, thereby showing a decline by 19.91%. The percental contribution of individual sampling centres Bhagalpur, Rajmahal, Dhulian and Lalgola, were 32.20, 18.06, 24.45 and 25.29 respectively. Contribution of different species at various centres is presented in the table 23.

Table 23. Centre-wise fish landings (in tonnes) in the lower stretch of the Ganga river

Species	Bhagalpur	Rajmahal	Dhulian	Lalgola	Total
<i>C. mrigala</i>	4.65	0.18	0.93	0.02	5.78
<i>C. catla</i>	8.34	0.59	1.90	—	10.83
<i>L. rohita</i>	3.72	0.23	0.52	0.05	4.05
<i>L. calbasu</i>	0.84	0.12	0.13	—	1.09
<i>M. aor</i>	6.13	1.28	1.14	0.01	8.56
<i>M. seenghala</i>	8.13	1.30	0.01	0.01	10.54
<i>W. attu</i>	16.49	1.74	3.78	0.01	22.02
<i>H. ilisha</i>	1.47	13.75	34.13	72.37	121.72
Miscellaneous	53.39	38.67	34.71	8.59	135.36
Total	103.16	57.86	78.34	81.06	320.42

At Bhagalpur the production has registered a decline by 12.34% and at Rajmahal by 29.16% as compared to that of the previous year. At Bhagalpur miscellaneous species were the prime contributors (51.71%) followed by cat fishes (29.80%), major carps (17.06%) and *H. ilisha* (1.43%). Miscellaneous species again contributed maximum (66.83%) followed by *H. ilisha* (23.70%), catfishes (7.47%) and major carps (1.94%) at Rajmahal. At Dhulian, the production showed a decline of 20.33% probably due to a decline in the

fishery of *H. ilisha* (39.93%) this year. At Lalgola the high yield (81.06 t) during the year was mainly due to heavy catches of *H. ilisha* in July contributing 96.89% of the total production at Lalgola centre. However, the production at Lalgola has also shown a decline of 20.83% over that of last year.

(b) *Primary productivity* : The average rate of gross organic productivity in the lower stretch of the river Ganga at Bhagalpur during the year was estimated to be 390 mg C/m<sup>3</sup>/day, as against 800 mg C/m<sup>3</sup>/day during the year 1969, thus registering a decline by 51.25%. The value was maximum in the month of November (780 mg C/m<sup>3</sup>/day) and minimum in the month of December (170 mg C/m<sup>3</sup>/day). A gradual decline in the value of gross productivity was noticed from January (660 mg C/m<sup>3</sup>/day) to September (200 mg C/m<sup>3</sup>/day). The rate of net organic productivity was estimated to be maximum during May (390 mg C/m<sup>3</sup>/day) and was seen to be generally low during the monsoon months, varying between 100 mg C/m<sup>3</sup>/day in September and October and 250 mg C/m<sup>3</sup>/day in August. The minimum value was, however, recorded in December (60 mg C/m<sup>3</sup>/day). Turbidity and water temperature were found to be inversely proportional to the gross productivity, the values for the former being high during the monsoon months when low gross productivity was recorded.

The maximum density of phytoplankton was found to be associated with high gross productivity during the post-winter months : February (2,166 u/l), March (2,107 u/l) and May (4,666 u/l). Phytoplankton dominated over the zooplankton throughout the year, with the ratio of zooplankters and phytoplankters varying between 1:3.8 in April and 1:79.4 in November. The zooplankters were most abundant in April (423 u/l). *GonantozYGON* sp. and *Microcystis* sp. among phytoplankters, and *Keratella* sp., *Brachionus* sp. *Bosmina* sp., *Trichocerca* sp. and *Notius* sp. among zooplankters dominated the plankton at Bhagalpur.

Problem : 14.3 Fisheries of the river Godavari  
(Research completed in 1969)

Problem : 14.4 Fish catch statistics of the Hooghly-Matlah estuarine system

Duration : Four years

Personnel : P. Datta, G. C. Laha and P. Mitra

During the period (December 1969 to November 1970), a total of 9,944.0 t. of fish was landed from the Hooghly-Matlah estuarine system. Zone III (*i.e.*, lower Sunderbans) contributed 79.1% of the total catch, while zones I, IV, II and V contributed 10.7, 5.7, 3.3 and 1.2% respectively.

The dominant species in the catches were : *H. ilisha* (19.3%), *H. nehereus* (16.9%), prawns (14.7%), *S. phasa* & *S. taty* (7.4%), *T. savala* & *T. haumela* (3.5%) and *T. jella* (3.3%). The actual landings of these species were : *H. ilisha*—1,917.0 t, *H. nehereus*—1,683.2 t, prawns—1,466.3 t, *S. phasa* & *S. taty*—731.2 t, *T. savala* & *T. haumela*—344.9 t, *T. jella*—329.2 t. Remarkably high

contribution of *H. ilisha* (739.6 t) i.e., above 38.5% of the total hilsa catch was recorded in August-October.

Among gears, bagnets, as usual, contributed maximum (52.3%) to the total catch followed by large seines (13.5%), drift-nets (13.2%) and small seines (8.9%), the actual landings from these nets being 5,198.7, 1,345.0, 1,314.0 and 889.5 t respectively. However, in the month of September, drift-nets led over bagnets with 51% (382.3 t) of the catch as against 31% (235.1 t) for bagnets.

Problem : 14.5 Fish catch statistics of the Puncat lake  
Duration : Three years  
Personnel : Ch. Gopalakrishnayya, K. Janardhana Rao, S. Srinivasagam, P. M. Abdul Kadir and K. Gopinathan

The total landings from the Pulicat lake were 1170.964 t registering a rise of 2.65% over the previous year (1969). The maximum catch of 178.404 t was in January and the minimum of 74.180 t in July.

Prawns contributed 566.54 t. *Penaeus indicus*, *Metapenaeus monoceres* and *M. dobsoni* formed 59.28, 13.44 and 9.60% of the total prawn catch

Mullets contributed 214.61 t. *Mugil cephalus* (53.48%), *M. cunnesius* (16.02%), and *M. tade* (13.46%) were the main contributors.

Clupeids amounted to 125.57 t. The important species were *Nematalosa nasus* (55.92%), *Chanos chanos* (13.03%) and *Thrissocles* spp.

Crabs occupied the next place (89.4 t). *Scylla serrata* and *Neptunus pelagicus* formed 54.53 and 45.47% of the crab landings respectively.

Perches accounted for 87.35 t. The important species were *Sillago sihama* (22.80%), *Siganus* spp. (14.88%) and *Gerres* sp. (11.59%).

The gear wise split up was : stake nets 378.40 t, drag nets 273.65 t, shore seine 108.80 t and hook & lines 95.57 t.

### Project 15: Fish Pathology

Problem : 15.1 Etiology and control of parasitic diseases of cultured warmwater fishes  
Duration : Four years  
Personnel : Y. R. Tripathi, R. N. Pal and A. K. Ghosh

15.1.1 Investigations on the parasitic diseases of cultivated fishes : *Trichodina*, *Gyrodactylus*, *Dactylogyrus*, *Myxobolus*, *Thelohanellus*

During the year under report, 1,699 spawn of Indian major carps (6 to 14 mm in length) were examined and none of them were found to be infected with any external parasite.

793 fingerlings of Indian major carps collected from Midnapur district of West Bengal were examined. Percentage of infection with *Trichodina* sp. on catla, rohu and mrigal was 0.77, 0.89 and 0.72 respectively. 0.36% catla and 0.40% mrigal suffered from the attack of *Myxobolus* sp. Intensity of infection of *Thelohanellus* sp. on catla and rohu was 0.15% in both the species. Infections of monogenetic trematodes were 0.3, 0.9 and 0.1% on catla, rohu and mrigal respectively, showing that infection is not wide spread.

*Jute-retting experiments*: Two sets of experiments were conducted to study the effect of jute-retting on the survival of air-breathing fishes in two tanks in Jute Agricultural Research Institute, Nilgange. Though experiments could not be completed due to natural calamities, yet mortality of test animals was observed in the cages, made of nylon netting. This was due to depletion of oxygen. The affected fry and fingerlings of *Heteropneustis fossilis*, *Anabas testudineus* and *Channa punctatus*, used as test animals during the experiments, were 75 & 117 mm 30 & 51 mm and 47 & 59 mm in length respectively. Initial readings of pH and D O were 7.9 and 2.4 ppm whereas the final readings, after 7 days were 7.6 and nil respectively.

Three sets of experiments were conducted in the cement cisterns in the laboratory. 7 cisterns were used where the dose of raw jute sticks (*Chorchorus olitorius* and *C. capsularis* were used separately) 1:10, 1:20, 1:30 with one control. Initial readings of turbidity, temperature, pH, DO, CO<sub>2</sub>, COD, total alkalinity were in the ranges of 38-49 ppm, 26°C, 7.9-8.0, 0.24-0.40 ppm, 72-216 ppm, 20.8-76.8 ppm and 324-392 ppm respectively. Final readings (after 4 days) were in the ranges of 62-170 ppm, 25°C, 6.6-7.8, nil, 28-132 ppm, 24.8-115.2 ppm and 218-356 ppm. Jute-retting scums, were observed on the surface of waters which might have resulted in the mortality of the test animals in the cisterns irrespective of the dose. Fishes could withstand oxygen deficiency for one day when they were coming up and resting on the jute sticks.

#### 15.1.2 Studies on epidemical diseases

There was no report of epidemic mortalities from fish farmers during the year.

#### 15.1.3 Studies on parasites of freshwater prawns

During the year under report 3,055 prawns (*Machrobrachium rosenbergii*, *M. mirabile*, *M. dayanum* and *Cardina nilotica*, *M. malcolmsonii*, *M. villosimanus*, *M. rude*, *M. lamarrei*, and *M. scabriculum*) were examined and the first four species mentioned above were free from infection. *M. malcolmsonii*, *M. villosimanus*, *M. rude*, *M. lamarrei* and *M. scabriculum* were found infected with *Palaegyge* spp. (Bopyridae, Isopoda); the intensity of infection was 21.90, 1.32, 6.06, 5.64 and 0.67% respectively. Parasites of *M. malcolmsonii*

and *M. villosimanus* were identified as *P. bengalensis*. Parasites encountered from *M. dayanum* and *M. lamarrei* were *P. prashadi*. It was observed that the parasites adversely affected the growth and sexual development of the hosts. Intensity was more during monsoon and decreased during summer.

#### Project 16: Weed Control

Problem : 16.1 Standardisation of methods of control of emergent and floating weeds with hormone weedicides.

Duration : Three years

Personnel : V. Ramachandran, T. Ramaprabhu, S. Patnaik, P. V. G. K. Reddy and K. M. Das

In field trials, about 3.7% of 2,4-D sodium salt with 0.25% detergent has been found to be highly effective against *Colocasia* sp. and *Ipomoea cornea*.

Yard and field experiments indicate that 2,2-dichloropropionic acid is highly effective against *Panicum* sp. at 10.15 Kg a.i./ha, but regeneration takes place within 2-3 months after treatment.

Gramoxone (a.i. 20% paraquat) at the rate of 0.1-0.2 Kg a.i./ha achieved more than 90% clearance of *Pistia* sp. infestations.

Problem : 16.2 Control of algae in fish ponds

Duration : Three years

Personnel : S. Patnaik, V. Ramachandran, P. B. G. K. Reddy and K. M. Das

From a ecological study of five ponds, it was observed that *Microcystis* sp. was forming blooms, showing density variation between 0.0009 and 61.08 millions/l when the pH of water body varied from 7.2 to 9.5. The associated phytoplankton and zooplankton forms along with physicochemical features of water have been studied. Minimum effective dose of available weedicides that will control the blooms and their effect on fish and fish food organisms in the field are being determined.

Problem : 16.3 Evolution and evaluation of weedicide formulations

Duration : Continuing

Personnel : V. Ramachandran, S. Patnaik, T. Ramaprabhu, P. V. G. K. Reddy and K. M. Das

Simazine and Copper sulphate @ 8 and 32 Kg/ha respectively in formulation with sand granules of 1% a.i., have been found to be effective against *Hydrilla* sp. and *Najas* sp. in field plots in a large weed infested lake.

Toxicity tests with gramoxone and simazine on *Cyprinus carpio* (90-126 and 17-24 mm respectively) indicate 50% mortality in the case of gramoxone and no mortality at 5 and 10 ppm a.i. in the case of simazine.

Problem : 16.4 Standardisation and evaluation of the use of ammonia as an aquatic weedicide/fertilizer

Duration : Four years

Personnel : V. Ramachandran, T. Ramaprabhu and P. V. G. K. Reddy

In field trials, spray of 1-1.5% aqueous solution of ammonia with 0.25% detergent was able to kill the floating infestation of *Pistia* sp. and *Salvinia* sp. within a few days.

Problem : 16.5 Eradication of weeds by treatment of bottom soil

Duration : Two years each pond

Personnel : E. Mitra (Miss), A. C. Banerjee, M. K. Banerjee (Later Sri S. C. Thakurta for plant analyses work)

In a big lake thickly infested with *Hydrilla verticillata*, *Vallisneria spiralis* and *Ceratophyllum demersum*, two separate sectors were treated with copper sulphate in mud pellets @ 75 Kg/ha. The intermittent doses were applied in one sector as 35, 10, 15 and 15 Kg/ha and in the other sector as 35, 20 and 20 Kg/ha. In both the sectors the underground parts of all the plants decayed and were removed by manual labour where they floated up. The dissolved oxygen in water was almost nil initially and increased to 8.0 ppm when 90% of vegetation was destroyed by the treatment.

Under laboratory conditions, it has been observed that the major carps (30-40 mm) when present in aquarium with the bottom soil treated with copper sulphate (3 intermittent doses of 35 Kg/ha each), absorbed copper ions to some extent in the flesh. Before treatment, the dried fish flesh had copper 1 mg/100 gm of flesh which increased to 4 mg/100 gm after the treatment when copper ion concentration was maximum in the water.

*Associated problem:* To make use of eradicated weeds in the form of compost for manuring fish ponds, *Hydrilla verticillata* was made into compost and laboratory experiments were conducted. The jars with compost as substratum gave maximum growth of plankton and maximum concentration of phosphate and nitrate in water was also observed.

Problem : 16.6 Autecology of *Vallisneria spiralis*

Duration : Two years

Personnel : E. Mitra (Miss) and A. C. Banerjee

Natural pond collections have shown that the plants thrive healthily in abundance in waters with pH varying from 6.8 to 9.5, dissolved oxygen from 0.800 to 16.728 ppm, total alkalinity from 54 to 276 ppm, phosphate from trace to 4.0 ppm, nitrate from trace to 2.0 ppm, magnesium from 2.40 to 19.32 ppm, calcium from 17.6 to 158.0 ppm, iron from 0.05 to 8.00 ppm and potassium from 18.5 to 46.0 ppm.

Vegetative reproduction and germination of seeds have been studied in detail.

*Project 17 : Frog Farming*

Problem : 17.1 Induced breeding of commercially important species of Indian frogs

Duration : Four years

Personnel : A. K. Mondal, R. K. Jana and P. Gopalakrishna

22 and 5 sets of *Rana tigrina* and *R. hexadactyla* respectively were bred during their pre-breeding and breeding seasons, using homo- and heteroplastic pituitary gland extracts. The time lag between injection and final stripping has been further reduced from 18-20 to 4-5 hr in the former and 7-8 hr in the latter species. An effective dose of 10 mg/Kg body weight of recipients is recommended for general adoption. Artificial fertilization of eggs by dry method with sperm suspension resulted in cent per cent success.

10 and 3 sets respectively of *R. tigrina* and *R. hexadactyla* were bred with progesterone alone and in combination with pituitary extracts. In 2 of the 3 sets of former species, ovulation could be induced with chronic gonadotropin.

Induced spawning through hypophysation in *R. crassa* was attempted with cent per cent success.

Problem : 17.2 Raising and rearing of tadpoles to early frogs of indigenous commercial species

Duration : Five years

Personnel : A. K. Mondal, R. K. Jana and P. Gopalakrishna

Cannibalistic habit of *Rana tigrina* has been markedly reduced by 50-60% through inter specific hybridization with *R. crassa*. Methods of culture of tubifex, a preferred food item of tadpoles, juveniles and adults of *R. tigrina* and early frog stage only of *R. hexadactyla* have been successfully developed by using drainage silt, mustard oilcake and cowdung.

Of the various plant parts of *Barringtonia acutangula*, *Randia dumetorum* and *Millettia auriculata* so far tested in order to develop a suitable methodology for assessing survival of tadpoles in field nurseries, only stem bark of *Millettia* has been found useful in assessing survival of early tadpoles of *R. tigrina*.

Incidental to various induced breeding experiments, nearly 1.4 lakhs of tadpoles of the above species (*R. crassa* excluded) were produced during the frog breeding season.

Problem : 17.3 Culture of frogs and study of productivity in frog farming

Duration : Five years

Personnel: A. K. Mondal, P. Gopalakrishna and R. K. Jana

In an experiment on productivity study, initiated during April 1970 in a 0.04 ha weed infested pond, with early frogs of *R. hexadactyla* stocked at 6,000/ha, the frogs had attained an average size of 96 mm/116.3 gm in about 8 months.

Problem : 17.4 Fish-cum-frog culture  
Duration : Initially five years  
Personnel : A. K. Mondal, P. Gopalakrishna, R. K. Jana and D. P. Chakraborty

An experiment on the possibilities of joint rearing of frog and fish was carried out during 1970 in three 0.08 ha fenced ponds. Early frogs of *R. hexadactyla* were stocked at 6,000/ha along with early fingerlings of Indian major carps at 4,000/ha and in the ratio of catla 3: rohu 3.75: mrigal 3.25, against frog and fish controls. The frogs were found to grow to an average size of 100 mm/124 gm in the control ponds, as against 98 mm/119.7 gm in the experimental pond. The fishes had attained an average size of 316 mm/459 gm (catla), 387 mm/723 gm (rohu) and 345 mm/424 gm (mrigal) in the control pond, as against 326 mm/486 gm (catla), 339 mm/470 gm (rohu) and 346 mm/430 gm (mrigal) in the pond where they were jointly reared with frogs. The production of *R. hexadactyla* and major carps in the experimental pond was 283.8 and 1,419 Kg/ha, as against the individual production of 378.2 and 1,925.1 Kg/ha respectively of frog and fish in the control ponds, in about 9 months.

The results so far obtained indicate that extra frog raising is possible in fishery waters.

Problem : 17.5 Stock building of *Rana catesbeiana*  
Duration : Initially five years  
Personnel : A. K. Mondal

No progress in the stock building work was made, since the breeders kept in two fenced ponds had escaped into the nearby fish farm during the breeding season since fencing collapsed by the end of April during the cyclonic weather and subsequent rains and flooding of farm in the later part of the year.

#### Project 18: Ecology of sewage fed fisheries

Problem : 18.1 Sewage fed fisheries  
Duration : Two years  
Personnel : Y. R. Tripathi, B. N. Saigal, R. R. Khan and P. K. Chakrabarti

Privately managed sewage fed ponds of Titagarh Municipality near Khardah Railway Station were taken up in September, 1970 for research investigation to ascertain the factors responsible for high fish production in

sewage fed fish ponds with a view to achieving optimum per hectare production in such ponds. To initiate the investigation, a pond of c. 2.5 ha area was chosen.

Physico-chemical factors for the pond during September to December, 1970 were as follows:—

Colour of the water: greenish; water temperature: 19.5-32.5°C; air temperature: 17.0-32.2°C; pH: 7.4-8.1; turbidity: <85 ppm; specific conductivity of the water at 20°C: 78.47-82.18 mhos  $\times 10^{-6}$ ; dissolved solid: 380-580 ppm; suspended solid: 0.019-0.045 ppm; DO: 2.94-7.84 ppm; OC: 3.56-12.4 ppm; carbonate alkalinity: 0.0-37.4 ppm; bicarbonate alkalinity: 619.0-896.4 ppm; hydroxide alkalinity: nil; chloride —Cl: 78.92-86.46 ppm; nitrite—N: 0.168-0.417 ppm; nitrate—N: 0.092-0.306 ppm; free  $\text{NH}_3$ : 1.20-2.52 ppm; albuminoid  $\text{NH}_3$ : 0.00-0.72 ppm; Organic  $\text{PO}_4$ : 0.00-3.76 ppm; inorganic  $\text{PO}_4$ : 0.80-9.30 ppm and silicate ( $\text{SiO}_2$ ): 1.117-1.804 ppm.

Except in September and October, the weather was fair with clear sky and sunny days during the sampling dates. The primary productivity of the pond was estimated by dark and light bottle method which varied as 217.22-639.22 mg  $\text{C}/\text{m}^3/\text{hr}$  from September till December.

The plankton samples were collected from the sewage intake end of the pond and rear end of the pond separately by a standard plankton net at 07.00 hours. The fortnightly quantitative and qualitative analyses of the surface plankton samples were done. During September to December the phytoplankters ranged as 20-4,100 u/l and the zooplankters as 420-3,660 u/l. The zooplankton comprised *Actinophrys* sp., *Keratella* sp., *Filinia* sp., *Polyarthra* sp., *Trichocerca* sp., *Brachionus* sp., *Daphnia* sp., *Ceriodaphnia* sp., *Diaphanosoma* sp., *Leptodora* sp., *Cyclops* sp., nauplius, *Diaptomus* sp., *Limnocalanus* sp., *Eubranchius* sp., *Coleoptera* sp., *Notonecta* sp., and mosquito larvae and phytoplankton comprised *Spirulina* sp., *Anabaena* sp., *Merismopoedia* sp., *Mycrocystis* sp., *Polycystis* sp., *Oscillatoria* sp., *Volvox* sp., *Dictyosphaerium* sp., *Coelastrum* sp., *Ophiocytium* sp., *Pediastrum* sp., *Gonatozygon* sp., *Nitzschia* sp., *Synedra* sp., and *Melosira* sp.

The bottom fauna and the soil samples have been collected.

#### Project 19: *Hilsa* investigations

Problem : 19.1 *Hilsa* fisheries of the middle stretch of the Ganga river system  
Duration : Five years  
Personnel : Ravish Chandra, V. R. Desai and S. K. Das

Observations on winter spawning of *hilsa* were initiated in September and were continued till November. The collection were made at 5 centres; viz., Mahewapatti on the Yamuna river, and Sirsa, Vindhychal, Sindhoraghat and Sujabad on the Ganga river. The catch/net/hr of prelarvae and postlarvae are shown in table 24.

Table 24. Weekly catch/net/hr of pre- and post-larvae of hilsa

Centre	Weeks of October				Weeks of November			
	I	II	III	IV	I	II	III	IV
<i>Prelarvae</i>								
Mahewapatti	48.16	143.33	383.00	—	0.16	—	—	0.66
Sirsa	2.70	44.70	—	—	5.00	0.16	4.33	0.83
Vindhyachal	—	7.33	14.33	37.83	0.70	—	0.83	—
Sindhroraghat	43.33	147.00	752.70	620.00	—	1.50	33.00	2.83
Sujabad	47.50	46.70	27.50	47.70	15.70	2.00	2.70	—
<i>Postlarvae</i>								
Mahewapatti	—	—	62.50	—	0.16	—	—	—
Sirsa	1.00	0.83	4.70	—	32.33	0.33	0.83	0.33
Vindhyachal	3.17	0.83	9.70	3.00	10.83	2.33	18.00	17.77
Sindhroraghat	26.83	36.33	36.16	49.50	20.17	0.83	46.17	33.00
Sujabad	0.33	0.17	2.00	71.17	295.00	43.33	2.70	0.83

As is evident from the above table, the peak period of hilsa breeding, as observed in the past, was found to be middle and end of October. The intensity of breeding was poor during 1970 as compared to that of 1969.

Studies on bathymetric distribution of hilsa larvae have shown that the larvae and the postlarvae prefer surface waters than the subsurface waters.

Morphometric measurements of 70 specimens of hilsa from Sadiapur, 81 from Sirsa, 114 from Vindhyachal and 225 from Varanasi on the Ganga river were taken. The data are being processed.

Problem : 19.2 Hilsa fisheries of the lower stretch of the Ganga river system.

Duration : Five years

Personnel : K. V. Rao, G. N. Mukherji, S. N. Sar, B. L. Pandey and A. Sarkar.

The estimated landing of hilsa from the lower stretch of the Ganga river system was recorded to be 122.45 t against 179.13 t of the preceding year, thus registering a decline by 31.64%. The species contributed 38.16 and 44.77% to the total fish production of the lower sector during the years 1970 and 1969 respectively. The downstream areas of the stretch represented by Dhulian (34.80 t) and Lalgola (72.37 t) were highly productive, contributing 87.52% to the total production of the species. While Rajmahal (13.81 t) contributed considerably, the production at Bhagalpur (1.47 t) was practically negligible. A comparison between the years revealed that the production dwindled at all the centres of observation, the percental decline being 80.56 at Bhagalpur, 38.57 at Rajmahal, 38.75 at Dhulian and 21.57 at Lalgola over that of the preceding year. The month-wise production of hilsa at individual centres reveal that the period June to November accounted for 92.05% of the total production.

The 'broader' variety contributed 49.58% to the total production, while 'slender' and 'broad' varieties contributed 24.16 and 26.42% respectively. The 'slender' variety formed the mainstay in the fishery at Bhagalpur (63.74%),

Rajmahal (53.01%) and Dhulian (47.25%). The catches at Lalgola centre (64.95%) comprised of 'broader' variety. The 'broad' variety formed 19.21, 22.17, 25.76 and 27.56% of the total catches at Bhagalpur, Rajmahal, Dhulian and Lalgola respectively. The distributional pattern of individual varieties during different months showed that while at Bhagalpur and Lalgola 'slender' and 'broader' subpopulations respectively dominated throughout the year, at Rajmahal and Dhulian, the former sub-population dominated the catches during post winter and monsoon months and the winter fishery at these centres comprised of 'broader sub-population only. The 'broad' variety contributed in varying degrees at different centres.

The mean sizes of the fish in the catches at Bhagalpur were estimated to be 361.3, 387.6 and 432.1 mm for 'slender', 'broad' and 'broader' varieties respectively. When compared to those of 1969, a decline of 32.5 mm in the mean size of 'slender' variety, which dominates over the other two, was recorded. The population at Lalgola exhibited the decline in the mean size of all the three varieties when compared to that of 1969. It was computed to be 355.0 mm for 'slender', 360.0 mm for 'broad' and 344.0 mm for 'broader' varieties. An appreciable reduction by 32.2 mm was registered in the mean size of the dominant subpopulation. Same trend was discernible in the mean weight of the individual varieties at these two centres. The decline was drastic in respect of 'slender' subpopulation at Bhagalpur, the figures for 1969 and 1970 being 611.0 and 320.4 gm respectively. The mean weight of the 'broader' variety at Lalgola for 1970 was found to be 542.7 gm, as against 696.4 gm in the preceding year.

Studies on larval abundance of hilsa in the Ganga river indicated the occurrence of independent spawning activity in Bhagalpur, Rajmahal and Dhulian sectors. Two separate spawning seasons one during the late winter and post-winter months of February, March and April and the other during the monsoon months of June to October, as evidenced by the availability of 4 mm stage spawn in the 1/6" mesh shooting net and 1/2 m organdie tow net collections were observed in these sectors. The intensity of spawning, per 1,000 m<sup>3</sup> water filtered, was found to be higher during the post-winter months at all the three centres of observation. While the number per 1,000 m<sup>3</sup> water varied between 19.4 in May and 2,307.2 in April at Bhagalpur, it stood between 5.6 during April and 30.6 in February at Rajmahal and 27.8 in April and 35.3 in March at Dhulian. It further revealed that the spawning activity was of lower magnitude during the monsoon months, the number of larvae per 1,000 m<sup>3</sup> water ranging between 0.9 and 7.7 at Bhagalpur, 5.3 and 15.3 at Rajmahal and 0.6 and 8.9 at Dhulian. Two distinct spawning peaks were observed in this stretch, one in April and the other in August at Bhagalpur, in February and September at Rajmahal and in March and July at Dhulian. The availability of 4.0 mm stage at Beniagramghat, located at a distance of 1 Km downstream of the Farakka barrage, which is midway between Rajmahal and Dhulian, tends to indicate a continuous spawning belt in this stretch.

Problem : 19.3 Hilsa fisheries of the river Godavari  
 Duration : Five years  
 Personnel : T. Rajyalakshmi, P. L. N. Rao, G. R. Rao, L. H. Rao  
 and T. S. Ramaraju

Migration of *H. ilisha* to the Dowlaiswaram anicut grounds was poor in 1970 also. Market sampling to study the gonad maturity yielded the following results :

Month	Ratio of ♂ : ♀ (%)	Stage of maturity (females) in %			
		IV	V	VI	spent
September	39:61	22.5	47.7	29.8	—
October	40:60	—	63.0	37.0	—

Oozing males were predominant in the first wave of migration in July. Occurrence of heavy flood in August hindered full scale fishing operations. Females in IV and V stages occurred during August and a very few oozing females were encountered in September. About the time of breeding, i.e. by mid-September, the floods having failed, the migration of hilsa also failed, thus preventing further observations.

Tow net operations failed to yield any eggs or larvae during this season, unlike as in 1969.

Studies on ovary weight were conducted. Availability of fully mature ovaries was very poor during this season.

Problem : 19.4 Hilsa fisheries of the Hooghly-Matlah estuarine system  
 Duration : Four years  
 Personnel : Apurba Ghosh, V. Gopalakrishnan, K. K. Bhanot and  
 P. U. Verghese

Delimitation of Hilsa spawning grounds and estimation of spawning and survival rate.

To delimit hilsa spawning grounds and to assess spawning and survival rate, the stretch of the Hooghly estuary from Tribeni to Datrigram was taken up. Collections were made with shooting and tow nets at Tribeni, Balagarh, Medgachi, Kalna and Datrigram during monsoon (July-September). The data showed that the stretch at Tribeni was very poor for hilsa spawn. Except for occasional occurrence of fingerlings (45-60 mm) in shooting net collections, hilsa larvae were not encountered. At Balagarh (situated about 240 km up-stream from the sea face), both shooting and tow nets collected hilsa larvae in appreciable numbers. The average number of larvae/shooting net/hr during June, July and August were 9.55, 43.63 and 62.33 and corresponding numbers in tow net collections were 143.3, 45.25 and 6.33 respectively. During August, the shooting net collections indicated an abundance of hilsa larvae of various size groups (between 4-12 mm), while the tow net collected only very few larvae, probably the fast currents during monsoon made the operation of tow net ineffective.

Maximum quantity of larvae was collected on the 24th and 25th June, 1970 at Balagarh in tow net collection. The larvae were mostly between 3-4 mm

size range and were available in sluggish current adjoining the banks. The presence of spawn at Balagarh and their absence in the Tribeni region (below Balagarh) indicates that the breeding ground of *Hilsa ilisha* extends up to Balagarh and not further down, in the estuary. Among the centres situated above Balagarh i.e., Medgachi, Kalna and Datrigram, the maximum concentration of larvae was encountered at Datrigram (106/net/hr) in tow nets, in the month of July, 1970.

Problem : 19.5 Artificial propagation of *Hilsa ilisha* (Ham.)  
 Duration : Five years  
 Personnel : J. C. Malhotra, P. K. Mathur, M. Y. Kamal and S. N. Mehrotra

*Artificial fecundation* : Artificial fecundation of hilsa through, 'wet method' of stripping was again successfully achieved during March and October, 1970, in the Ganga river at Sirsa near Allahabad. Out of the fifteen experiments six were carried out in March, 1970 and nine during October, 1970 (Table 25).

Table 25. Details of the stripping experiments carried out during 1970

Date	Time (hours)	Details of females			Details of males			Eggs stripped (lakh)	Average fertilization (%)	Average hatching (%)	Remarks
		Total length (mm)	Maturity condition (G/Ps)	Total length (mm)	Maturity condition (Oz/Ps)						
9.3.70	16.15	390	G	315	Oz	6.30	80.0	45.0	* Breeder had		
9.3.70	16.35	490	G	305	Oz	7.50	82.0	40.0	died 60 min		
11.3.70	17.15	356	G	354	Oz	0.60	0.0	0.0*	earlier		
13.3.70	17.00	361	G	300	Oz	3.24	98.0	66.0	† ♀ had		
13.3.70	17.20	361	Ps	300	Ps	0.03	78.0	40.0 †	died 20 min		
15.3.70	17.30	345	G	279	Oz	0.68	72.0	64.3	earlier		
17.10.70	18.30	470	Ps	300	Oz	2.10	90.0	80.0			
17.10.70	19.00	490	G	365	Oz	9.60	95.0	85.0			
23.10.70	18.30	480	Ps	300	Oz	—	—	—	—		
				326	Ps						
				331	Ps						
				355	Ps						
25.10.70	17.55	468	Ps	330	Ps	4.35	95.0	80.0	Breeder had		
				329	Ps						
				325	Ps						
				325	Ps						
28.10.70	17.15	373	Ps	340	Oz	2.10	80.0	80.0			
28.10.70	17.15	369	Ps	409	Ps	2.70	80.0	80.0			
				340	Ps						
				340	Ps						
31.10.70	17.15	452	G	345	Ps	13.20	85.0	70.7			
				339	Ps						
				329	Ps						
				308	Ps						
				308	Ps						
31.10.70	17.15	452	Ps	324	Ps	1.00	85.0	70.0			
31.10.70	19.30	493	G	340	Ps	6.60	80.0	63.7			
				346	Ps						

Ps = Partly spent

G = Gravid

Oz = Oozing

The respective lengths of the females used in these experiments in March, 1970 ranged between 345 and 390 mm and that of the males between 279 and 354 mm. The rate of fertilization of eggs ranged from 72 to 98%. The respective lengths of the females and males employed in October, 1970 ranged between 369 and 469 and 493 and from 308 to 409 mm. It was observed that hilsa in the right stage of maturity suitable for stripping is available only in the day between 16.00 and 22.00 hours. In one experiment (No. 5) female which had died 20 minutes earlier was stripped and the rate of fertilisation was estimated to be 78%, but when parents either one or both of which had died 60 (No. 3) and 90 (No. 9) minutes earlier were stripped, no fertilization of the eggs took place.

*Hatching of fertilised eggs* : Experiments to hatch the resultant fertilised eggs were carried out in markin cloth *hapas* fixed in flowing waters (river, close to bank), in pond treated with lime (CaO) at the rate of 200 Kg/ha and in pond not treated with lime. In flowing waters, the percentage of hatching ranged between 40 and 90% during March and 50 and 90% during October. In treated pond, it was estimated to be 80% and in the untreated pond it was estimated to be only 25%.

The higher magnitude of hatching in riverine environment during March, 1970 (40 to 90%) and in October, 1970 (50 to 90%) could be attributed probably to higher values of Fe ions (0.16 to 0.22 and 0.60 to 2.20 ppm respectively) accompanied by higher values of the bivalent ions of Ca (162 to 225 ppm) during March, 1970, while during October 1970 the values of Ca ranged between 62.5 and 133.0 ppm. Higher values of Ca are probably necessary to counteract the adverse effects of Fe ions in water whose pH varied between 8.0 and 8.4, but when the pH varied from 7.4 to 7.6 comparatively low values of the antagonistic Ca ions (62.5 to 133.0 ppm) were sufficient. A close scrutiny of the data collected during March, 1970, revealed that the low magnitude of hatching in riverine environment (40 to 45%) could be attributed probably to comparatively low values of Ca (162.5 ppm) when the value of Fe ions was 0.18 and the pH of the water was 8.0. In the subsequent experiments carried out in the same environment, the values of Fe ions were 0.18 ppm which is not much different from those observed earlier and that of Ca ranged between 180 and 230 ppm and pH fluctuated between 8.2 and 8.4, while the percentage of hatching was estimated to range between 40 and 90%. This indicates that higher concentrations of Ca are probably necessary in waters of higher pH and containing higher contents of Fe, but when pH of the water is of low order, lower values of Ca appear sufficient to counteract, the probable adverse effect of comparatively higher values of Fe. Further, in the treated pond during hatching, the pH of the water was 7.8, while the values of Ca and Fe ranged between 150-177 and 0.40-1.14 ppm respectively and hatching was estimated to be about 80%. In the untreated pond, the respective values of pH, Ca and Fe were 8.2, 75 ppm and 0.56 ppm and the percentage of hatching was observed to be 25 only. These observations also add weight to the above assumption.

In the experiments carried out during October, 1970, it was observed that the percentage of hatching was of higher magnitude (80 to 90%) when pH fluctuated between 7.2 and 7.6 and values of Ca and Fe ranged between 62.5-133.0 and 1.00-2.20 ppm respectively, while the hatching was of low magnitude (50 to 70%) when pH was 7.6, and respective values of Ca and Fe were in the range of 75-88 and 0.60-1.00 ppm.

During October, nylon *hapas* of yellow and green colours were used along with the markin *hapas* and it was observed that in both the nylon *hapas* hatching took place  $2\frac{1}{2}$  hr earlier than in markin *hapas*. Further, the percentage of hatching in the former case was estimated to be about 90, while it ranged between 50 and 70 in the latter case.

*Transport of hilsa spawn:* Fertilised eggs were successfully transported in open polythene buckets of 10 l capacity @ 1.5 lakh eggs per bucket containing about 5 l of water, to distances requiring about 2 hr to cover. The rate of mortality was estimated to range between 5 and 10%. Successful experiments were also carried out for the transportation of hilsa spawn under oxygen in sealed polythene bags, of 18 l capacity in March. One lakh hatchlings (2.5 to 3.0 mm in T.L.) were packed in each bag containing 6 l of river water. The mortality was estimated to be about 30% for distances requiring  $2\frac{1}{2}$  hr to cover, while during the experiments carried out in October, mortality was reduced to 5% for distances requiring 5 hr to travel by reducing the number per bag from 1,00,000 to 75,000 and rearing the hatchlings to 3.0-3.5 mm size in river before transshipment.

*Rearing of hilsa hatchlings in confined freshwaters:* 1.25 lakh of hatchlings were stocked in a nursery pond measuring 30.48 m  $\times$  15.24 m. The pond was manured with 50 Kg of raw cow-dung, 10 Kg of lime (CaO) and 40 Kg of mahua oilcake. Subsequent observations revealed total mortality of the hatchlings. This could be attributed to predation by the heavy population of frogs and tadpoles which had developed in the pond subsequent to stocking. 9.25 lakhs of hatchlings were stocked in another untreated farm pond, but in this case also predation by the heavy population of frogs and tadpoles resulted in total mortality.

During October, the hatchlings were first reared in *hapas* fixed in the river bed for 2 to 3 days and they grew to 3.0-4.0 mm size. Amongst these, 1,00,000 were stocked in one pond 30.98 m  $\times$  15.24 m at Taraon fish farm on 22.10.70 and 1.25 lakh each in two ponds (No. 2 and 3), each measuring 45.72 m  $\times$  15.24 m, at Mogarson fish farm on 1.11.70 and 5.11.70, respectively. The pond at Taraon fish farm was manured with 62 Kg of raw cow-dung, 10 Kg of lime (CaO) and 2.5 Kg of each of ammonium chloride, urea, potassium nitrate and superphosphate. 60 Kg of mahua oilcake was also used primarily for the eradication of all fishes present in the pond. The pond was inoculated with Zn, Co and Mn. Hatchlings were stocked about 15 days after manuring, while 24 hr earlier to stocking, soap oil emulsion treatment was applied to control predatory insects. Hatchlings (3.0-3.5 mm) grew satisfactorily till December 4, 1970, to an average length of 27.4 mm in the range of 26-30 mm in 43 days of pond

life. At the time of next observation on December 24, 1970, it was observed that total mortality had occurred, the causes of which are under investigation.

At Mogarson, pond 2 was manured with 150 Kg of cow-dung, 10 Kg of lime (CaO) and 70 Kg of mahua oilcake, while in pond 3 only inorganic fertilisers; viz., 7.5 Kg each of urea and potassium nitrate, 15 Kg of superphosphate and 10 Kg of lime (CaO), were used in addition to 70 Kg of mahua oilcake. Both the ponds were inoculated with Zn, Co and Mn. Stocking was done nearly 3 weeks after manuring and soap oil emulsion treatment was applied 24 hr earlier to the release of hatchlings. During the first observation on 13.11.70, it was observed that total mortality had occurred in both the ponds, probably due to the heavy recurrence of predatory insects subsequent to stocking.

Hilsa hatchlings produced through artificial fecundation in October, 1969 and being reared in freshwater ponds, completed 14 months of life in pond on December 22, 1970 and had grown to an average length of 170.4 mm in the length range of 140-231 mm on December 24, 1970.

To start with, hatchlings were reared in two nurseries, number 3 and 4, which were stocked on October 13 and 24, 1969, respectively, and towards the end of 1969 they grow to average lengths of 50.1 and 53.0 mm in 80 and 70 days of pond life respectively. The rearing of the two stocks continued in the two ponds till July 3, 1970, when the respective average lengths attained in pond 3 and 4 were 187.6 and 136.7 mm.

Analysis of the data revealed that the increment in average length was minimum during the months of December and January, when the temperature of the water ranged between 8.0 and 23.0°C. The respective increments in the average lengths during the two months, in pond 3 were estimated to be 1.1 and 8.3 mm, while in pond 4 they were of the order 8.9 and 5.2 mm respectively. Thereafter the increment in length showed an increase of magnitude, being 19.5 mm in February and 39.3, 20.8, 30.0 and 19.6 mm during March, April, May, and June respectively in pond 3, while in pond 4 the respective increments were estimated to be 26.3, 14.3, 17.8, 14.5 and 3.7 mm. Thereafter the increase ranged between 6.0-13.0 mm per month.

*Studies on the food of hilsa in pond:* Examination of the gut contents of hilsa, being reared in freshwater ponds, had revealed that the fish of different lengths feed predominantly on zooplankton; like, rotifers, copepods, cladocerans, etc. A few blue-green algae were also encountered in the guts examined.

*Studies on the artificial feeding of hilsa:* To circumvent situations where the density of plankton in the pond decreases in levels when it cannot meet the total food requirement of the fish population present in the ponds, experiments were undertaken to adjudge whether artificial feed can be accepted by hilsa and if so, its quality and thereafter the quantity which will not only maintain the growth, as in natural environments, but would increase the growth coefficient, conversion ratio etc. Artificial feed comprising mustard

oilcake, rice bran, white been powder, in the proportion of 2:2:1 inoculated with traces of Co, Zn, and Mn was given to 8 specimens of hilsa (58 to 67 mm in T.L.) kept in markin *hapa* fixed in a pond. The examination of the gut after 24 hr, revealed the presence of artificial feed (20%) in the guts, indicating thereby that artificial feed is taken by the fish. Thereafter, the same artificial feed is being given to the fish daily @ 2% of the estimated total fish weight present in the pond.

*Project 20 : Water pollution*

Problem : 20.1 Pollution in the Hooghly-Matlah estuarine system  
 Duration : Three years  
 Personnel : P. Ray, V. Gopalakrishnan, S. B. Saha, B. B. Ghosh and D. D. Halder

The types of industries contributing to the pollution of the Hooghly estuary are : paper & pulp—6, textile—5, distillery—3, tannery—1, rubber—1, miscellaneous—13 and thermal power station—7. The domestic wastes and wastes from 55 jute mills and local municipalities also add to the pollution problem of the estuary.

Various hydrological factors ; *viz.*, turbidity, pH, DO, 5 day BOD and OC (30 minutes at 100 C°) in respect of various types of industrial wastes were determined and are presented in the table 26.

Table 26. Characterisation of wastes during the year 1970

Type of waste	Turbidity	pH	DO (mg/l)	OC (mg/l) (KMnO <sub>4</sub> value for ½ hr at 100°C)	5-day BOD at 20°C (mg/l)
<i>Biological</i> (Tanneries, cotton textile, pulp and paper, yeast and distillery)	<85—>1,000	5.0—>10.5	0.0—6.8	6—5,000	12—19,660
<i>Miscellaneous organic chemical Wastes</i> (paints and varnishes, shellac)	<85—>1,000	6.1—8.5	0.0—9.6	8—1,240	11—1,600
<i>Wastes chiefly mineral in nature or partly organic</i> (Rayon, match, metal and steel)	<85—763	<2.1—8.1	0.0—6.8	4—200	10—760
<i>Hydrocarbon waste</i> (Rubber)	<85	7.9—8.0	1.5—4.6	53—55	20—26
<i>Domestic waste</i>	<85—700	7.3—8.2	0.0—7.1	10—540	29—560

Total pollution load (industrial waste only) calculated in terms of B.O.D. was found to be 1.41 lakh Kg per day against 1.18 lakh Kg per day in the year 1969. Total pollution load contributed by the domestic waste and jute mill

waste was about 1.14 lakh Kg per day as B.O.D. The volume of domestic waste and jute mill wastes was about three times higher than that of industrial wastes, the discharge being about 175 and 57 mgd. respectively.

The hydrological studies of the Hooghly river showed no significant change in the chemical constituents from that of the last year. Although low concentrations of DO (3.7-4.9 mg/l) were noticed between Nawabganj-Baghbazar in February extending up to Garden Reach and Batanagar in March and June, it did not affect any aquatic life as B.O.D. and OC were observed to be normal. During April, May, and June, the concentration of plankton was low. The extent of pollution felt around the out-fall of India Pulp and Paper Mills, Tribeni Tissue, Kesoram Rayons, distillery and yeast factory and Dunlop Rubber Co., under neap tide conditions during the above months, revealed that the pollution effect was maximum around the out-fall of India Pulp and Paper Mills. The stretch of the river receiving these wastes, is shallow and wide with almost no flow, and DO was found to be nil up to a distance of 0.6 Km, unlike at other out-fall areas.

*(c) Research contemplated*

Over and above the problems on which work is continuing during the year relating to this report, a number of problems under different projects which could not be initiated in view of limitations of facilities and resources or which need confirmation, are envisaged to be taken up next year. These are listed below :

*Project 1 : Optimum per hectare production of fry, fingerlings and fish in culture fishery operations*

1.1 : Composite culture of fingerlings of indigenous and exotic species to study comparative production of large fish at the end of one year and two years.

1.2 : Evolving a balanced fish diet and to improve feeding technique

1.17 : Effect to irradiation on fish

1.18 : Role of some trace elements in pond fertilisation

*Project 2 : Induced fish breeding*

2.6 : Experiments on the production of multiple crops from the same individual of major carp in the course of one year

*Project 3 : Reservoir fisheries*

3.1 & 3.2 : Population dynamics of commercial fishes in the Tilaiya and Konar reservoirs

3.3, 3.4 and 3.5: Charting of bottom contour and scatter of tree stumps and quantitative assessment of initial fish fauna; control of total eradication of predatory and uneconomic species in the reservoirs for benefit of desirable fishes and evolving effective exploitation techniques for rational management of the reservoirs; viz., Loni, Govindgarh and Kulgarhi

3.8: Fisheries of peninsular tanks—introduction and propagation of cultivable species

*Project 4: Riverine carp spawn prospecting and collection techniques*

4.3: Assessment of the magnitude of spawn quantity that is being disposed off through road transport during the season

*Project 5: Brackish water fish farming*

5.1: Studies on (i) phreatic line and (ii) response of different fertilizers both inorganic and organic, on fish productivity

5.2: Contour survey of an area of 450 ha for fish farm in different parts of the lower Sunderbans

5.5: Studies on (i) estimation of optimum stocking rate in mixed and mono culture of fish and prawn, recording the relative economics using or without using supplementary feed, (ii) cause of disintegration of fertilised eggs of *M. parsia* on induced breeding and gonadal development in *L. calcarifer* and *M. tade* by hypophysation and (iii) optimal ratio of N:P, release of nutrient in salinity condition and the effect of cobalt chloride in increasing the productivity.

5.6: Survey of collection centres for *L. calcarifer* and *M. tade* seed

5.8: Induced breeding of grey mullet, *Mugil cephalus*

*Project 6: Freshwater prawn culture*

6.1: Culture of *M. rosenbergii* in nursery pond

6.2: Artificial propagation of *M. malcolmsonii* (in laboratory)

*Project 7: Murrel and live fish culture*

7.1: Induced breeding of *Channa marulius* and *C. punctatus*

7.2: Induced breeding of *Clarius batrachus* and survey of available resources of live fish

*Project 8: Estuarine and brackish water lake fisheries*

8.1 : Seed prospecting in the Matlah and Thakuran rivers below Canning and evolving methods of collection and transplantation of brackish water fish and prawn seed

8.3 : Studies on (i) induced breeding of *Mugil cephalus*, (ii) flora of the Pulicat lake and (iii) oysters of the Pulicat lake

*Project 9: Selective breeding and hybridisation*

9.2 : Liquid nitrogen, dimethyl sulphuride, coconut milk and physiological solutions other than Frog Ringer's and Moltfrecter's solutions will be tried as fish sperm preservative

*Project 10: Fish farm designing*

(Unit being set up)

*Project 11: Economics in fishery investigations*

11.1 : Economic evaluation of fish culture operations in West Bengal and Orissa

11.2 : Economic evaluation of various spawn production methods

11.3 : Economic evaluation of different weed control method

*Project 13: Cold water fish culture*

13.2 : Studies on the food and feeding habits of trouts

13.8 : Commercialisation of trout culture

*Project 14: Riverine and estuarine fish catch statistics*

14.1 : Alteration of sampling centres for catch statistics of the middle stretch of the Ganga river system

*Project 15: Fish pathology*

15.1 : Fish culture in jute-retting ponds

*Project 16: Weed control*

16.2 : Control of *Anabena* bloom

*Project 18: Ecology of Sewage fed fisheries*

18.1 : Collection of fish samples for gut analysis

*Project 19: Hilsa fisheries*

19.1 and 19.2 : Collection of hilsa larvae in live condition from the middle and lower stretches of the Ganga river system

19.3 : Exploration of the possibilities of Gadavari-hilsa culture in confined freshwater

19.4 : Determination of the characteristics of the Hooghly-hilsa shoals

*Project 20: Water pollution*

(Old programme will continue)

3. PAPERS PUBLISHED

The following papers were published by the staff of the Institute during the year 1970 :

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Soil nutrients and plankton production in fish ponds. A. Available soil phosphorus. *Indian J. Fish.* (A), 10 (1): 627-633.

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A note on seasonal changes of fat in rohu, *Labeo rohita* (Hamilton). *J. ind. Fish. Soc. India*, 1 : 139-142.

Barrackpore, Central Inland Fisheries Research Institute 1970

Annual Report, 1967: 58 p., 1968: 93 p. and 1969: 114 p.

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Half-yearly Technical Progress Report, July-December, 1969: 63 p. and January-June, 1970: 61 p. (Mimeo.).

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- 1968  
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- Jhingran, A. G. and D. N. Varma 1969  
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Gopalakrishnan, V.

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Jhingran, V. G. and V. Gopalakrishnan

Estuarine fisheries resources of India in relation to adjacent seas.

Saha, S. B., B. B. Ghosh and V. Gopalakrishnan

Plankton of the Hooghly estuary with special reference to salinity and temperature.

## 6. SUMMARY

During the year progress was made in 19 out of 20 projects and action was taken to set up the project on "Fish Farm Designing".

### *Project 1 :*

1.1: Composite culture of Indian and exotic carp fry in different combinations and at a stocking rate of 1 and 2.13 lakh/ha, yielded 1,582.1 and 1,701.7 Kg/ha/6 months. Composite culture of fingerlings of Indian and exotic species in different combinations and at a stocking rate of 6,000 (in three ponds) and 3,000 (in two ponds)/ha gave net productions of 2,129-2,314 Kg/ha/year and 1,308-1,422 Kg/ha/6 months. Rohu when cultured with exotic carps @ 5,000/ha in two ponds recorded a gain in weight of 299 gm in 9 months. Two ponds with stocking rate of 5,000/ha and one pond with 4,650/ha produced 1,098.3 and 1,613.5 Kg/ha/6 months in the former case, the gain in the weight being 1,016 and 1,082.3 gm for catla and silver carp respectively in 5 months.

1.2: Comparative study on the survival and growth of spawn and fry were tried with feeds; *viz.*, zooplankton, mustard oilcake+rice bran, silkworm pupae and groundnut oilcake+wheat bran, along with cobalt chloride.

1.3: For better survival, feeds (fish meal, bone meal, mustard oilcake, mustard oilcake+prawn powder, horse gram + millet + wheat bran and horse gram+millet+wheat bran+fish meal+prawn waste) and antibiotics (Chloromycetin, Hostacyclin and Entarocyclin) given to the fingerlings and spawn respectively, proved satisfactory. Cobalt chloride, boron and starch as growth promoters in common carp spawn were successful in yard and field experiments.

1.4: Urea, ammonium sulphate and ammonium nitrate were used as fertilisers @ 20, 50 and 80 kg N/ha and the medium dose gave better results in laboratory as well as in yard experiments, while these nitrogenous fertilisers responded much in alkaline soil type.

1.5: In Laboratory experiments with alkaline soils (unsterilised, sterilised + algae, unsterilised + phosphorus and sterilised + phosphorus + algae) the respective, increase in nitrogen were 12.1, 8.0, 38.5 and 28.0 mg N/100 gm of soil, indicating better fixation of nitrogen by algae in presence of phosphorus. In trials with acid soils, carp spawn gave better survival in algae treatment.

1.6: In a crude culture experiment of fish food organisms, mainly diatoms and a few phytoplankters grew better in ammonium sulphate—bone meal—potassium nitrate (5-15-3) at 230 ppm as compared to urea—double superphosphate—potassium nitrate treatment and control.

1.7: *Spirogyra* sp. was cultured in 3 litres of Czurda's solution and from 0.1 to 50 cc of the algae was produced in two months. From eggs, adults of *Cyclops* sp. were produced in 5 litres of 0.025% cotton seed extract in a month. *Moina* sp. had better survival in cotton extract + snail faeces. Sub-culture of *Chlorella* sp., *Gomphonema* sp. and *Navicula* sp. and stock culture of *Pinularia* sp. were continued

1.8: Fry of *Cyprinus carpio* were fed with 3 types of feed made from *Spirogyra* powder, plankton powder and fish meal. Chemical analysis for protein, fat, ash and carbohydrates for the individual feed ingredients, feed, resultant faeces and fish in the initial and final stages of the experiment were made.

1.9: Samples of two unproductive pond soils from Orissa and Tripura, treated with  $N_{40}P_{40}$  in 4 divided doses at an interval of three months, showed marked response to the fertiliser combination as measured by primary productivity.

1.10: Observations were made on one highly unproductive and one highly productive pond in acid soil zones of Tripura. The productive water had markedly higher organic content, dissolve phosphorus, organic nitrogen and ammonical nitrogen while unproductive water had higher nitrate nitrogen.

1.11: In an experiment to prevent seepage in fish pond, a percolation rate of 26 cm/hr was reduced to 8.8, 7.4 and 5.4 cm/hr with treatment. The seepage rate was further controlled in laboratory with 2% raw cowdung, 2.5% common salt, 2.5% caustic soda, 2.5% common salt + 2.5% caustic soda and 0.6% common salt + 1.0% caustic soda to 10.6, 2.1, 1.6, 1.25 and 0.6 cm/hr respectively.

1.12: *Barringtonia acutangula* seed powder at 15 ppm killed murels, catfishes, tilapia, carps and weed fishes within  $1\frac{1}{2}$  hr of its application. The toxic effect of the poison lasted for about 48 hr.

1.13: Specieswise estimation of population gave under estimate when capture-recapture method were employed in ponds with known population. Surface-, column- and bottom-feeders were underestimated by 2-15, 3-20 and 15-45% which led to the modification of the conventional drag net.

1.14: Carp spawn did not show any positive response to different colours of light, lights of different intensity and varied types of sound.

1.15: To make selective capture of predators and unwanted fishes from carp culture ponds, bamboo-, metallic- and fibre-trap were fabricated.

1.16: Growth rings and checks on opercular bones, vertebrae, otoliths and scales of rohu did not appear to indicate age of the fish accurately.

#### Project 2:

2.1: Twenty immature rohu (700 gm) were given 7 weekly injections of pituitary extract at 6 mg/Kg. They responded to hypophysation along with untreated controls.

2.2: Pituitary extract from *Pangasius pangasius* and *Silonia silonia* was equally effective as carp gland extract when applied on rohu. Application of Synahorin/HCG as contrast to Antuitrin—S (HCG) reduced the requirement of pituitary extract. Pituitary glands of *M. cephalus*, *L. Troschelli* and *Tilapia* sp. were ineffective in hypophysation.

2.3: Ampoules of carp pituitary extract in glycerine were distributed to 24 induced breeding centres. Reports have been received from 10 centres so far and excepting 2, all centres reported successful results. Carp pituitary glands preserved in acetone under refrigeration for 1½ years were found effective.

2.4: In a hatching jar (6.35 lt), 3.55 lakh spawn were produced from carp eggs, recording 100% hatching.

2.5: No distinct difference between the growth of advance fry of major carps obtained from induced breeding and that from riverine source could be noticed.

#### Project 3:

3.1 & 3.2: Studies on physico-chemical characteristics of water and soil, primary productivity, plankton, bottom boita, effect of impoundment on reproduction and survival of fishes, biology of commercial fishes, experimental fishing and fishery management and development in the Tilaiya and Konar reservoirs were taken up during the year.

3.3, 3.4 & 3.5: Investigations on hydrology, soil analysis primary productivity, plankton, bottom fauna, macro-vegetation, experimental fishing and biology of commercially important fishes were undertaken in the Loni, Govindgarh and Kulgarhi reservoirs. Besides, level survey in the Loni reservoir and investigations on the biology of uneconomic species in the Kulgarhi and Govindgarh reservoirs were also made.

3.6: Assessment of primary productivity, biomass production, plankton, littoral and benthic organisms and physico-chemical conditions of the water and soil were carried out in Hutchammankere, Sakalawera, Karpur and Bellandur tanks and Kadagrahara and Sidehoskote ponds. Biological investigations on *Puntius pulchellus* were continued.

3.7: Observations on annual fish production, gearwise catch and abundance of species were made in Bellandur tank for conservation of fishery.

#### Project 4:

4.1: Three riverine stretches; viz., (i) Gauhati to Dhubri in Assam (385 Km), (ii) Patna to Buxar in Bihar (150 Km) and (iii) Bud Bud Ghat to Lapan in West Bengal (25 Km), were surveyed to locate new spawn collection centres. About 12,785 ml spawn from Hamidabad on the Brahmaputra river, no spawn from Pairachali on the river Kangsabati and 2,546 ml spawn from Ahirauli on the river Ganga were collected.

4.2: The index of spawn quantity at Mahawapatti on the river Yamuna was 98.3 ml, while major carps contributed 17.2% to this spawn. Properties of shooting nets; viz., filtration rate, net size and mesh size effects, rate of spawn escapement from 1/8, 1/12 and 1/16" meshed nets and net selectivity were studied. Records of hydrological data were also maintained to standardise spawn collection techniques.

4.3: Commercial spawn export figures collected from Koelwar, Patna Jn., Fatwah, Bakhtiarapur, Barh, Jamalpur, Sultanganj, Bhagalpur, Colgong, Pirpanti, Sahibaganj, Rajmahal, Farakka, Nimita, Sajnipara, Jangipur Road, Gankar, Ajimganj Jn., Lalbagh Court, Tenya, Katwa Jn., Dainhat, Moharajpur and Lalgola were 1,918, 8,096, 225, 318, 190, 2,080, 2,287, 2,447, 3,138, 352, 5,505, 4,695, 5,332, 1,019, 870, 2,029, 778, 1,433, 665, 1,037, 1,627, 1,324, 1,771 and 3,385 *hudies* respectively showing a fall over the last year's total booking figure by 13.45%.

4.4: In a comparative growth rate study of spawn from sources; viz., Nowgong (bunhd-bred), Taraon (induced-bred), Buxar (of the Ganga river) and Allahabad (of the Jamuna river), the spawn reared upto fry stage under

identical condition had a survival rate 39, 191, 100 and 210 out of 600 respectively after 22 days, while the best growth among rohu, catla and mrigal were recorded in case of bundh-bred (29.1 mm), Ganga-bred (27.5 mm) and Yamuna-bred (38.2 mm) respectively. The respective best growths were 70.5 mm (Yamuna-bred) after 52 days, 81.0 mm (Ganga-bred), 80.0 mm (bundh-bred) and 109.5 mm (Ganga-bred) after 80 days and 85.5 mm (Ganga-bred), 85.0 mm (bundh-bred) and 117.4 mm (Ganga-bred) after 110 days rearing.

#### Project 5 :

5.1: Observations on rain fed ponds at Bakhali Fish Farm revealed that seepage through puddle core and non-puddle core dykes was negligible. The tidal amplitude at Bakkhali creek ranged between 16—520 cm. The salinity and primary productivity in the central pond 'K' ranged as 3.2-9.5‰ and 104-272 mg C/m<sup>3</sup>/hr. The survival of carp fry was better in 7‰ salinity against negligible in 12‰ while mullets, milk-fish and prawns were growing satisfactorily.

5.2: Lay-out plan for 243 ha area of Henry's Island to construct fresh water and brackish water fish farm has been completed. Bench marking in Dia Island and prismatic survey of Fredrick Island were carried out.

5.3 : To study different methods of stocking brackish water ponds with fish seed, wild and selective culture have been taken up. Studies on soil chemistry and sluice designs were continued while seed prospecting at Bokkhali creek was carried out.

5.4 : In salinity tolerance experiments rohu and catla fingerlings thrived well up to a salinity level of 5‰ while the fish exhibited reluctance to feed at 8‰ salinity, fasting at 11‰ salinity and total mortality at 13‰ salinity. Mrigal showed low tolerance (mortality 93%) even at a salinity of 5‰.

5.5 : Pilot investigations on (i) different stocking rates and ratios of fish and prawn, their survival and growth, effect of artificial fertilisers and removal of uneconomic species for better production, (ii) breeding of *Mugil parsia*, *M. tade*, *Lates calcarifer* and *Eleutharonema tetradactylum* through hormone injection and/or stripping and (iii) evolving suitable manuring and stocking rates, were carried out.

5.6 : Studies on (i) the role of tidal amplitude in relation to the lunar phase and calendar months in determining the extent of flooding the fish farm and quantitative availability of required species of fish and prawn, (ii) control of pond siltation, (iii) the compatibility of different species of herbivorous

fishes and prawns under mixed culture, (iv) establishment of ratio between carnivorous and forage fishes for proper utilisation of fish food, and (v) establishment of silt-clay and water volume relationship and effect of salinity on productivity were continued.

5.7 : Preparatory culture of *Cymbella* sp., and *Nitzschia* sp. in artificial and natural sea water was achieved. Under field condition *Gyrosigma* sp., *Synedra* sp., and *Pinnularia* sp., grew when treated with urea—mustard oil-cake—super phosphate—cow dung (1-4-8-12) and *Closterium* sp., *Amphora* sp., developed with the treatment of mustard oilcake alone at 10 and 20‰ salinity.

5.8 : For the first time in India, success was achieved in induced breeding and hatching of *Mugil cephalus* and the larvae could be reared for 6 days only.

#### Project 6 :

6.1 : In plastic pools, fry of *M. malcolmsonii* could be reared successfully for about two months. The fingerlings had very poor survival in plastic pools and nursery ponds due to oxygen depletion. Attempt to maintain oxygen level artificially did not prove satisfactory. Further trials are in progress.

6.2 : Investigation to propagate and culture *M. malcolmsonii* has been initiated in Kadium and Katheru Fish Farms, Rajahmundry.

#### Project 7 :

7.1 : Murrel breeders (*Channa striatus*), stocked for induced breeding experiment, spawned naturally. About 2,000 fry are being reared.

7.2 : Maturity stages of 55 specimens of *A. testudineus*, 70 specimens of *H. fessilis* and 25 specimens of *C. batrachus* were examined. Three sets of koi and two sets of singhi were induced bred and 10,750 and 4,000 spawn respectively were produced. 100 fingerling of koi could be obtained from 500 spawn. Hatchlings of singhi when fed with live plankton and treated with either yeast at 0.05 gm/l or cobalt chloride at 1 ppm in water showed a survival of 80 and 52% respectively as against 42% in control after 18 days.

#### Project 8 :

8.1 : Investigation on the brackish water fish seed resources at the Diamond Harbour, Namkhana and Port Canning stretches of the Hooghly-Matlah estuarine system were carried out.

8.2 : *M. rosenbergii* could not be reared beyond the fourth larval stage. Identification of stages between postlarval and adult stages of prawns occurring in the Hooghly river and location of prawn seed collection centres were continued.

8.3 : Studies on larvae and juveniles of fishes of the Pulicat lake were continued. Research investigations on (i) the biology and experimental feeding of mullets, (ii) bottom biota, (iii) hydrography, plankton and productivity, (iv) experimental fishing in the Pulicat lake, (v) food habits of *Penaeus indicus*, (vi) marking of prawn, and rearing of crab were also carried out.

*Project 9 :*

9.1 : Biological and genetical features of mrigal x catla, rohu x mrigal and rohu-calbasu x calbasu hybrids were studied.

9.2 : Sperms of *C. carpio* and rohu preserved in (i) GPC-5 solution + 3% glycerine under refrigeration and (ii) in coconut water for 3 hr did not fertilise eggs.

9.3 : The hybrids between common carp x silver carp and common carp x grass carp were produced for the first time in India. Observations on growth, maturity etc. are being continued.

*Project 10 :* (Not yet initiated)

*Project 11 :*

11.1 : Studies on economic evaluation of fish culture operations in three water bodies, two managed by the Government and one privately managed, in West Bengal were initiated.

*Project 12 :*

12.1 : About 1.01 lakh grass carp spawn and 0.41 lakh silver carp spawn were produced from 8 out of 38 and 14 out of 39 sets of the respective carps after hypophysation.

12.2 : Fingerlings of silver carp (average 46 gm) were cultured in two 0.12 ha ponds at a stocking density of 4,000/ha. They attained size of 700 and 458.5 gm in ponds, recording gross/net productions as 1,558/1,374 and 1,923/

1,739 Kg/ha/yr respectively. In another pond (0.12 ha), silver carp (average 6.0 gm) at 1,500/ha density attained 131 gm in one month.

12.3 : Grass carp when fed at 100 gm/day with guinea grass, cauliflower, cabbage or *Ipomoea* sp.; at 500 gm/day with guinea grass and at 125 gm/day with Ficus fruit, increased in weight by 28.5, 25.0, 14.0, 5.6, 30.0 and 12.5 gm respectively in one month as against a loss in weight by 1.9 gm in control. The record of growth increment in grass carp under regulated feed was maintained fortnightly.

### Project 13 :

13.1 : Regulated artificial feed in trout hatchery checked whirling disease. Injections with thiamin chloride failed to save diseased fish as the disease is detectable at a very late stage.

13.2 : (Not yet initiated)

13.3 : To standardise trout culture techniques, studies on (i) the stocking rates of egg, alevin and fry stages, (ii) different types of feed and (iii) control of fungus, white spot etc. were continued with much success. Rearing of breeders and hybridisation among trout have been taken up.

13.4 : Studies relating to propagation of mirror carp in hilly areas have been concluded. Fecundity was 1.84 lakh eggs/Kg body weight. Percentage hatching with *Hydrilla* sp. as attaching medium was 82.5 as against 54.0 with '*Kakabans*'. Incubation period below 30°C is 3-4 days and above 30°C, 2 days only. The percentage survival was 33.45, the highest being 75.00 in one month and 17.2 in one year. A fish (30 gm) grows fifty times in weight in one year, consuming food @ 1,000 gm/133 gm increment.

13.5 : Two stretches in the Ravi and Ujh stream were surveyed. The number of fry ranged as 62/m<sup>2</sup> and 17.34/m<sup>2</sup> respectively. The physico-chemical features were also noted. The respective percentage of nymphs and larvae of Odonata, Ephemeroptera, Plecoptera, Trichoptera, Diptera and Coleoptera were 2.66, 48.66, 9.99 14.25, 9.70 and 5.56 in one stretch and 6.26, 40.03, 0.91, 31.57, 9.14 and 4.91 in the other stretch among the insect populations.

13.6 : Two centres, Hazaratbal and Saidakadal, were selected to assess the productive potential of the Dal lake. Studies on physico-chemical features, surface plankton, and catch/ man/hr were continued. The dominant species recorded were *S. esocinus*, *S. nigor*, *S. micropagon*, *S. curvifrons*, *C. carpio*, *C. latius* and *Botia birdi*.

13.7 : Greel census of the trout streams Sind and Lidder in relation to ecological conditions have been completed. The angling pressure, maximum

surface plankton (i.e. in January), minimum surface plankton (i.e. in May), maximum insect population and minimum insect population were 104 rod/295 Kg 578 u/l, 83 u/l, 95 u/m<sup>2</sup> and 39 u/m<sup>2</sup> in the Sind and 326 rod 598 Kg, 1,255 u/l, 213 u/l, 169 u/m<sup>2</sup> and 71 u/m<sup>2</sup> in the Lidder. Detailed observations on various types of insects in the population and record of physico-chemical features of the regions were noted.

*Project 14 :*

14.1 : Mean landings per day could be best estimated on an arath basis as far as fish catch statistics of the middle stretch of the Ganga river is concerned. Hence, sampling survey was continued at Sadiapur, Rasulabad, Daraganj, Meja Road, Mirzapur and Chunar. Complete enumeration was done for landings at Buxar. The primary productivity in the Ganga and Yamuna rivers above the confluence and in the Ganga river below the confluence ranged as 300-1,557.5, 75-1,125 and 300-1,350 mg C/m<sup>3</sup>/6 hr respectively.

14.2 : The total estimated landing from Sultanganj to Lalgola stretch of the Ganga river system was 320.42 t against 400.08 t in the previous year. The landings at Bhagalpur, Rajmahal, Dhulian and Lalgola were 103.16, 57.86, 78.34 and 81.06 t respectively. The respective contributions of *C. mrigala*, *C. catla*, *L. rohita*, *L. Calbasu*, *M. aor*, *M. seenhala*, *W. attu*, *H. ilisha* and miscellaneous were 5.70, 10.83, 4.52, 1.09, 0.56, 10.54, 22.02, 121.72 and 135.36. In the river Ganga at Bhagalpur, the primary productivity ranged as 170-700 mg C/m<sup>3</sup>/day during the year. Estimation of plankton at Bhagalpur region of the Ganga was continued.

14.3 : Project has been completed in 1965.

14.4 : The total landings from the Hooghly-Matlah estuarine system were 7,626.6 t during December, 1969 to October, 1970. Bagnet among gears and hilsa among species caught contributed maximum ; i.e., 46.1% and 21.7% respectively.

14.5 : The total landing from the Pulicat lake was 1,170.964 t, registering a rise of 2.65% over the previous year's landing. The respective contribution of prawns, mullets, clupeids, crabs and perches in the catch were 566.54, 214.61, 125.57, 89.40 and 87.35 t. Stake net contributed maximum (378.40 t), being followed by drag net (273.65 t), shore seine (108.80 t) and hooks + lines (95.57 t).

*Project 15 :*

15.1 : A total of 1,699 spawn, 793 fingerlings of Indian major carps and 3,055 prawn were examined to detect parasitic diseases. In experiments to

explore the possibility of culturing air-breathing fishes in the jute-retted water bodies, total mortality of the test fishes was encountered and fishes were found to withstand oxygen deficiency for one day only.

#### Project 16 :

16.1 : Investigations to standardise the doses required for 2, 4-D sodium salt + detergent, 2, 2-Dichloropropionic acid and Gramoxone were continued in yard and field experiments for controlling weeds.

16.2 : Minimum effective dose of available weedicides to control algal bloom and their effect on fish and fish food organisms in the field were being determined.

16.3 : To evolve and evaluate weedicide formulations, Simazine, copper sulphate and Gramoxone were tried to eradicate weeds and to test the toxicity on fish.

16.4 : In field trials 1-1.5%  $\text{NH}_4\text{OH}$  solution + 0.25% detergent killed floating *Pistia* sp., and *Salvinia* sp., within a few days.

16.5 : 90% of *Hydrilla* sp., *Vallisneria* sp., and *Ceratophyllum* sp., were effectively controlled in a big lake treated with copper sulphate in mud pellets @ 75 kg/ha. Test fish in aquarium was found to absorb copper ions with a record of 1 mg Cu/100 gm of flesh in pre-treated condition and 4 mg Cu/100 mg of flesh in post-treated condition. Compost of eradicated *Hydrilla* sp., as manure released lot of nutrients and gave enough growth of plankton.

16.6 : The physico-chemical conditions required for healthy growth of *Vallisneria spiralis* were recorded. Vegetative reproduction and germination of seeds have been studied in details.

#### Project 17 :

17.1 : 32 and 8 sets of *R. tigrina* and *R. hexadactyla* respectively were induced bred by various methods. Standardisation of the technique of hypophysation was more or less completed. Attempt to induce breed *R. crassa* was met with cent per cent success.

17.2 : Canibalism was checked to 50-60% in the hybrids of *R. tigrina* and *R. crassa*. *Tubifex* sp., as a preferred food for all the stages between tadpole and adult frog, was successfully cultured. Stem bark of *Milletia auriculata* was found effective as a poison in assessing the survival of early tadpoles of *R. tigrina*.

17.3 : Early frogs of *R. hexadactyla* when stocked at 6,000/ha in a 0.04 ha weed infested pond attained a size of 96 mm/116.3 gm in 8 months.

17.4 : In joint rearing of *R. hexadactyla* and Indian major carps, 285.8 Kg/ha frog and 1,419 Kg/ha carps were produced, while in isolated culture of fish and frog, 1,925 and 378.2 Kg/ha productions respectively were obtained.

17.5 : No further progress has been made to build up stock of *R. catesbeiana*.

#### Project 18 :

18.1 : Observations on physico-chemical features of the sewage fed pond of Titagarh Municipality were continued since September, 1970. Primary productivity during September to December varied at 217.22-639.22 mg C/m<sup>2</sup>/hr. The soil samples and bottom fauna are being analysed. In the plankton samples, zooplankton and phytoplankton ranged as 420-3,660 u/l and nil-4,100 u/l respectively.

#### Project 19 :

19.1 : Observation on winter spawning of hilsa was continued at Sirsa, Vindhyachal, Sindhraghat, Sujabad and Mahewapatti. Hilsa bred mostly during mid and end of October. The larvae preferred to be at the surface or sub-surface waters. Morphometric studies of hilsa were continued.

19.2 : Hilsa constituted 38.16% of the total fish landing from the lower sector of the Ganga river system, registering a decline of 31.64% over the previous year's hilsa landing. The percentage compositions of 'broader', 'broad' and 'slender' varieties of hilsa were 49.58, 26.42 and 24.16 respectively. The distributional pattern of different varieties at Bhagalpur, Lalgola, Dhulian and Rajmahal was studied. Larval abundance of hilsa in the Ganga was also recorded at Bhagalpur stretch.

19.2 : Migration of hilsa to Dowleiswaram anicut grounds was poor. Studies on maturity and fecundity were continued on the basis of market sampling.

19.4 : In the stretch from Tribeni to Datrigram, appreciable number of hilsa larvae were obtained from Balagarh while Tribeni was very poor. As no spawn was available below Balagarh, the spawning ground appears to be restricted above Balagarh. The maximum concentration of larvae was at Datrigram (106/net/hr).

19.5 : Success was achieved in 14 out of 15 sets of experiments for artificial fecundation in hilsa. In one case of failure, the breeders died 90 minutes ahead of the trial. The percentage hatching ranged between 40-90. An attempt has been made to correlate the physico-chemical features with the rate of hatching. Rate of hatching was also tested in nylon *hapas* against marking *hapas*. Studies on transport of hilsa spawn and rearing of hatchlings in confined waters were continued. Studies on the food of hilsa, both natural and artificial, in pond have been taken up.

*Project 20 :*

20.1 : Investigations on the characterisation of wastes from paper and pulp mills, textiles, distilleries, tanneries, rubber and miscellaneous industries, thermal power stations, jute mills, municipalities and domestic sources were continued to examine the pollutional affect of these wastes in the Hooghly-Matlah estuary.

The quantity of waste discharged to the Hooghly river was 175 mgd from jute mills and domestic sources and 57 mgd from industries. Hydrological studies of the river were continued. Effect of discharge around out-fall of Indian Pulp and Paper Mills, Tribeni Tissues, Kesoram Rayon, Distillery, Yeast Factory and Dunlop Rubber Factory were noted.

## 7. PERSONNEL

*Retirement:* Shri A. C. De, Administrative Officer of this Institute retired from service in the afternoon of July 31, 1970.

*Promotions:* The following promotions have been made during the year under report.

<i>Name and Designation</i>	<i>Promoted as</i>
Shri R. M. Bowmick, Assistant Fishery Scientist :	Junior Fishery Scientist
Shri G. Lahiri, Stenographer :	PA-cum-Stenographer
Shri N. K. Srivastava, Junior Survey Assistant :	Survey Assistant
Shri D. K. De, Junior Survey Assistant :	Survey Assistant
Shri D. K. Rao, Junior Survey Assisntnt :	Survey Assistant
Shri A. R. Mazumdar, Artist :	Artist Photographer
Shri S. P. Ghosh, Laboratory & Field Assistant :	Junior Survey Assistant
Smt. S. Mazumdar, Junior Clerk :	Senior Clerk
Shri D. Bhuloka, Fisherman :	Fieldman

*Transfers:* The following transfers have been made during the year under report.

Shri B. N. Saigal, Assistant Fisheries Scientist	:	From Bhagalpur to Barrackpore
Shri A. Chowdhury, Senior Survey Assistant	:	From Namkhana to Diamond Harbour
Shri A. R. Chowdhury, Survey Assistant	:	From Diamond Harbour to Namkhana
Shri D. K. De., Survey Assistant	:	From Kakdwip to Barrackpore
Shri R. M. Rao, Research Assistant	:	From Barrackpore to Bangalore
Shri P. R. Das, Research Assistant	:	From Hazaribagh to Port Canning
Shri K. Singh, Junior Clerk	:	From Allahabad to Rewa
Shri R. L. Raikwar, Fieldman	:	From Panna to Rewa
Shri Mewalal, Fieldman	:	From Rewa to Bhagalpur
Shri A. K. Sarkar, Fieldman	:	From Calcutta to Barrackpore
Md. Samood, Fieldman	:	From Allahabad to Calcutta
Shri Ganga Ram, Fieldman	:	From Bhagalpur to Loni
Shri A. Rahaman, Fieldman	:	From Lalgola to Bhagalpur
Shri K. Prasad, Fieldman	:	From Allahabad to Loni
Shri K. L. Chakraborty, Fieldman	:	From Namkhana to Hasnabad
Shri M. Iruthiraj, Laboratory Boy	:	From Barrackpore to Madras
Shri R. D. Saha, Laboratory Boy	:	From Allahabad to Taraon
Shri B. P. Pandey, Laboratory Boy	:	From Rewa to Govindgarh
Shri L. K. Parbat, Peon	:	From Barrackpore to Calcutta
Shri S. Bhowmick, Peon	:	From Calcutta to Barrackpore
Shri B. Narasappa, Peon	:	From Madras to Pulicat
Shri Budhi Bahadur, Watchman	:	From Cuttack to Barrackpore
Shri Hari Bahadur, Watchman	:	From Cuttack to Kakdwip
Shri Bhim Bahadur, Watchman	:	From Barrackpore to Cuttack
Shri Karna Bahadur, Watchman	:	From Kakdwip to Barrackpore
Shri Golab Shaw, Watchman	:	From Barrackpore to Cuttack
Shri N. C. Jena, Fisherman	:	From Rewa to Lalgola
Shri L. Somulu, Fisherman	:	From Arambakkam to Pulicat
Shri R. N. Tiar, Boatman	:	From Kakdwip to Bhagalpur
Shri J. R. Das, Chainman	:	From Kakdwip to Fregergunj

*Staff:* The following staff rendered their services to the Institute during the year under report.

Director	:	Dr. V. G. Jhingran
Deputy Director	:	Dr. Y. R. Tripathi

## 1 Freshwater Fish Culture Division (Cuttack)

### 1.1 Central Inland Fisheries Research Substation, Cuttack (Orissa)

Fishery Scientist	:	Dr. H. Chaudhuri (on FAO service), Dr. M. T. Philipose and Dr. A. K. Mondal
Junior Fishery Scientist	:	Sarvashri V. Ramachandran, S. B. Singh, R. D. Chakraborty, M. A. V. Lakshmanan and R. M. Bhowmick
Assistant Fishery Scientist	:	Sarvashri K. Raman, K. H. Ibrahim (on other service under Tanzanian Govt.), S. Patnaik, G. N. Saha, P. R. Sen and T. Ramaprabhu
Research Assistant (Sel. Grade)	:	Shri A. K. Banerjee
Research Assistant	:	Sarvashri A. C. Nandy, D. K. Chatterjee, M. D. Rout, D. P. Chakraborty, D. S. Murthy, M. M. Bagchi, G. V. Kowtal, P. C. Chakraborty, P. Gopalakrishna, R. K. Jhana and G. C. Panicker (upto 5.3.70)
Survey Assistant	:	Shri P. V. G. K. Reddy
Accountant	:	Shri P. C. Kanungo
		and others

### 1.2 Central Experimental Fish Farm, Panna (Madhya Pradesh)

Research Assistant	:	Shri C. Selvaraj
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## 2 Riverine Division (Allahabad)

### 2.1 Central Inland Fisheries Research Substation, Allahabad (Uttar Pradesh)

Fishery Scientist	:	Sarvashri H. P. C. Shetty and J. C. Malhotra
Assistant Fishery Scientist	:	Sarvashri K. K. Ghosh, Ravish Chandra, Dr. A. G. Jhingran and Shri D. V. Pahwa
Research Assistant (Sel. Grade)	:	Sarvashri V. R. Desai, S. N. Mehrotra, P. K. Mathur and M. Y. Kamal
Survey Assistant (Sel. Grade)	:	Sarvashri S. P. Singh and S. Jana
Research Assistant	:	Sarvashri M. R. Sinha, A. G. Godbole, S. D. Gupta, S. C. Pathak, B. Singh, S. K. Das, P. N. Jaitly and P. M. Mathew
Survey Assistant	:	Sarvashri R. K. Sexena, S. K. Wishard, G. N. Srivastava and N. K. Srivastava
Head Clerk	:	Shri K. B. Rajani
		and others

## 2.2 Central Inland Fisheries Research Unit, Bhagalpur (Bihar)

Junior Fishery Scientist	:	Dr. G. N. Mukherjee
Research Assistant (Sel. Grade)	:	Shri K. V. Rao
Research Assistant	:	Sarvashri B. L. Pandey and R. N. Seth
Survey Assistant	:	Sarvashri S. N. Sar, R. K. Bhattacharya (up to 31.1.70) and R. C. Singh

and others

## 2.3 Small Reservoir Unit, Rewa (Madhya Pradesh)

Junior Fishery Scientist	:	Shri S. J. Karamchandani
Research Assistant (Sel. Grade)	:	Shri G. K. Bhatnagar
Research Assistant	:	Sarvashri D. N. Misra, J. B. Rao, H. C. Joshi and Shri Prakash
Survey Assistant (Sel. Grade)	:	Shri K. P. Srivastava
Survey Assistant	:	Sarvashri M. D. Pisolkar and R. K. Dwivedi

and others

## 2.4 Krishna Godavari Unit, Rajahmundry (Andhra Pradesh)

Junior Fishery Scientist	:	Smt. T. Rajyalakshmi
Assistant Fishery Scientist	:	Shri Y. Rama Rao (on long leave)
Research Assistant	:	Sarvashri P. L. N. Rao, G. R. M. Rao and L. H. Rao
Survey Assistant	:	Shri T. S. Ramaraju

and others

## 3 Estuarine Division (Barrackpore)

### 3.1 Estuarine Fisheries Research Substation, Barrackpore (West Bengal)

Fishery Scientist	:	Dr. V. R. Pantulu (on ECAFE service) and Dr. V. Gopalakrishnan
Junior Fishery Scientist	:	Shri P. Datta
Assistant Fishery Scientist	:	Dr. M. Subrahmanyam, Sarvashri P. Ray, A. Ghosh, H. A. Khan and Dr. C. S. Singh (up to 22.8.70)
Research Assistant (Sel. Grade)	:	Sarvashri S. B. Saha and B. B. Ghosh
Survey Assistant (Sel. Grade)	:	Sarvashri S. N. Datta and A. Chaudhury
Research Assistant	:	Sarvashri N. K. Thakur (on long leave), K. K. Bhanot, S. K. Mukhopadhyaya, Shrimati K. K. Bhanot, Sarvashri G. C. Laha, P. U. Verghese, P. R. Das, K. Alagaraja (upto 21.9.70) and M. V. Gupta (upto 25.4.70)

Survey Assistant : Sarvashri D. D. Halder, P. B. Das, B. K. Saha, R. N. De, A. R. Chaudhury, R. K. Chakraborty and D. K. De

Computer : Shri P. M. Mitra  
and others

### 3.2 Estuarine Fisheries Research Unit, Kakdwip (West Bengal)

Junior Fishery Scientist : Shri A. N. Ghosh

Research Assistant : Sarvashri S. R. Ghosh, N. K. Das and L. K. Das

Survey Assistant : Sarvashri P. K. Pandit and H. S. Majumdar  
and others

### 3.3 Pulicat Lake Unit, Madras (Tamil Nadu)

Assistant Fishery Scientist : Shri Ch. Gopalakrishnayya

Research Assistant (Sel. Grade) : Shri K. N. Krishnamurthy

Research Assistant : Sarvashri S. Radhakrishnan, A. V. P. Rao, R. D. Prasadam, C. P. Rangaswamy and M. Kaliyamurthy

Survey Assistant : Sarvashri H. Srikant, K. J. Rao, S. Srinivasagam, K. S. Rao and D. R. Rao  
and others

### 4 Reservoir Fisheries Research Unit, Hazaribagh (Bihar)

Fishery Scientist : Shri A. V. Natarajan (on ad-hoc basis)

Assistant Fishery Scientist : Sarvashri S. P. Ayyar and B. V. Govind

Research Assistant : Sarvashri S. K. Sarkar, M. Ramakrishnaiah and M. A. Khan

Survey Assistant : Sarvashri B. Ray, B. K. Banerjee and S. L. Kar  
and others

### 5 Tank Fisheries Research Unit, Bangalore (Mysore)

Fishery Scientist : Dr. A. David

Research Assistant : Sarvashri S. Lakshmiraghavan and R. M. Rao  
and others

### 6 Coldwater Fisheries Research Unit, Srinagar (Kashmir)

Junior Fishery Scientist : Shri K. L. Sehgal

Research Assistant (Sel. Grade) : Shri K. V. Ramakrishna

Survey Assistant (Sel. Grade) : Shri M. J. Bhagat

Research Assistant : Sarvashri K. L. Shah, C. B. Joshi and Kuldip Kumar

Survey Assistant : Shri Shyam Sundar  
and others

### 7 Pathology Unit, Barrackpore (West Bengal)

Assistant Fishery Scientist : Shri R. N. Pal  
Research Assistant : Shri A. K. Ghosh

### 8 Sunderbans Survey Unit, Kakdwip (West Bengal)

Fishery Scientist : Shri B. B. Pakrasi  
Junior Fishery Scientist (Engineering) : Shri A. Sengupta  
Draftsman : Shri A. B. Mukherjee  
Senior Research Assistant : Shri N. C. Basu  
Survey Assistant : Shri M. K. Mukhopadhyaya  
Overseer : Shri P. N. Bhattacharjee  
and others

### 9 Soil Chemistry and Weed Control Unit, Calcutta (West Bengal)

Junior Fishery Scientist : Shri S. M. Banerjee and Dr. (Miss) E. Mitra  
Research Assistant (Sel. Grade) : Sarvashri S. C. Banerjee, S. C. Thakurta and A. C. Banerjee  
Senior Research Assistant : Shri R. K. Banerjee  
Research Assistant : Shri M. K. Banerjee  
and others

### 10 Fishery Economics Units

Junior Fishery Scientist : Shri M. Ranadhir

### 11 Library and Documentation Unit

#### 11.1 Sewage Fed Fisheries Unit cum Documentation Unit, Barrackpore (West Bengal)

Junior Fishery Scientist : Shri B. N. Saigal  
Research Assistant : Shri R. R. Khan  
Reference Collection Assistant : Shri P. K. Chakrabarti  
and others

## 11.2 Library

Librarian : Miss Anjali Ghosh  
and others

## 11.3 Studio

Senior Artist : Shri J. Ghosh  
Artist Photographer : Shri A. R. Mazumdar  
and others

## 12 Administrative Section, Barrackpore (West Bengal)

Administrative Officer : Shri H. N. Mukherjee  
Superintendent : Sarvashri S. N. Chakraborty and P. K. Sthanapati  
PA-cum-Stenographer : Shri G. Lahiri  
and others

## 13 Stores Section, Barrackpore (West Bengal)

Superintendent : Shri S. K. Chatterjee  
Senior Store Keeper : Shri K. C. Roy  
and others

## 14 Accounts and Audit Section, Barrackpore (West Bengal)

Accounts Officer : Shri B. N. Das  
and others